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How can the UAE Government best promote a successful national innovation Ecosystem?

By

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List of Abbreviations

AI	Artificial intelligence
BII	Bloomberg innovation index
CEO	Chief executive officer
DARPA	Defence Advanced Research Projects Agency
EDI	Electronic data interchange
EU	European Union
GCI	Global competitiveness index
GDP	Gross domestic product
GII	Global innovation index
IARPA	Intelligence Advanced Research Projects Agency
IAS	Institute for Advanced Study
IMF	International Monetary Fund
IP	Intellectual property
KBE	Knowledge-based economy
KIST	Korean Institute of Science and Technology
KPI	Key performance indicators
MBR	Mohammed Bin Rashid
MBRIF	Mohammed Bin Rashid Innovation Fund
MBRIC	Mohammed Bin Rashid Innovation Centre
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
PISA	Programme for International Student Assessment
PPP	Purchasing power parity
PR	Permanent residency
R&D	Research and development
RIS	Regional innovation system
ROI	Return on investments
RTO	Research and technology organisations
STEM	Science, technology, engineering, mathematics
UAE	United Arab Emirates
US	The United States of America
VC	Venture capitalist
VoIP	Voice over Internet Program

Acknowledgments

"The real asset of any advanced nation is its people, especially the educated ones, and the prosperity and success of the people are measured by the standard of their education." His Highness the late Sheikh Zayed bin Sultan Al Nahyan -the founding father of the UAE-.

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Declaration of Originality

I declare that this thesis 'How can the UAE Government best promote a successful national innovation Ecosystem?' is my own work and no part of the dissertation has been previously submitted to any other university for any degree, diploma or other qualification. Previously submitted work by the author in the form of a reviews and conference presentations are drawn on for parts of this thesis. When reference is made to the work of others, the extent to which it has been used is indicated in the text and bibliography. Any errors or omissions within this thesis are the sole responsibility of the author.

This document contains 83,866 words, excluding bibliography and appendices, and therefore adheres to the requirements of Warwick Business School, University of Warwick.

Signature:

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Professor Mark Skilton

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Research Question

How can the UAE Government best promote a successful national innovation
Ecosystem?

Abstract

This thesis aims to develop a framework for the UAE to activate its national innovation
ecosystem. The present study was guided by the following research questions: What is
the current nature of the national innovation ecosystem that exists in the UAE? What are
the main drivers that influence or hinder a sustainable (educational) innovation-based
national ecosystem? How can the UAE Government best promote and activate a
successful national innovation ecosystem? These questions were answered using
qualitative and quantitative methods to gather data about innovation in the UAE. A total
of 24 semi-structured interviews were conducted and thematically analysed,
representing the qualitative aspect of the study. Then, 207 descriptively analysed
surveys were conducted, providing quantitative data. These were used to validate the
qualitative findings. An initial draft of the national innovation framework was developed,
which was validated through further semi-structured interviews with six influential
policymakers from the UAE national ecosystem of innovation. Their input was considered
carefully and used to refine the final version of the framework.

1   Introduction

1.1   Introduction

The research begins with the broad aim of developing an education-based framework for the activation of a national innovation ecosystem in the United Arab Emirates (UAE). In line with this aim, the following objectives are established: to understand why the UAE should create a sustainable (educational) innovation-based ecosystem, to evaluate how the UAE Government can best promote a successful national innovation ecosystem and to identify the main drivers (e.g., cultural, political, regional) that influence or hinder a sustainable (educational) innovation-based ecosystem. The first chapter will establish the background of the study and outline the conceptualisation and evolution of the national innovation system. Specifically, the chapter outlines the institutional actors, interactive learning processes and institutional intermediaries within the system. Chapter 1 also outlines institutional incentives and competencies, as well as new conceptual boundaries and process dynamics of national innovation systems. The chapter then outlines the functions, process dynamics and politics of national innovation systems, as well as the innovation intermediaries. The national innovation system concept is examined in the context of rapidly emerging economies and less-developed countries, and the internationalisation of national innovation systems and industry associations in developing countries is explored.

1.2   Background

Since the Organisation for Economic Co-operation and Development (OECD)'s landmark publication about managing national innovation systems in 1999, the national innovation system framework has become increasingly popular. It was first developed as a theory, concept and analytical perspective used to study the flow of technology and information among people, enterprises and institutions. This systems-based theory diverged from earlier theories prevalent during the 1950s, 1960s and early 1970s, which were characteristically linear. Economic growth was often studied using these linear theories, which typically presented innovation as being dependent upon scientific discoveries, followed by their application.

According to Godin (2009), the first version of the national innovation system was called 'science-push' (Godin, 2009), and then another version, known as 'demand-pull', followed. Demand, research and development (R&D), construction and sales were important factors in these systems (Godin, 2009; Manley, 2003). The first structural

theory, called the 'chain-connected model', centred on the interconnection among basic science, marketing, production and R&D (Manley, 2003; Godin, 2009). In this respect, innovation is viewed as an interactive and complex operation. Freeman (1982) and Lundvall (1985) first developed the theory and definition of national innovation structures in the 1980s to understand technological innovation because of the dynamic interaction between institutions (Lundvall, 2007). In the 1990s, research, technology and innovation studies started to follow this conceptual structure to analyse innovation processes (Freeman, 1995; Lundvall, 1992; Lundvall, 2007; Nelson, 1993). Godin (2009) has shown that the 'method approach' has grown, thanks in part to the OECD's contribution in this field and its early work from the 1960s. Overall, the theory of national innovation systems emphasises that the flow of technology and knowledge between individuals, companies and organisations is essential to the creative phase of innovation. Therefore, innovation and technology advancement results from a complex collection of interactions between the system's participants, including businesses, universities and government research institutes (Godin, 2009).

A distinct aspect of the national innovation system is the participation of the country's research framework in this dynamic collection of relationships. Godin notes that the ultimate aim of the research system is innovation and that this involves a broader network of sectors such as government, universities, industry and the environment. As the 'trigger' explaining the success of innovation structures, the structure also stressed the relationships between the components or sectors. The theory behind the national innovation system relies on the assumption that enhancing technical efficiency requires relations between the actors involved in innovation.

Innovation and technological advancement are the products of complex interactions among actors that produce, transmit and apply different information (OECD, 1997). McKelvey (1998) views innovation as a new way of doing things: redesigning an existing product for a niche market or changing how a company operates (OECD, 1997). The definition of the national innovation system also includes two major categories: business institutions and non-market institutions (Manley, 2003). These two categories are considered together to influence the course and pace of innovation and technology diffusion in a region (OECD, 1997). As Freeman put it, 'it is a network of public and private sector institutions whose activities and interactions initiate, import, modify and disseminate new technologies' (Freeman, 1987 in OECD, 1999:10). Notably, this theory of the national innovation system was primarily developed by observing the innovation systems of developed countries (Freeman 1987; OECD, 1999). Sharif's definition follows: 'the totality of institutions and practices that interact to produce and diffuse new

technology is taken to be the national system of innovation' (Sharif, 2006:84). Here, the national innovation system is considered as a system that can be studied in the context of the appellation of the British national innovation system, the US national innovation system, the UAE's national innovation system and others.

The value of the innovation mechanism in relation to new technology was generally recognised during the 1990s and 2000s, and its use started to spread in developed and developing countries (OECD, 1999). Meanwhile, the importance of the dissemination of information in the innovation process became an object of considerable interest. Consequently, awareness to achieve and accelerate sustainable economic growth has been described as a catalyst (OECD, 1997; 1999). This contemporary view has been widely accepted (OECD, 2005) and, especially in developing countries, has had a major effect on innovation strategy and policy. The OECD stated: 'Individual institutions' contributions are not considered in isolation, but with how they communicate with each other as components of a collective structure of information formation and use and how they interact with social institutions (e.g., principles, standards, legal frameworks)' (OECD, 1999:24). In this interaction, the government can play a key role through its policy options and regulations.

Approaches to the innovation system, underpinned by the framing of perceptions and norms of developed countries, have been extended to developing countries without much adjustment. The national innovation framework can also be used as a policy instrument or model to steer national innovation systems. The government's interest in the national innovation system as a policy tool is particularly useful for this study. It points to the concept that national innovation system is viewed as a policy tool in relation to the policy circle (Lundvall, 2007:1), which offers policymakers a realistic coherence to plan and implement their policies. It can be considered as a policy narrative through which policymakers frame their policies. Godin captures this aspect when he says that 'Policy-makers construct their problem through conceptual frameworks that structure policy action' (Godin, 2009:5). With the support of policymakers, the national innovation system can be considered 'a technology that allows us to … make things work in the world' (Morgan and Morrison, 1999:32). In this thesis, the concept of the national innovation system as a policy tool in the UAE (and its sectoral development strategy) is investigated. The UAE has recently launched its National Vision 2021, depicting the country's endeavour to become a leading nation in innovation. One of the most important aspects of this vision is the UAE's transformation from the traditional picture of an oil-based economy to a knowledge-based economy. With this transformation comes the idea of developing a top-class educational system. Both public and private sector education in

the country has now been focusing on the practical application of knowledge. As mentioned in the National Agenda, the priorities of the country include an investment to drive R&D activities, improving the standard and quality of education system and fostering innovation. These priorities are essentially focused on transforming the country into a knowledge-based economy.

With this vision, Ahmed and Alfaki (2013) noted that the UAE is trying to expand its economy and move away from its dependence on hydrocarbons. The study also noted that the country is focusing on the participation of UAE nationals in the country's workforce. This process is known as Emiratisation. Through its efforts to upgrade the economic system, D'Mello (2018) noted that UAE has now been positioned as the most diversified marketplace in the entire Middle East. In 2018, the World Economic Forum ranked the UAE 17th out of 137 economies using the global competitiveness index (GCI). Thus, the culture of the country promotes innovation and development.

1.3   National innovation system: Early concepts and approaches

The concept of the national innovation system was initially introduced by Freeman (1982, 1987) as a response to Washington and neoclassical approaches to development, deriving partly from List's ideas (1841) and his conception of domestic production systems. There has always been a connection between the idea of a national system of innovation and public policy (Sharif, 2006). Based on the work of Nelson and Winter (1982) as well as the theory of economic growth through innovation, Freeman and Lundvall (1985, 1988) and Nelson (1990) stated that the neoclassical models of economic growth are inefficient because they fail to consider the role of innovation and technological change. This is a drawback because the roles of science, technology and innovation are not accounted for, and are increasingly shaped by global competitive forces. Technological change and creativity are central to economic growth—an idea Freeman emphasised as evident since before the industrial revolution, and which Schumpeter already founded (1939, 1942). In this perspective, innovation is interpreted not only as the function of individual organisations but as a collaborative movement involving combinations of experience, knowledge and competence. Therefore, nations will have different innovation capabilities (Patel and Pavitt, 1994).

The idea of the national innovation system asserts that governments and joint initiatives can and do play a pivotal role in generating and spreading innovation in a national economy, contrary to the neoclassical perception of economic development. In his study of the Japanese post-war 'catch-up' strategy, Freeman (1987) addressed this issue.

Institutions are important; they can build and encourage an atmosphere by which mutual expertise and resources could be more freely transferred to develop innovation and creativity in companies that are becoming more diverse and unstable (Freeman and Soete, 1997).

1.3.1 Institutional actors and interactive learning

Pioneering studies first explored commercially advanced nations to understand national innovation systems (specifically, OECD countries). Governments and associated agencies that promote innovation through policy, capacity building, public–private partnerships and financing fundamental research, as well as industry sectors generating business innovations via exploration, are key institutions comprising the national innovation framework identified in early research (Patel and Pavitt, 1994). Innovative capacity-building interactions between institutions, defined by Lundvall (1992) as a variety of user–producer relations that facilitate information sharing that contribute to mutual knowledge and learning as defined by Arrow (1971), are vital (Lundvall, 2007; Nelson and Winter, 1982).

The concept of the national innovation system also builds upon other concepts of innovation theory—that learning is a stochastic and continuous process based on efficient feedback mechanisms between stakeholders and entities that correct inventory, R&D and commercialisation. It is important to focus on the dynamic and path-dependent essence of technological transformation through the concept of the national innovation system. Therefore, recognising innovation involves history and analysis, which again differs sharply from neoclassical economics (Freeman, 1995). Importantly, the first emphasis was on identifying structures, and the first goal was to capture the national structure of innovation at the macro level of analysis; the conceptualisation and recognition of the system within the framework instead of the underlying mechanisms (Lundvall, 2007).

Early establishment of the national structure for innovation concentrated on corporations (large and small) as core agencies for developing and commercialising innovation (Patel and Pavitt, 1994). In this context, the other key institutions play an important yet supportive role. Governments typically include incentives and legislative backing, while academic institutions cultivate new technologies and talent that recolonise the entrepreneurial ecosystems and R&D sectors of high-tech industries. Subsequent work will challenge the firm-centred strategy of national innovation by considering universities as central to the country's research infrastructures, such as Mode 2 and Triple Helix

(Etzkowitz and Leydesdorff, 2000; Leydesdorff and Etzkowitz, 2001). These concepts and the regional nature of the innovation system depend on interactions between primary institutions, especially between universities and industry (Lundvall, 2007).

How to inform an innovation environment was not a focus of early publications. The role of governments, as an almost passive player in the dynamics of the national innovation system, involved interacting with other institutions to provide a secure, supportive and productive competitive environment. Again, much of this may be attributed to the macrolevel focus of early work and the emphasis on connections between university and industry and mutual collaboration and input between companies. An alternative view is that the strategy should not be permitted to describe the early national innovation framework. That is, the concept of an early national innovation system largely omits the political processes that inform governments and affect national innovation. This literature on the early national innovation framework does not consider organisations (e.g., businesses) that work with the state by advising and negotiating innovation and growth criteria and incentives.

1.3.2 Institutional intermediaries

A significant effort has been missing from the key national structure for innovation: to recognise and justify the operation of organisations known as 'other public and private organisations' beyond their supposed and somewhat vague 'educational' function. In research about emerging technologies (technology innovation structures), the network opportunities created by cooperative learning concepts started to concentrate on specific stakeholders and institutions from an intermediate point of view: businesses and organisations, which were able to promote the sharing of information by linking (i.e., combining) common and complementary actors. Carlsson and Stankiewicz (1991), whose aim is to draw on mutual knowledge to solve problems for individual companies, proposed that intermediary companies should be involved in a 'bridging institution' in specific industries. More broadly, Stankiewicz (1995) and Lynn et al., (1996) describe superstructural organisations linking and networking in a system of creativity and offering shared goods to members. These intermediaries are not well known or represented. However, there is a possibility to promote knowledge transfer among policymakers and innovators via intermediary institutions (Kelly, 2003; Van der Meulen and Rip, 1998). Examples of intermediaries include study councils, various financial bodies and universities. These intermediaries must be defined as institutional actors that will help form the whole innovation system (institutional environment and governing structure).

Early studies led to a consideration of the intermediaries' role, but not from an innovation structure perspective.

Knowledge collection and sharing occurs through networks. Intermediaries are searching for the information relevant to the network (e.g., participants, incidents and trends inside or outside the network), are gathering and bundling this information and sharing it with network members (Hargadon and Sutton, 1997). This can include current and evolving technology, new products and processes, new laws and future partners and competitors (Aldrich and von Glinow, 1992; Turpin et al., 1996; Wolpert, 2002). The latter can contribute directly to the establishment or growth of such a network by sharing information with network participants (Kogut and Zander, 1992). The intermediary serves as the critical selection mechanism for the network by bringing together similar or complementary players. This helps to determine who will play a part in the network and to what extent, and so makes it easier to move technology and distribute it through alternative technology (Rosenfeld, 1996). The intermediary could also contribute to the network's collaborative culture and structure (Rosenfeld, 1996) by supporting certain network standards (e.g., frequency and modes of interaction between members). Finally, once collaborative relationships between network participants are established, intermediaries may help manage and strengthen these connections, allowing for a collaborative process (Davenport, Grimes and Davies, 1999). They will encourage partnership growth by recognising and addressing the changing needs of the parties. As coordination becomes more explicit and nuanced, the intermediary is the point of contact between parties (Luukkonen, 2005).

Business organisations are not involved in this early intermediary discussion, as already outlined. This omission is shocking, as the intermediaries mentioned above require data collection, the distribution of collective goods and the education of policymakers. The absence of industry associations from the literature in early innovation systems may be due to the negative connotations assigned to them, and the significant inability of politics to define the early national innovation system. Many politicians and economists have indicated that they are sceptical of the role of businesses in innovation and growth. For example, in The Wealth of Nations, Adam Smith accused industry groups of playing a negative role in the economy as early as the 18th century, plotting against the public and raising commodity prices. In recent years, business groups have been viewed as special interest organisations trying to make small rents to a restricted number of members, to the detriment of the larger market and the economy (Olson, 1982; Schmitter and Streeck, 1999). In addition, Cawson's work demonstrates that corporations, in certain political contexts, may also endanger democracy (Cawson, 1982).

1.3.3 Different institutional incentives and competencies

As previously noted, the early structures of the domestic innovation system were mostly drawn from developed countries. When the OECD countries of the time are considered, some differences in incentives and competences between these countries can be identified. For example, the Japanese national innovation system (Freeman, 1987; 1988) showed that the government–industry partnership centred heavily on regulatory protection and funding for applied research in some industries (e.g., automobiles and consumer electronics), which provided less funding for basic research and far less emphasis on university-led research. In comparison, the supposedly deteriorating resilient economy in the US was attributable to a national innovation framework that provided strong government funding for fundamental science, high levels of defence funding and the university's research system that effectively connected fundamental research activities with emerging technological industries (e.g., see Nelson, 1988; 1993).

Innovation frameworks in countries such as Germany, Sweden and Switzerland have proven to be especially strong, particularly in promoting privately financed R&D. There, large corporations engaged in chemical and advanced engineering (production and defence) dominate (Ray, 1989). Countries such as Italy and Portugal, as opposed to other Western European countries, displayed relatively poor national innovation structures (Patel and Pavitt, 1994).

However, early definitions of the national innovation structure were not entirely restricted to OECD countries. The idea of the national innovation structure first came to light for the least developed countries in the South (Nelson, 1993) in the context of increasing concerns about economic development and future models. The idea of a national innovation system was quickly adopted in East Asia's fast-growing economies, particularly South Korea, Taiwan, and Singapore. Freeman's highlights Japan as an illustration of successful economic catch-up, compared to Western Europe and the US, where economies in many areas of technology are now being overtaken (Freeman, 1995; Kim, 1993; Nelson, 1993; Mowery and Oxley, 1995). Studies in East Asian countries revealed variations between national systems of innovation (Wong, 1999), but certain features were similar. Similarities included government involvement; promotion of key industries; carefully designed policies to promote international technology, reverse engineering and latecomers' rapid technology transformation; patent enforcement support; the reliance on public education; and the building of technical staff (Nelson, 1993). These countries witnessed strong economic growth, combined with initially lower labour costs (Chang, 1999).

The national innovation systems of these East Asian countries were especially striking because they endorsed and guided innovation strategies that effectively combined protectionism for key indigenous industries with a degree of system transparency. This enabled those industries to adopt, leverage and develop advanced economic technology and organisational practices. While such activities primarily reflect the flow of technology and expertise, their popularity in the early literature of national systems of innovation has given the impression that successful systems of innovation have needed a degree of transparency and receptivity to external ideas and information. It is Bell and Pavitt (1993) who say that effective government policy to create national innovation capacity (e.g., effective relations between universities and industry) has divided the Asian Tigers from the Latin American (Argentina, Mexico and Brazil) industrial economies (Alcorta and Peres, 1998; Viotti, 2002). They claim that many Latin American economies lacked sustainable growth and competitiveness because of inefficiencies induced by socialist regimes for many decades. However, in extending the idea of the national innovation framework to developing nations, Arocena and Sutz (2000) suggest more than just a lack of institutional capability. Although many developed countries are technologically skilled and excelled in different sectors, they often function in isolation to anything that resembles an organised system of institutions, as defined in the national system of innovation.

Arocena and Sutz (2000) also argue that the supremacy of the partnership between stakeholders and institutions, fundamental to the definition of the national innovation system, was often lacking at that time: 'In Latin America, it is a relatively easy task to create organisations to foster innovation, but it is quite difficult to make them operate as bridges between people' (Arocena and Sutz, 2000:56). The implementation of a national system of innovation in developing countries is also complicated by the normative tendencies of the definition of national innovation systems, which constantly confer an innovation system and often quickly correct inefficient paths of industry advancement and maturity (i.e., good and bad national innovation systems) (e.g., ICT and biotech). The implementation of domestic innovation mechanisms in developing countries, based on less technologically oriented, more slowly developing industries (such as farming and craft industries), may be more likely to fail.

The research presented here included alternatives for the construction of effective innovation systems for sustainable economic development. Diversity in national innovation systems was captured across developed and newly industrialised countries, and the role of institutional actors as facilitators of collective learning for innovation was presented. This offered developing countries a possible policy development roadmap,

while also highlighting the substantial structural differences between the developed North and most of the developing South.

1.3.4 New conceptual boundaries and process dynamics of national innovation systems

Although Porter's (1990) theory of the 'competition advantage of nations' became a policy necessity for catch-up, early concepts of the national innovation system received criticism for being too open to interpretation, to the extent that they were too unrealistic to be understood (Miettinen, 2002). As a result, many principles have been established so that innovation 'at other economic levels than the nation state' is based on creative systems, theory and ideas for collective learning and path dependence (Lundvall, 2007:100).

The first approach to technology systems was Carlsson and Stankiewicz's (1995), which started with a specific technology and looked at the impact on production and distribution among actors and institutions (Bergek et al., 2008). The second was Breschi and Malerba's (1997) sectoral systems of innovation approach, which argued that innovation could be better understood by considering a variety of products and a particular range of agents interacting in networks in the development, production and selling of those products. These agents have sector-specific expertise and are informed by organisations' experience, which can be both local and international. Breschi and Malerba primarily argued that agents provide insight into the relationships and improvements between industries, and, thus, sets of technologies over time. The third approach was the regional innovation system (Asheim and Isaksen, 1997; Cooke et al., 1997). This approach aims to better understand innovation as a local or regional phenomenon, where interactions, information sharing and learning occur in geographical proximity and between connected locations. The RIS focuses on the idea that high-tech creative business needs to accommodate a range of high-capability metropolitan regions—in which high-tech companies, academic universities, financial and legal institutions, state agencies and skilled workers are located—and that tacit and asymmetric information flows are best communicated.

Although these approaches to technology systems have provided crucial answers to the idea of the national innovation scheme, Lundvall (2007:100) proposes that 'these are not alternatives to the analysis of national systems. They have important contributions to make to the general understanding of innovation in their own right'. They should be viewed as complementing and contributing to the national innovation system concept:

'To compare sectoral, regional and technological systems across nations is often an operational method for understanding the dynamics at the national level' (Lundvall, 2007:100). Although these techniques derive new insights into how developments arise and propagate through a system context, the emphasis is on how interactions affect the creation of new ideas and technologies, rather than how such interactions affect and shape the innovation system itself. At least initially, these approaches do not adequately connect technological change and innovation processes with institutions' capacity-building and governance processes.

1.3.5 Functions, process dynamics, and politics

The discussion above looked at how innovation systems promote the appearance and spread of innovation, and at the degree to which such systems are successful in doing this outside the largely systemic context provided by the national definition of the innovation system. Jacobsson and Johnson (2000) have suggested an approach to innovation systems that first defines the fundamental functions of an efficient system of innovation, and then evaluates the relative significance of the different functions and related interactions in the innovation process and the increasing ability of a given system of innovation. Interestingly, the collection of functions eventually defined can be used to understand innovation systems at various analytical levels from technology and industry to regional and national innovation systems, while mainly implementing them in technical innovation systems (i.e., microsystem standards) (Markard and Truffer, 2008). Based on previous studies that undertook the innovation systems functional approach (e.g., Bergek et al., 2005; Edquist and Johnson, 1997; Jacobsson and Bergek, 2004), Hekkert and colleagues (2007) propose a list of seven primary functions that effective innovation systems support: (1) entrepreneurial activities, (2) collective learning, (3) knowledge diffusion through networks, (4) technology selection/promotion, (5) market formation, (6) resource mobilisation and (7) technology legitimacy/overcoming resistance. Importantly, these functions and their interactions lead to virtuous rounds of creative operation, whereas a lack of any single function or interaction leads to system shortfalls and failure.

To verify the functions above, studies by Bergek, Hekkert and Jacobsson (2008) and Hekkert and Negro (2009) use a historical event analysis approach developed by Van de Ven and colleagues (1999; 2000) to map the events, interactions and processes associated with the successful production and marketing of various clean technology systems and their technological innovations (e.g., biofuels and solar cell technology). The 2008 and 2009 studies identified common patterns and trajectories in system functions and interactions. In reaction to exogenous events and developments,

governments offer incentives to promote investment in specific fields. These incentives encourage business practices leading to experimentation, knowledge-sharing and new technologies and production processes. This performance diminishes uncertainty and facilitates increased investment, mobilisation of capital and subsequent business growth. In some situations, virtuous cycles are characterised by violent cycles that require additional lobbying from the industry and more political corrections (e.g., if initial legislation proves ineffective) (Hekkert and Negro, 2009).

Three essential notions of institutional dynamics within innovation structures can be learned from technical innovation from these case studies. First, the effective creation and marketing of new technologies are the products of interactions and links among microbusiness processes and institutional macroelements. These interactions intentionally and recursively connect corporate processes to broader industry activities and government policies—these interactions shape and form technological innovation systems (Kaiser and Prange, 2004). In these case studies, the government initially encourages entrepreneurial activities at the national level. It then reacts to the demands of emerging technology manufacturers and a fragile yet emerging market. Second, it is generally industry organisations known for lobbying governments for greater incentives and favourable business conditions on behalf of entrepreneurs and the industry—industry associations play the role of institutional intermediaries. Lastly, the existence and interplay of virtuous and vicious cycles indicate that policies and agreements between organisations are both unavoidable and important, as shown by industry association activities. The mechanisms are used to educate the institutions, adapt their policies, provide incentives, develop industry standards and create favourable conditions in the market.

1.3.6 Innovation intermediaries

The above case studies are some of the first to recognise industry associations as key players in the innovation process and position them as institutional intermediaries in the innovation framework literature. This is a small and growing area of research, which explores the role of so-called innovation intermediaries in the transfer of information and technology between partners and along increasingly complex production and supply chains (Howells, 2006). Intermediaries include industry-specific technology consultancy firms and corporate service providers, wider governance and policy consultation firms and risk-funding outlets such as risk capital companies.

A case study by Howells (2006) focuses on the different roles of intermediaries in the UK. Besides the intermediate functions, including information gathering and packing, intelligence and partnership brokering, and technology selection, Howells describes a range of additional functionality provided by the intermediaries. These include, but are not limited to market and industry prediction, technological research, diagnosis and other validation work.

Work involving legislation and arbitration is also listed but to a lesser extent (Howells, 2006). The absence of industry organisations from the possible innovation intermediaries is noteworthy given the various roles defined, particularly those that are not usually connected with direct technology dissemination and diffusion activities (e.g., work on standardisation, intellectual property security and regulating). Dalziel (2006) explored the role of industry associations in Canada in one of the few trials that intentionally linked industry associations and innovation, arguing that market associations allow innovation by bringing member firms together (e.g., legitimising member firms through industry directories and promoting network cooperation) that provides knowledge. Dalziel (2006) also indicates that the absence of scientific and political literature by non-profit organisations, such as business associations, on national innovation systems is due the secondary view that this literature gives social experiences—that is, the structures of the players and access to a more theoretical approach to the idea of the national innovation system (e.g., industry associations).

Lyytinen (2001) explored the role of industry associations in the adoption of electronic data exchange technology in three countries: Denmark, Finland and Hong Kong. Their work shows that industry associations play an important role in spreading new technology, particularly regarding adoption, training and standardisation. Later, Kautto (2007) illustrates how companies with leading European industry associations, like Nokia, have worked on building coalitions between big companies to directly lobby the European Commission. The study explains how they have influenced the drafting of the European Union (EU) directive of 2005 on electronic equipment, which imposes new environmental and efficiency requirements.

1.3.7 Applying the national innovation system to rapidly emerging economies and less-developed countries

Although most innovation system studies were based on the advanced northern economies, at levels other than the nation state (technology, sectoral and local innovation systems), a concerted shift was made towards the study of national innovation

systems in developing countries. Many of these studies centred on the large and rapidly growing economies of China, India, and to lesser degree Brazil, and shifted away from the newly industrialised economies of East Asia (Intarakumnerd and Vang-Lauridsen, 2006). In particular, China and India emerged rapidly as global economic forces, following consecutive government policies to increase economic liberalisation. These policies include China's 'open door' policies of the late 1970s and market reforms of the 1980s and 1990s (Mathews, 2009). Although the policies varied between both countries because of historical and cultural backgrounds, the methods used for catch-up purposes were quite similar. These included greater openness to external trade and direct foreign investment, denationalisation of certain industries (China) and opening indigenous industries to global competition. There was also more funding for private and business operations, and coexisting policies towards advancing technology, maturations and global orientation of indigenous industries (Krishnan, 2003; Motohashi and Yun, 2007).

Mathews (2009) argues that these liberalisation policies are reminiscent of the Japanese and newly developed countries' earlier rallying strategy. In China, these policies include programmes and incentives to adopt foreign production technology, decentralisation of national R&D efforts from state institutions and universities to business enterprises, the promotion of collaborations between indigenous and foreign companies and the creation of numerous business areas and science parks (Leydesdorff and Guoping, 2001; Sun, 2002). First, China's economic growth and rising living standards across its population are virtually inextricable due to these policies. In comparison, Gu and Lundvall (2006) argued that China, which has been focused on modernising its indigenous manufacturing industries for decades, has introduced vulnerabilities in its national system of innovation; particularly weakening basic research capability and high-tech entrepreneurship. They argue that China's inability to absorb advanced foreign technology and to build and grow domestic high-tech industries has been influenced by systemically inadequate interactive learning on organised markets. In comparison, China's robust research universities and expertise in areas such as aerospace, as well as the already rising indigenous industry in computational electronics and pharmaceuticals, has allowed India to build on its historically strong science and engineering base, establish a world-class, global focused ICT industry and become an increasingly emerging leading country for medical equipment (Herstatt, Tiwari, Buse and Ernst, 2008; Krishnan, 2003).

However, unlike China, India has failed to bring about a widespread improvement in living standards, with a substantial portion of India's population remaining in poverty. Several points need to be considered when analysing China and India's economic liberalisation policies and subsequent domestic innovation programmes. The state has

played an important role in China and India by introducing reforms and influencing the mechanism of innovation. However, it can be argued that China's innovation system, a single party commodity and a central-planner tendency, relies heavily on downstream knowledge (i.e., the macroinformed administration and the structural and bureaucratic powers of the state and its agencies). India's innovation system exists in a more pluralistic state (i.e., the government acting more upon information from both industry and civil society). Therefore, China may be less capable than India in meeting the demands of evolving of ever complex industries like ICT and biotech, hindered by its attempts to develop and expand certain industries internally. India's pluralism may permit some industries or actors to dominate upstream policies that are advantageous to governments but disadvantage the broader economy and underdevelopment.

These structural and political variances may affect China and India's involvement in and reaction to external information, capital and trade flows. In line with Gu and Lundvall's claims, it is possible that the lower-level domestic innovation regime in China may more effectively protect the interests of indigenous industries, to the detriment of absorbing and improving radical innovations from abroad; India's national innovation framework may do so at the cost of its indigenous people while it is more capable of integrating global R&D flows. In light of the prominence of global interactions and interdependencies among most high-tech industries, the question emerging is how the inclusion of international information and technology in a national innovation framework is informed and negotiated.

Another fascinating case of the emerging economy in this sense is in Brazil. A small number of studies on Brazil's national innovation framework have captured a large and emerging economy that has struggled to build its innovation capacities despite its size and vast resources. In 2002, Viotti argued that Brazil had struggled because of its relatively poor education system, creating a labour force whose capacity to absorb and develop external technology was inadequate. For example, Brazil followed a policy approach focused on promoting foreign direct investment. This approach included policies that made it easier for MNCs to introduce foreign direct investment operations in the country.

As highlighted by Viotti, Brazil was efficacious in promoting foreign investment: 'foreign subsidiaries were estimated to be responsible for 33% of whole industrial sales in the Brazilian domestic market, and for 44% of industrial exports, during 1990' (Viotti, 2002:670). However, Viotti argues that Brazil's MNCs activities were almost entirely manufacturing focused and remain so, because the Brazilian workforce was mostly low-

skilled. Moreover, Brazil focused strongly on incentivising MNCs to the detriment of predominantly crowded indigenous producers. Brazil emerged as a global export leader in raw materials, agriculture and more recently in aviation and biofuels, leading to substantial economic gains over the last 10 years, adopting a more oriented and rather protectionist export policy (e.g., steel and agribusiness) (Mathews, 2009).

Hall (2005) suggests that less-developed countries, especially those from sub-Saharan Africa, could develop national systems of innovation based on their strengths in farming to establish indigenous biotechnology industries. Brazil's success with agriculture and biofuels is informative (Hall, 2005). A 2005 study by Lall and Pietrobelli looks at national innovation systems in sub-Saharan Africa, including Ghana, Uganda, Kenya, Tanzania and Zimbabwe. They point out that, in some of these nations, government agencies that focus on agriculture seem 'potentially' better placed in support of viable R&D efforts than any other agency. But, they conclude that the majority of R&D institutions in these countries 'generally lack the facilities (physical and human) to provide meaningful support to industrial enterprise … they have no means of assessing the technological needs of industrial enterprise or of diffusing to them the few technologies they have created [or adapted]' (Lall and Pietrobelli, 2005:334). Because of this, 'the institutions carry little credibility with the private sector' (Lall and Pietrobelli, 2005).

Some sub-Saharan African countries are examining policy initiatives to establish their indigenous agriculture biotechnology industries (agriculture and healthcare). However, Hall (2005) points to continued structural failure, particularly the lack of effective linkage at the local level between government institutions and industry. They also point towards some progress in the institution-building around those initiatives, notably in the connections between national institutions (such as R&D institutes, universities) and institutions in the developed North. This will hinder the growth of indigenous industry due to the lack of successful diffusion and input from national to local and vice versa. Interestingly, Hall (2005:621) suggests that international bodies and associations should 'have played an important role in brokering partnerships' between research institutions in developing countries 'and both public and private organisation' in the developed North. This raises the question as to whether non-governmental organisations (NGOs) and other organisations may also play a similar role in developing countries, promoting the exchange and distribution of knowledge and information between national and local governments (e.g., industry and civil society) to better link and integrate local and development priorities and needs with global technology and knowledge.

1.3.8 Internationalisation of national innovation systems and industry associations in developing countries

The concurrent ideas that domestic innovation systems operate within an increasingly global framework and that various national innovation systems have different potential for competition and innovation date back to the earliest iterations of the national innovation system (Niosi and Bellon, 1994). The terms internationalisation or globalisation are used, sometimes interchangeably, in three forms within the national innovation framework literature. The first definition refers to transferring the national innovation system concept to the development context, initially designed on frameworks from developed countries. Although transferability is a long-standing term, its application in developed countries is more recent. The second definition refers to the traditional literary practice of comparing the national structures of innovation of various countries, mostly between developed countries. The third principle is to what degree global linkages and interactions define the national innovation environment of a country (i.e., how open they are to external knowledge flows). International cooperation and the setting of global standards between leading research universities are illustrated in early literature (Pietrobelli, 1996); however, studies based on the global R&D activities of MNCs are even more popular (Patel and Pavitt, 1999; Pavitt 2002).

The overall feeling in national innovation system literature is that the institutions that regulate interactions are mostly national, but international linkages are increasingly significant (Carlsson, 2006). In developmental contexts, this integration relates to the idea of a national framework of innovation. First, there is a growing recognition that successful national systems of innovation need significant internal information flows and links with innovative potential in other countries. Therefore, the pursuit of global connections may enable the creation of efficient national innovation frameworks as capacity-building mechanisms. Second, how the external flows are negotiated within the context of the national innovation system are not only relevant but controversial for developing countries. Thus, development policy would play a major role in shaping these countries' innovation environment. Development policy, produces, rules and regulations for certain relationships with innovative industries and form 'growth coalitions' (Leftwich, 2009; Scerri and Lastres, 2013). Third, intermediaries, such as industry associations, are likely to be key players in working with governments to build healthy business environments for growth and industry innovation.

1.4 Research aim

This research aims to develop an education-based framework for the activation of a national innovation ecosystem in the UAE.

1.5 Research objectives

The objectives of this research are:

- to understand why the UAE should create a sustainable (educational) innovation-based ecosystem
- to evaluate how the UAE Government can best promote a successful national innovation ecosystem
- to identify the main drivers (e.g., cultural, political, governmental, regional) that influence or hinder a sustainable (educational) innovation-based ecosystem
- to propose a framework that the UAE can implement to activate its national innovation ecosystem.

1.6 Research questions

1. Why should the UAE create a sustainable (educational) innovation-based ecosystem?
2. How can the UAE Government best promote a successful national innovation ecosystem?
3. What are the main drivers (e.g., cultural, political, governmental, regional) that influences or hinder a sustainable (educational) innovation-based ecosystem?
4. How can the UAE activate its national innovation ecosystem?

1.7 Overview of research methodology

Because this research focuses on understanding the current innovation environment in the UAE and what changes can be implemented to develop a robust national innovation ecosystem, an interpretivist approach has been selected. The interpretive and pragmatic method is suitable to address the project's overall aim, as it provides room for qualitative analysis of the quantitative data. The quantitative data will uncover an accurate picture of the UAE's innovation ecosystem. Importantly, the quantitative data will be descriptive. Although the research is primarily based on the qualitative data, and draws from an interpretivist epistemological stance, quantitative data will help gain more fruitful research results.

The availability of research time was stated by Saunders, Lewis and Thornhill (2012). It may be straightforward to conduct a short-term study using the deductive method, but this approach may require adapting to an existing theoretical model. Conversely, inductive reasoning takes longer and requires time to gather and to evaluate knowledge in detail. The amount of risk the researcher is prepared to tolerate is a significant factor in this relation. However, a deductive approach may often lead to problems like the return of the questionnaire and hence to a low answer rate.

Research into innovations systems in the UAE is scarce, and the literature available focuses on the environment of nations other than the UAE. Therefore, an exploratory study is necessary. This study also involves an overview of the creative ecosystem of the UAE: whether it exists or is required. A mixed approach is appropriate for this study as it enables the collection of descriptive information about the current state of the country's regime and gives insights into the qualitative study, so that the UAE's domestic innovation ecosystem may be enabled. This thesis often considers qualitative interpretation and takes a more subjective approach, based on interpretive theory, in gathering quantitative data.

For gaining an in-depth understanding of the UAE's national innovation ecosystem, a mixed-method approach is suitable. The central question that guides the research seeks to understand the measures that can best promote a successful national innovation ecosystem in the UAE. Following this, research questions are formulated around understanding the fundamental question as outlined above. These questions look for the current condition of (educational) innovation-based ecosystem in UAE, the need to create a sustainable innovation-based ecosystem and identify the various factors that affect the development of the ecosystem. Thus, a mixed-method research design is adopted to measure and assess the different aspects of the UAE's innovation ecosystem.

The present study is inspired by the vision and mission of the UAE and, therefore, has chosen UAE as the research setting. From a policy perspective, the research aims to define the ideal national innovation ecosystem that can create sustainable programmes to drive economic transformation. A national innovation ecosystem will serve the dream of the country to have a self-sufficient and growing economy. Such an ecosystem will enhance knowledge-sharing activities, promote alliances between the industries, business, government and academic institutions and encourage innovation. This sort of collaboration will also enhance the optimal use of scarce resources and encourage recycling.

1.8   Structure of the thesis

Chapter 2 will provide a deeper insight into national innovation systems research and critically evaluates the same. **Chapter 3** critically analyses key countries that have already established national innovation systems to derive best practices that can be applied to the UAE. **Chapter 4** presents and justifies the research methodology, and **Chapter 5** outlines the results from interviews. **Chapter 6** discusses the results obtained in the context of prior research, provides the results of the triangulation, and proposes the framework. **Chapter 7** concludes the study, outlines the contributions of the research and evaluates the limitations. Finally, Chapter 7 provides recommendations for practitioners and future researchers.

2 Literature review

2.1 Introduction

The UAE has outlined strategies to establish itself as a knowledge-based economy. According to Webb (2000), a knowledge-based economy has three characteristics: emphasis of investment in innovation, increased technological dependencies and a highly skilled and educated human capital. In addition, the knowledge-based economy can be defined as having increased dependence on and usage of information, knowledge and complex skills, which can be used by all the sectors to enhance their economic gains (OECD, 2005). The trend is usually observed in advanced economies and developing economies that strive for higher economic standing.

A country needs to establish a robust system of innovation that is driven by policy and change to transform into a knowledge-based economy. In the following sections, the concept of a national innovation system is discussed. This is important, as the national innovation system of a country allows it to tap into innovative and technological resources and generate high knowledge output. As this study is seeking ways in which the UAE can create an education-based national innovation system, it is crucial to gain a primary understanding of the same. Furthermore, the concept of a national innovation system is evolving into being an 'ecosystem'. Thus, it is important to understand the basic concept of the national innovation system to then understand the concept of the national innovation ecosystem. Later in this section, the importance of clusters, university–industry collaboration and a culture to innovate is provided, highlighting these as core components of a national innovation ecosystem.

This chapter concludes by developing a definition of the national innovation ecosystem, given the current lack of a unified definition. The definition given here will serve as the basis of this research.

2.2 How to define a national innovation system

2.2.1 What is innovation?

The word 'innovation' is being used increasingly in today's world, so much so that corporate organisations and academic institutions alike are promoting innovation across all their operational areas (Kahn, 2018). Kahn (2018) has stated that innovation is not merely a means to an end but can also be a process and a mindset. Put simply; innovation is the creation of a new product, or change in an existing product or process, which can lead to economic growth either by conserving resources or by adding new

revenue streams for entirely new products or services. Lundvall (2000) states that innovation:

> Is a ubiquitous phenomenon in the modern economy. In practically all parts of the economy, and at all times, we expect to find ongoing processes of learning, searching and exploring, which result in new products, new techniques, new forms of organization and new markets. (Lundvall, 2000:8)

Norman and Verganti (2014) have identified two types of innovation: incremental and radical. The central concept of incremental innovation involves questioning how current systems can be improved. Making small changes to a product or system over time, thereby increasing its efficiency and resource utilisation, is the essence of incremental innovation. Conversely, radical innovation is best termed as a 'breakthrough'; it involves new things that have not been explored before. Radical innovation disrupts current systems and presents new processes and behaviours.

2.2.2 Levels of innovation

Several innovation theories (Kirzner, 1973; Schumpeter, 1942) view the innovator at the firm level. Nevertheless, theories have been extended to include firms operating at a country level, as well as to national regulations and government policies (Feinson, 2003). There are several systems of innovation: technological, regional and national. Edquist (2005) has stated that an 'innovation system' consists of networks and actors who are engaged in the creation of innovation that can then be distributed and utilised.

Mark and Truffer define a technological innovation system as 'a set of networks of actors and institutions that jointly interact in a specific technological field and contribute to the generation, diffusion and utilisation of variants of a new technology and/or a new product' (2008:611). A regional innovation system is like a national innovation system, but with the collaboration between the actors and networks taking place at a regional level rather than a national level (Cooke et al., 1997). Silicon Valley in the US is an example of a regional innovation ecosystem.

2.2.3 National innovation systems

Over the years, many definitions for the national innovation system have emerged, and Lundvall (2010) concludes that the meaning changes based on the authors who use the concept differently, even as the term has entered the vocabulary of policymakers at the national and international level. He stated that a national innovation system could be thought of as a social and dynamic system that is categorised by learning as its core

principle, as well as positive feedback and reproduction processes. Freeman (1995) described a national innovation system as an integrated network run by intricate interactions between several public and private sector institutions, which seek to develop, transmit and gain new technologies.

Lundvall (1992) described the national innovation system as being situated within a nation's borders, involving the creation and use of knowledge in an economically useful manner. Nelson and Rosenberg (1993) characterise a national innovation system as an interaction between the institutions, which ultimately contributes to the innovative competence of national organisations. Another definition of a national innovation ecosystem can be understood as a system that comprises of 'institutions and economic structures affecting the rate and direction of technological change in society'. Niosi, Sa, Bellon and Crow (1993) expanded the definitions of Freeman and Lundvall, stating that the interaction between public or private sector institutions can be commercial, legal, technical, social or financial. The goal of the interaction will be developing, regulating, financing or protecting new technological advancements.

Patel and Pavitt (1994) identify a national innovation system as the determinant of the 'rate of direction and technological learning (or the volume and composition of change generating activities) in a country'. Metcalfe (1995) gives a broad explanation, which describes the system as a:

> 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. (Metcalfe, 1995:38)

The rationale for the increased importance of the national innovation system has been outlined by the OECD (Kayal, 2008) as being due to three primary factors. The first factor is that there is an increased understanding of the influence of knowledge and technology on economic growth. The second factor concerns itself with a generalised increase in the usage of a systems approach, and the third factor is simply the increasing number of institutions involved in knowledge creation. The OECD has identified four paths of knowledge flow in a national innovation system that take place between the actors involved: '1) interactions among enterprises; 2) interactions among enterprises, universities and public research laboratories; 3) diffusion of knowledge and technology to firms; and 4) movement of personnel' (Kayal, 2008:13).

All four knowledge flow paths can influence the national innovation outcome. For example, interactions among enterprises can maximise the utilisation of limited resources and, therefore, maximise R&D output. Knowledge generated by research universities can be utilised to solve problems faced by enterprises, and advanced technology can be shared, particularly among the technology sectors. Movement of personnel can create a flow of expertise and result in a highly competent workforce who are able to tackle challenges in the different sectors. This movement can be reciprocal between research institutes and industry (Kayal, 2008). Collaboration can also increase the stimulus that is necessary to drive innovation.

A national innovation system can enable policymakers to enhance the innovative competence and general competitiveness index of a nation, as outlined by the OECD. Therefore, the poor innovative performance of some countries may be attributed to inadequate interaction between the various actors of a system, a lack of balance between research in the public and private sectors, insufficient technology diffusion or a lack of knowledge and technology absorption at the firm level. Hence, the OECD has called for an integrative approach to the development of policies to, first and foremost, enhance the absorption of knowledge among various firms. Strengthening the networking and links between the actors in a national innovation system should be at the helm of policy development.

The OECD has pointed out that the knowledge flow differs between countries and can be influenced by the institutions involved and the links between them. Feinson (2003) has outlined some strategies that developing countries can adopt to augment knowledge flow:

- Acquiring foreign technology
    - Imitation of foreign capital goods
    - Foreign direct investment
    - Foreign licensing
- Employing and disseminating technology
- Improving and developing technology
- Investing in human capital.

Feinson (2003) has also stated that for developing countries, using global knowledge flow is essential to catch up with technology and be on par with the rest of the world. To understand the influence that knowledge flow can have on innovation, Roper and Hewitt-Dundas (2015) carried out an empirical study aimed at identifying the effects of existing

knowledge stocks and current knowledge flows on innovation. They found that the innovation output is positively influenced by internal and external knowledge flow (the latter also being non-linear). The researchers suggested that importance must be paid to internal R&D investment and external knowledge acquisition.

2.3 Adding the 'eco' to the system: National innovation ecosystems

Traditionally, the term ecosystem is used in a biological context. However, there is an increasing trend in today's world towards biomimicry. This is apparent in the use of the term 'national innovation ecosystem'. Although it is commendable to incorporate natural elements into design and concepts, it is at the risk of 'false analogies between biological and ecological ecosystems' (Oh, Phillips, Park and Lee, 2016).

The similarity between a biological ecosystem, in which all the living resources and habitats are continuously interacting to maintain equilibrium, and an innovation ecosystem was highlighted by Jackson (Jackson, 2011). According to Jackson, the innovation ecosystem can be defined as a system that channels economic energy and comprises of actors like financial and material resources and human capital, which interact with institutions like schools, universities and corporate firms. Here, attention is drawn to two economies: the research economy, which generates fundamental research; and the commercial economy, which is driven by the marketplace.

However, Jackson's definition (2011) is limited as it fails to recognise the influence of a geographical boundary on innovation, and the various interactions that take place between the actors and institutes that traditionally make up a national innovation system (Oh et al., 2016). Furthering the definition of the innovation ecosystem, Jackson (2011) explained that an innovation ecosystem could reach a state of equilibrium when the two economies (research and commercial) contribute to the growth of each other. In essence, investment in a research economy will generate innovation, which will lead to higher returns in the commercial economy, which will then fund more research; this leads to a continuous cycle. One challenge of the study related to the absorption of new technologies created by investments in R&D. To create a cyclic feedback loop between the two separate economies, business firms, entrepreneurs and venture capitalists (VCs) (which form the central entities of the commercial economy) must absorb new and improved technology that is generated through the research and apply it to their business operations so that high rates of return can be generated. A lack of resources could be another issue, potentially damaging the proposed state of equilibrium. Innovation cannot thrive in a state of limited resources, whether they are financial or knowledge-based.

Relating the innovation ecosystem to a biological ecosystem, Jackson states that there needs to be a process of continuous recovery and recycling to prevent losses for the research and commercial economies. Just as there is a nutrient exchange in a biological ecosystem, there is an innovation cocktail in the innovation ecosystem that consists of knowledge, intellectual property (IP), marketplace knowledge, human capital and innovative ideas, which seek to regulate and maintain equilibrium.

Going back to the critical examination of an innovation ecosystem conducted by Oh et al., (2016), the researchers have cautioned against using a nature-based analogy, as there are fundamental differences between a natural system and an artificial system. For example, where the biological ecosystem has naturally evolved to optimise its resources, the innovation ecosystem needs to be designed by policymakers. Linking an artificial system that does not have natural evolutionary processes to a biological ecosystem will lead to inaccurate policy development and might harm the economy.

Durst and Poutanen (2013) state that there is little literature available that uses the term ecosystem in all its meaning without interchanging it with the term 'system'. Oh et al., (2016) found similar results but suggested a typology of innovation ecosystems:

- Open innovation ecosystems: These are systems that transcend the organisational boundaries and consist of internal and external entities like users, suppliers, partners and others (Xiaoren, Ling and Xiangdong, 2014). The open innovation model theorised by the researchers can be seen in Figure 2.1.
- National innovation ecosystems and regional innovation ecosystems: Morrison (2013), in line with the Open Innovation Ecosystem, talked about 'innovation networks' which are created by the ecosystem through valued interactions.
- Digital innovation ecosystems: These refer to the ecosystems that generate new digital technology applications and platforms (Rao and Jimenez, 2011).
- Innovation districts or city-based innovation ecosystems: These include technology parks and planned governmental research sites (Cohen et al., 2014; Morrison, 2013).
- High technology-based SMEs: Oh et al., provided the example of Taiwan, where much of the country's innovation takes place in small to medium-sized manufacturing firms.
- University-based ecosystems: Although not implemented yet, there are plans for developing university innovation centres that are expert-ranked (Graham, 2013).

Edquist (2005), notes that there is a general lack of coherence among the terms used to define innovation systems. More specifically, the term 'institutions'[1] may be used to refer to so-called social rules that society uses to make sense of itself (Lundvall, 1992) or it could be used to refer to various firms and organisations (Nelson et al., 1993).
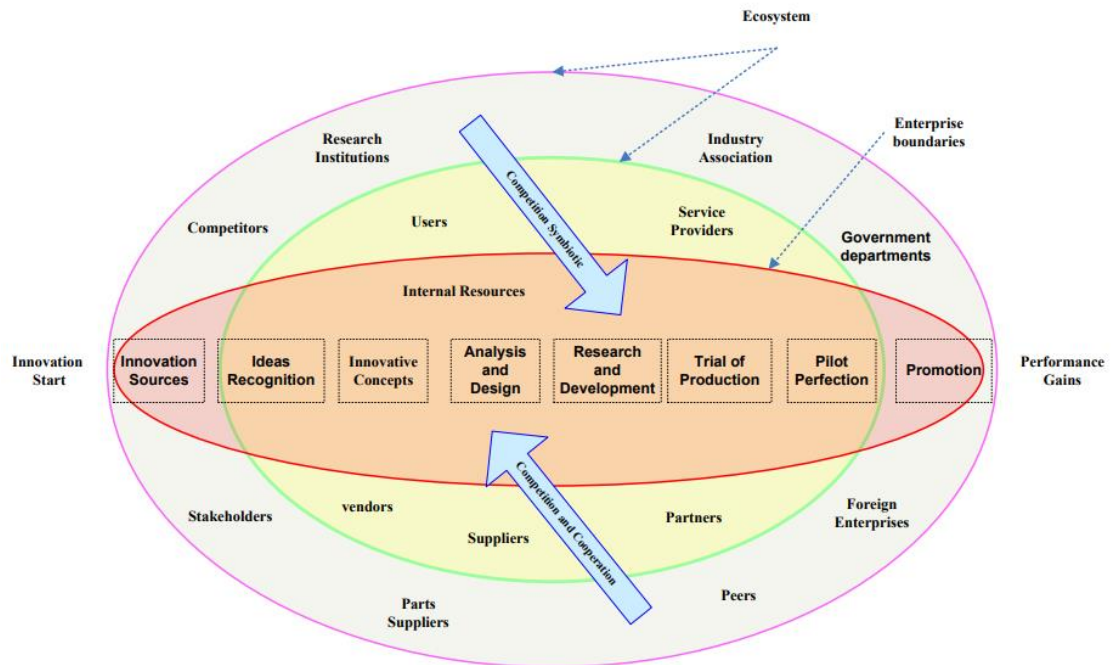
Figure 2.1: Model of an open innovation ecosystem

Source: Interaction of open innovation and business ecosystem

Edquist has also stated that there is no consensus of what is included in the system and what is not. There is an emphasis placed on institutions as opposed to the marketplace, which may be so, but the lack of a uniform definition for 'institutions' creates an issue, which may impede policymakers in developing national innovation ecosystems.

The innovation ecosystem can be differentiated from an innovation system by its dynamic nature. Applying the definition of Jackson (2011) and considering the critical examination from Oh et al., (2016), an innovation ecosystem must continuously evolve and improve resource utilisation according to market changes. Defending the innovation ecosystem, Ritala and Almpanopoulou (2017) suggested 'that the term innovation ecosystem should ideally be used in respect of systems that focus on innovation activities (goal/purpose), involve the logic of actor interdependence within a particular context (spatial dimension) and address the inherent coevolution of actors (temporal dimension)' (p. 41).

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[1] For institutions as 'rules of the game', see North (1990)

Using the term innovation ecosystem as opposed to innovation system is increasing due to a lack of difference between an innovation event and an innovation structure (Mercan and Götkas, 2011). According to Mercan and Götkas, there are economic and non-economic factors that influence innovation. From these factors, the study developed three primary components that make up an innovation ecosystem: cluster development, university–industry collaboration and culture of innovation. The researchers also pointed out the dynamic nature of an innovation ecosystem, which is ever-changing, cannot be directly governed by policies and needs a balance between the public and private sectors.

A national innovation system is a web of networks and actors that consistently interact and generate a flow of knowledge, which can stimulate the innovation capacity of a nation and, thus, drive economic growth. Freeman (1987), Lundvall (1992), Metcalfe (1995), Nelson and Rosenberg (1993), Niosi, et al., (1993) and Patel and Pavitt (1994) have developed various definitions of the national innovation system, which, as Edquist (2005) puts it, lack coherence and unification of meaning. However, the concept of a national innovation ecosystem has developed, founded on biomimicry of a national innovation system, and this ecosystem is different from one that naturally evolves over time.

2.4   Components of an innovation ecosystem

2.4.1   Clusters

The first component of the national innovation system identified by Mercan and Götkas (2011) is based around cluster development. Clusters, as defined by Porter (1998), are 'critical masses' that are geographically locked or in close proximity, and display an 'unusual competitive success in particular fields'. Silicon Valley, in California, US, is an example of a cluster. It is generally regarded as a centre for high-tech innovation and a birthplace of innovative start-ups. Several countries are increasingly applying the cluster approach for the purposes of examining and determining the knowledge flows within clusters, which can differ between two clusters or even countries (Kayal, 2008).

Mercan and Götkas (2011) identified a positive correlation between cluster development and the global innovation index. The authors measured the global innovation index of 142 countries and found that the degree of cluster development in a country was a significant predictor of the innovation output of that country. They suggested that in clusters, due to the geographical lock-in, there is an increased interaction and value

generation through innovation networks. Clusters also lead to an increased concentration of skilled labour.

The second component, university–industry collaboration, is considered the most crucial component of the ecosystem. It has been stated several times in this discussion that there is a need for industries to absorb the innovation that is produced by the research education system. Because universities are research centres, it is only natural for the collaboration between the universities and the industry to be critical.

The culture to innovate is the third component. Although there was no statistically significant influence on innovation, Mercan and Götkas (2011) note that there was a greater output of innovation when the culture promoted higher levels of innovation.

The OECD (2017) encourages the inclusion of schools for the development of better innovation ecosystems. Learning and education are important in a knowledge-based economy. Contributing to the development of the educational infrastructure will ensure that there is sufficient knowledge being produced in the economy, which will ultimately lead to its growth and development. In terms of clusters, educational institutes, schools and other learning centres form an intense network of connections that enable information sharing. This information can then be applied to technological development. Overall, the OECD has identified schools and other educational institutions as important drivers of an innovation and learning ecosystem.

A critical concept of innovation ecosystems is that they are not constructed in the manner that systems are typically built (Russell and Smorodinskaya, 2018). Instead of a traditional hierarchic structure, innovation ecosystems evolve under the influence of market forces, value transactions and complex interactions. In essence, an innovation ecosystem is a non-linear process that is based on the generation of new technologies and values, which are interactive and continuous in a highly dynamic and ever-changing environment. Some definitions given earlier referred to a state of equilibrium; however, Russell and Smorodinskaya have defined the innovation ecosystem as being in a consistent state of change, so much so that the nature of this innovation ecosystem is 'dissipative'. However, the researchers also stated that 'large-scale innovation-led growth will rely on the same collaborative synergy effects that can be observed in a localised innovation cluster' (2018:13). In the same vein, the study provided several practical applications for enhancing collaboration in clusters:

- Increasing the nodes in the communication network
- Augmenting the quality and quantity of feedback links

- Promoting sovereign contracts between various agents to create a shared vision and a general model of governance
- Removing any communication gaps between the agents
- Managing the overall performance of the innovation ecosystem
- Creating a value system that promotes interdependence and sharing of resources (Russell and Smorodinskaya, 2018).

From a policy perspective, Russell and Smorodinskaya (2018) stated that policies that favour one industry over another are not effective in the evolving technologically complex state. They also stated that the quality and quantity of collaborative partnerships must be augmented to promote a higher innovation capacity and greater sustainability in the face of a non-linear and dissipative ecosystem. This will, in turn, increase the innovation capacity. The researchers also provided the example of Russia and Belarus, who have failed to eliminate traditional barriers, leading to increased vulnerability to a global economic paradigm shift. Figure 2.2 shows the complexity model developed by Russell and Smorodinskaya, and Figure 2.3 displays the entire ecosystem as a triple helix system.

The world of business networks
(inter-firm and inter-organizational)

Agglomerations of co-located companies

Cooperation networks (ecosystems)

Business networks

Collaborative networks (ecosystems for innovation)

Triple-helix collaborative networks (ecosystems for continual innovation)

Growing complexity of interaction patterns
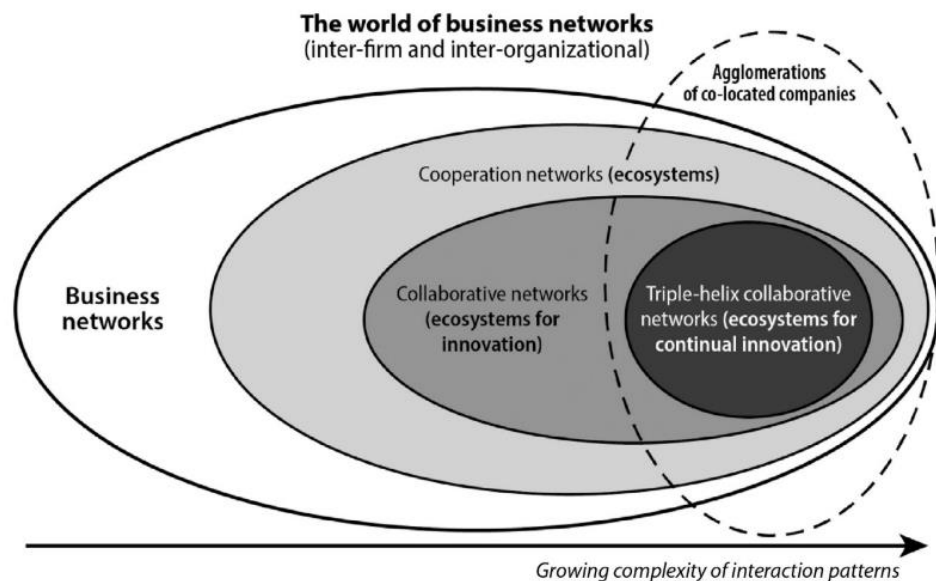
Figure 2.2: Internal interaction complexity of business networks

Source: Leveraging complexity for ecosystem innovation

Innovation ecosystems can also be thought of in terms of complex pathways—interdependent business models that continually engage in the recycling of resources (Shaw and Allen, 2015). Here again, the researchers have compared the innovation

ecosystem to a natural ecosystem and hypothesised that an innovation ecosystem must be designed in a close resemblance to a natural one.

The primary role defined by this study was related to the natural ecosystem's pathways that are engaged in the process of recycling. Hence, similarities are drawn between the ecological innovation ecosystems at the pathway level, not the firm level.

The triple helix model in Figure 2.3 depicts the relationship between universities, the state or government of a country and the industry. One of the core assumptions of the triple helix model is that the government plays the role of the facilitator by way of policymaking, where innovation is considered a broader phenomenon taking place in a single institutional profile (Etzkowitz, 2003). The author has highlighted the fact that this model tries to reflect the 'transformation of roles and relationships in the emerging primary institutional triad of university–industry–government' (Etzkowitz, 2003:303). Furthermore, the author has highlighted that the triple helix model becomes operational when the triad enters a reciprocal relationship that attempts to enhance each other's performance; a relationship that begins with collaboration.
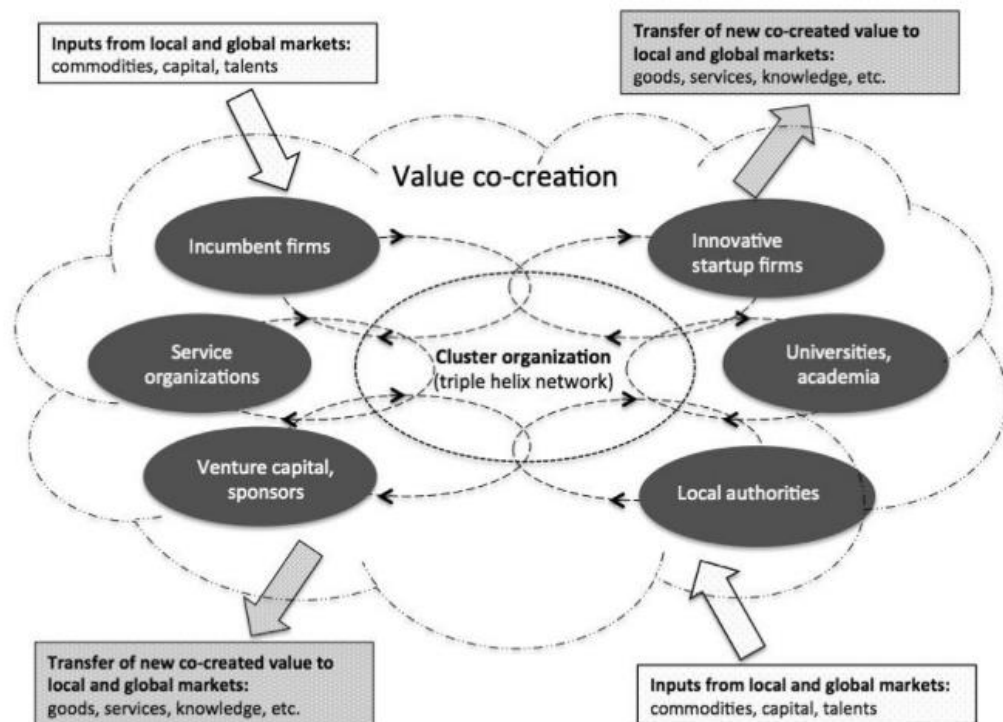
Figure 2.3: A triple helix ecosystem model

Source: Leveraging complexity for ecosystem innovation

One of the core activities in the triple helix model of innovation is technology transfer through market or non-market collaborations and interactions (Carlsson et al., 2002). Because universities are consistently innovating in areas such as nanotechnology, biotechnology and ICT, they become key stakeholders in this model of innovation (Ranga and Etzkowitz, 2013). In line with this, the triple helix model provides the potential for economic development of a knowledge-based society that contains the hybrid elements from government, university and industry. This can lead to newer social and institutional formats for the application and transfer of knowledge. The primary role that the government can play in innovation, according to this model, is to outline policies that strengthen the technology transfer between the university and industry; this can help foster a strong relationship between the same. There are three configurations that each of the components of the triple helix model can occupy (Etzkowitz and Leydesdorff, 2000; Ranga and Etzkowitz, 2013):

- A statist configuration, where the government plays the most important role and leads the education system and industry, but also ensures that there are limitations to where academia and industry can venture. A classic example of a statist configuration is in China, where the government plays a very active role.
- A laissez-faire configuration, which is categorised by limited government involvement in the economy; where the government only provides secondary, regulatory support to innovation systems. An example of a laissez-faire configuration is the US.
- A balanced configuration, which specifically considers the transition to a knowledge-based economy. Although the government takes the lead role, it acts in partnership with the other sectors.

According to Ranga and Etzkowitz (2013) and Etzkowitz and Leydesdorff (2000), the balanced configuration presents the ideal scenario for facilitating innovation. In the balanced configuration, the interaction creates synergy and leads to 'innovation in innovation', which creates new organisational formats and venues. It facilitates individual actors and organisations who not only perform the role but also facilitate the role of others (Etzkowitz, 2003).

2.4.2 University–industry collaboration

The second component of the innovation ecosystem identified by Mercan and Götkas (2011) is university–industry collaboration. The authors state that 'the traditional function of universities is providing qualified labour for private and public sectors' (p. 108). They

state that university–industry collaboration has a positive influence on the innovation generated in a country. In essence, universities create new knowledge, and industries can use that knowledge, either in the form of products or human capital.

University-generated knowledge can be important to an industry (Maietta, 2015). According to Maietta, the proximity of the firm and the university positively affects the rate of innovation. The proximity enables more firms to collaborate with the universities, who jointly benefit from any knowledge spillover. Morgan (2004) also noted that the geographical proximity is an important factor for university–industry collaboration because it promotes shared experiences; this is not possible when the knowledge is simply bought from the greater market. The more universities in a region, the greater the opportunity for firms to collaborate with the university sector.

However, the more codified or standardised the knowledge, the less product innovation takes place (Maietta, 2015). Codified knowledge can transcend geographical boundaries and be applicable in a range of contexts. More specifically, Maietta found that there is increased collaboration between universities and firms when the programme has a direct or indirect benefit for the local firms. The author posits that the structure of the national innovation system is important and influences the level and rate of university–industry collaboration. In effect, the author stated that having a detached and polycentric national innovation system carries with it the chance of creating a conflict of interest between the universities and independent research labs, thereby creating an information asymmetry. The authors also found that there is an increased knowledge spillover from universities to the economy at large, especially in the case when the industry requires that specific knowledge. This phenomenon, and the size of the spillover, are also determined by the national innovation system.

There are two broad types of R&D activities: those that enhance knowledge and those that increase wealth (Bozeman, Fay and Slade, 2013). Knowledge is quantified by the number of scientific articles generated, and wealth encompasses the creation of newer technology, more patents and sometimes even profits. Bozeman and colleagues state that research collaboration is primarily defined by the use of human capital, and not by financial or other physical resources. The authors state that even if the collaborating party does not receive academic credit for the research, whether it is co-authorship or co-patenting, the research collaboration still stands true.

The intensity of university–industry collaboration is higher in scientific fields than in other sectors and is driven by the in-person exchanges between the members of a research team (Balconi and Laboranti, 2006). Balconi and Laboranti state that the collaboration

between universities and firms allows the recruitment of high-performing individuals into the industry. They also suggest that there is no explicit motivation for the researchers to create patents, and that they simply engage in research collaboration for creating new knowledge.

The nature of the university–industry collaboration and the innovation generated will differ between emergent and mature economies (Bodas Freitas, Marques and Silva, 2013). This could be attributed to the fact that, according to Bodas Freitas and colleagues (2013), mature and emergent industries have varying market turbulence and, thus, require different innovation inputs. Here, the collaboration and the strategies will also change if one is looking at an emergent economy or a mature economy. Furthermore, R&D performance and collaboration of firms in either emerging or mature economies can be influenced by the national institutional environments (Bodas Freitas, Marques and Silva, 2013). Gittelman (2006) provides examples of the institutional environment in the US, France and Japan. The author states that these environments greatly encourage the development and exploitation of the biotechnology sector (in the US), and the pharmaceutical sector (in France and Japan). Robertson and Smith (2008) found that in mature economies, firms have a general reliance on standardised knowledge or codified knowledge for innovation activities. However, as it was identified earlier, codified knowledge does not create a greater degree of innovation. It can be stipulated that emergent economies can generate greater innovation outputs with a local and exhaustive collaboration within clusters. Research conducted by Grimpe and Sofka (2009) also points towards the fact that emerging economies create shared knowledge and the resultant innovation by engaging in joint university–industry collaboration. Conversely, mature economies lead the industry to engage in knowledge acquisition. In essence, in emerging industries, there is a focus on creating new knowledge, whereas, in mature economies, there is an emphasis placed on the management of existing knowledge. However, although there are differences between mature economies and emerging economies, they do not reflect the intensity of innovation, but rather the characteristic of innovation (Bodas Freitas et al., 2013).

Lee (2000) stated that as long as universities and industries located inside of a cluster have private agendas for the joint collaboration, university–industry collaboration can be sustainable in a national innovation system. The survey identified that there needs to be a symbiotic relationship between industry and university to enable collaboration. The primary motivation that drives firms to engage in R&D activities is the development of new and innovative products. This is also in line with the stipulations made by Scandura (2016), who stated that collaborating in a joint manner with universities allows firms to

build competitiveness in the technological sphere. In addition, the university–industry collaboration can have a positive influence on an organisation's sales (Klomp and Van Leeuwen, 2001). Firms engage in university collaboration because it allows them to acquire and use the knowledge created by external resources, which can be used for a variety of corporate reasons (Caloghirou, Ioannides and Vonortas, 2003). Caloghirou and colleagues also identified several benefits that encourage collaboration relating to economies of scale and cost optimisation.

A study conducted by Becker and Dietz (2004) in German manufacturing firms showed that there is a positive correlation between collaboration and innovation output. Similar results were also discovered in Belgium firms (Veugelers, 1997). There is a significant body of research that points towards a positive correlation between collaboration and firms' innovation intensity, output, patent generation and increased sales of innovative products (Fritsch and Franke, 2004). Scandura (2016) also found that there is an increase in the organisation's innovation propensity and R&D employment when there is an increase in collaborative efforts that are publicly funded.

Although proximity plays an important role in encouraging collaboration between university and industry, the collaboration is reduced when there are 'technologically complementary firms' that are clustered together in a geographical area (D'Este, Guy and Iammarino, 2013). If there is knowledge spillover from a university, it will be confined to a local area. Given this implication, D'Este and colleagues suggest that public resources should be scarce in the technologically dense clusters because the university–industry collaboration will take place regardless of geographical proximity; the reason being that the firms are driven to form collaborations with universities for research, despite the location of the university. However, in many countries, policies ensure that there is a concentration of public research funding in areas where the collaboration will take place regardless of other factors. From a policy perspective, there needs to be funding focused on universities that are not located within a dense cluster of firms. A funding focus is imperative because 'the extent and nature of investments in national innovative capacity are associated with observed levels of innovative output and R&D productivity' (Furman, Porter and Stern, 2000:6). Therefore, the implication is that more focus should be placed on firms located away from such technologically dense areas because it is these firms who will place a greater emphasis on geographical proximity for research collaboration and innovation.

Venturing further into the factors that can hinder university–industry collaboration, motivational differences between firms and universities are likely to create a challenge.

Partha and David (1994) stated that universities emphasise the creation of valuable knowledge and education, whereas firms want to capitalise that knowledge and generate a better return on investment or profit from the innovation. However, in universities, there is an increased focus on the creation of IP (Bruneel, D'Este and Salter, 2010). Bruneel and colleagues studied the barriers that affect or are likely to affect university–industry collaboration. They found two major factors that can hinder the university–industry collaboration: orientation-related and transaction-related barriers. Orientation-related barriers are those that depend on differing attitudes and opinions, and transaction-related barriers are those that arise from conflicts over IP or other administrative issues. In addition to these barriers, other factors can affect the university–industry collaboration, such as the level of trust between the two parties, prior experience working together and the nature of the interaction. The study found reduced conflict and increased barrier mitigation where parties had had earlier coordination. This could be attributed to factors such as familiarity and an increased level of trust. However, there is an important caveat to consider here; the authors state that in the face of any IP-related or administrative conflicts, repeated collaborations can increase conflict to an unprecedented rate. This study also concluded that where there is an interaction among many people in both parties, there is a greater chance of conflict and the negation of possible collaboration. In addition, the authors found evidence that the orientation of the university and the firm in terms of their objectives and long-term agenda can be a major deterrent to the collaboration. Transactional-related barriers affect collaboration, especially those involving the administrative functions of the university and industry. From a policy perspective, because the conflict of interest and IP-related factors are major deterrents to university–industry collaboration, there is a need to improve the processes that define and oversee the university–industry collaboration. There needs to be an increase in trust and a systematic resolution of past IP-related or administrative conflicts. However, more important is the merging of the varying interests between universities and industries to lead innovation through collaboration. Research by Murray and Stern (2007) has indicated that formal IP rights have the capacity to reduce the extent of diffusion of knowledge due to the anticommons hypothesis.

It is important to consider the absorptive capacity of firms, which can allow them to adopt new technology that is developed as a result of R&D. Absorptive capacity of the firm has been defined by Teece, Pisano and Shuen as 'the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments' (1997:516). In other words, the absorptive capacity of the firm can be defined as the capacity to recognise the value of innovative technology and apply it to

gain a competitive edge in the market. Lane, Koka and Pathak (2006) noted that the external knowledge that firms can capitalise on is generated from R&D activities, the market, competitors and internal and external partners. The author noted that the absorptive capacity of the firm is characterised by the extent of assimilation that the firm can exercise. In other words, it measures the extent to which the firm can accept new knowledge and apply it in various contexts. This is also referred to as 'organisational ambidexterity' (Gibson and Birkinshaw, 2004), which is the capacity of the firm to search for new knowledge while simultaneously exploiting new knowledge. Since the rate of innovation is dependent on the capacity of organisations to adopt external knowledge, apply it to their current knowledge pool and develop new products (Roper, Du and Love, 2008), the challenge becomes the codification of the knowledge that is available to the firms to drive innovation (Zahra and George, 2002). Furthermore, research by Roper, Love and Bonner (2017) suggests a clear link between firms' engagement in active collaboration and inactive collaboration, such as reverse engineering on firms' innovation output. In summary, the absence of a strong firm absorptive capacity, organisational ambidexterity and limited engagement in sourcing new knowledge means that R&D carried out in universities will not translate into commercial applications in the industry.

Seven factors were identified by Pertuzé, Calder, Greitzer and Lucas (2013) that can promote a beneficial university–industry collaboration:

1. During the selection process, a clear definition of the project goals and objectives need to be provided to avoid miscommunication or conflicts of interest.
2. The project managers should be selected based on their knowledge, networking abilities and their capabilities to develop product applications.
3. An in-depth outline of the intended project outcomes and the implications of the same for the industry need to be provided at the outset.
4. The firm should develop a long-term collaboration vision with the university.
5. There needs to be strong communication between the two parties.
6. Interactions between the university teams and the organisation's teams need to be extensive and productive.
7. Essential support must be provided to both the firm and the university until the research results can be commercialised.

From a policy perspective, university–industry collaboration can be promoted through the increase of R&D grants, performance-based funding and reward systems, new regulations for IP, the development of research parks and incubators, education and training and globalisation (Guimón, 2013). Guimón stated that these factors could be

considered, especially in the case of developing countries, for the promotion of robust university–industry collaboration. These six aspects are considered each in turn below:

- **R&D Grants:** Guimón (2013) suggests the development of grant policies that require collaboration with a university (in the case of a firm applying for a grant) or firm (in the case of university applying for a grant). Similarly, the concept of an innovation voucher, which is essential in promoting the university–industry collaboration according to the OECD (2010a), has been tested in the Netherlands and the UK.

- **Performance-based funding and reward systems:** Guimón (2013) stated that there is a stigma attached to university professors collaborating with firms in several developing countries. Therefore, they suggested that there need to be initiatives to motivate collaboration and provide returns for the professors that go beyond the publications.

- **New Regulations for IP:** IP conflicts are a major barrier to successful and productive university–industry collaboration. Guimón suggests developing better policies and establishing 'technology transfer offices' that facilitate communication and collaboration between universities and firms in developing countries. But, applying IP policies in developing countries may have minimal effects because there is a lack of awareness of IP uses and benefits (Brundenius, Lundvall and Sutz, 2009). Other reasons why the IP policies are not effective may include the weakness of the national innovation system (Guimón, 2013) and the weakness of the universities' technological competencies (Brundenius et al., 2009).

- **Development of research parts and incubators:** This promotes research collaboration and creates technologically dense clusters that can promote the economic success of the region and the country (Guimón, 2013). However, Guimón cautioned the governments who are developing such plans to be mindful of the outputs that a cluster can realistically create in its infancy.

- **Education and training:** The development of skilled labour is an important link between universities and industry and can also promote collaboration (Guimón, 2013). By enhancing the education and training quality, Guimón suggests that the transfer of knowledge to the firm can be facilitated. Allowing industry leaders to be part of the curriculum development process would ensure that universities are meeting industry requirements.

- **Globalisation:** For developing countries, it can be important to develop local industry using international university knowledge. Collaboration can take place

between the local subsidiaries of an international university and a local firm, according to Guimón. However, he stated that 'benefits will only accrue if the appropriate conditions, including human capital, universities and public research institutes, clusters of innovative local firms, and innovation-friendly regulatory regimes are in place' (2013:8).

2.4.3   Culture of innovation

Mercan and Götkas (2011) identified culture to innovate as a key component of a national innovation ecosystem. The correlation between the culture to innovate and the innovation outcome was statistically insignificant in their study but showed a positive trend. The authors point out that the economy of a nation and the rate of innovative activity is affected by its culture.

In an empirical study to identify if culture matters in innovation, Taylor and Wilson (2012) found that in a society where collectivism is encouraged, the rates of innovation tend to be lower. In effect, there is a higher value of innovation and advancements in individualistic societies. However, Taylor and Wilson's study did not identify any causal links between the phenomena and only reported a correlation. The authors cautioned against 'stereotyping all collectivist cultures as anti-innovation' (p. 245) because they found evidence of collectivism being used to solve problems of a societal nature by influencing innovation. This was also true for cultures like institutional collectivism, which is a display of national patriotism.

Another study found that there is a positive correlation between the levels of individualism on innovation output (Efrat, 2014). The study also identified that masculinity affects innovation as does uncertainty avoidance. The author notes that one factor may affect the rate of innovation negatively when it is acting alone, whereas the same factor can influence innovation positively when it is acting together with other factors.

Shane (1992) found a correlation between greater power distance between parties and lower rates of innovation. This might be because a power distance means that there is a more complex channel of communication between the two parties located at either end of the power spectrum, thereby implying that there is a lower information processing capacity. This can be observed in multinational organisations that have a highly developed and enforced hierarchical structure. In contrast, Shane also noted that smaller firms might be at an advantage because information processing takes place at a faster rate, due to the informal structure of the organisation. Furthermore, evidence suggests that an organisational culture that values and rewards innovative approaches positively

influences innovation (Chandler et al., 2000; Hofstede, 2001). Chandler and colleagues (2000) also identified that gender or gender constructs influence the rate of innovation. More specifically, there is a higher rate of innovation displayed in 'masculine' societies, a result that was also stated by Efrat (2014).

Hofstede (2001) has stated that there is a link between the culture of an organisation and that of a nation. That is, the national culture will influence the culture of the organisation. Thus, Hofstede stated that there is a positive correlation between societies that favour openness and reward innovation and flexibility and the rate of innovation or innovative capabilities of that organisation. Therefore, cultural factors do motivate and affect the rate of innovation and can become an integral part of policymaking for the development of a robust national innovation system.

2.5 Key concepts

Table 2.1 presents a summary of the core concepts that have been discussed in the preceding sections.

Table 2.1: Core concepts of national innovation systems and national innovation ecosystem

Authors	National innovation system concepts
Freeman	A complex network with interactions between public and private sectors to share new ideas and technology
Lundvall	The creation of new knowledge in an economically beneficial manner in a country
Nelson and Rosenberg	An interaction between institutions that characterises the innovative competence of national organisations
Niosi et al.	Interaction can take different forms, such as legal or financial, but will advance innovation in the nation
Patel and Pavitt	Determines the rate of technological advancement and change in a country
Metcalfe	A set of institutions that work together to develop, transfer and use new knowledge in an economy
OECD	An interaction between enterprises
	An interaction between enterprises and educational institutes

The diffusion of new knowledge and technology to firms

The movement of skilled labour

Authors	National innovation ecosystem concepts
Jackson	The author created the concept using the ecosystem analogy.
	A system that has two economies: research and commercial, that are striving to be in a state of equilibrium
Oh et al.	The geographical boundary is important when considering the interactions.
	The ecosystem needs to be developed by policymakers and cannot be expected to evolve naturally.
Edquist	There is a lack of coherence between definitions of a national innovation ecosystem.
	Urges to move from system to ecosystem
Shaw and Allen	Complex business model pathways that seek to recycle resources.
	Similar design to a natural ecosystem
OECD	Educational institutes are critical tools for the innovation ecosystem.
Russell and Smorodinskaya (2018)	Innovation ecosystems evolve under the influence of market forces, value transactions and complex interactions.

Authors	Components of National Innovation Ecosystem
Mercan and Götkas (2011)	Three major components: cluster development, university–industry collaboration and policy development
Kayal (2008); Mercan and Götkas (2011); Porter (1998); Russell and Smorodinskaya (2018); Shaw and Allen (2015)	**Cluster Development:** Groups located in proximity to one another encourage optimal knowledge flow. Clusters provide a better selection of skilled labour and promote the development of innovation networks. Increasing network nodes increases communication through networks within a cluster.

Enhanced linkages improve the quality of feedback loops.

Communication gaps should be avoided.

The performance of the ecosystem should be managed.

Sharing of resources is encouraged.

In the triple helix model, clusters are at the centre of the ecosystem while engaged in continuous outputs and inputs.

Balconi and Laboranti (2006); Bodas Freitas et al., (2013); Bruneel, D'Este and Salter (2010); Caloghirou et al., (2003); D'Este, Guy and Iammarino (2013); Gittelman (2006); Guimón (2013); Lee (2000); Maietta (2015); Morgan (2004); Pertuzé, Calder, Greitzer and Lucas (2013); Scandura (2016)	**University–Industry Collaboration:** Geographical proximity is important for university–industry collaboration. However, geographical proximity is not important in the case where technologically competent and advanced firms are located in a dense cluster. These firms collaborate across geographical boundaries with universities. The proximity can create a shared experiences approach, which can add value to the collaboration. Several barriers prevent successful university–industry collaboration: orientation-related and transaction-related. Orientation-related: different attitudes, orientations, opinions of university and firm. Transaction-related: IP conflicts, administration issues, communication issues. Several measures mitigate issues with university–industry collaboration: clear delineation of goals and objectives, long-term collaboration initiative, R&D grants, performance-based funding and reward systems, new regulations for IP, the development of research parts and incubators, education and training and globalisation.
Chandler et al (2000); Efrat, 2014; Hofstede, 2001; Mercan and Götkas (2011); Taylor and Wilson (2012); Shane (1992)	**Culture to Innovate:** Although the correlation between culture and innovation is not statistically significant, culture is an important driver of economic growth. Individualism positively influences innovation. High masculinity in a country influences the rates of innovation.

A smaller power divide between groups is an indicator of higher innovation rates in a culture.

Collectivist culture is usually detrimental to the rates of innovation but can positively influence innovation when it is applied towards solving a common cultural problem.

National culture influences firm culture, which in turn influences the rate of innovation.

Source: Author's interpretation of the definitions of a national innovation system and ecosystem

2.6 National innovation ecosystems: A definition

Considering the concepts given in Table 2.1, a lack of coherence of what exactly constitutes a national innovation ecosystem is evident. A definition of the national innovation ecosystem is required, accounting for the varied and sometimes overlapping definitions and critiques presented in this section. The definition will lend a cohesive structure to this thesis and will ensure that a uniform result is generated. Therefore, the definition includes the core components of a national innovation ecosystem:

A national innovation ecosystem is an ecosystem that does not transcend a nation's boundaries and creates complex pathways of sharing knowledge, technology and information across various actors, organisations and institutions. This network allows continual reuse and recycling of potentially scarce resources. It promotes effective cluster development, sustainability and enhanced integration of educational and learning programmes. University–industry collaboration plays a fundamental role in the functioning of the ecosystem, and it is driven by cultural norms and practices that influence the actors, organisations and institutions in a geographical area. The national ecosystem will reach full potential when information flows across all its pathways, and when available resources are utilised efficiently.

The definition presented above is based on a cumulative understanding of the core concepts explored in this section. However, this definition uses the term institutions in the sense that they are social rules that define interactions across systems. Many of these institutions are geographically distinct, meaning that they differ from one country to another and are heavily influenced by the cultural norms and situations. Organisations refer largely to the commercial context, such as VCs and business firms. Actors are the educational institutes, innovators, SMEs and research centres.

In the following sections, this definition will be applied to a case study of several countries, which are chosen based on their most recent GCI, global innovation index (GII) and Bloomberg innovation index (BII). These three indices were chosen because they show different rankings. The following countries will be considered: South Korea, Sweden, Netherlands, Switzerland, the US (it would be interesting to critically examine the reasons behind the drop in rank according to one index), Singapore and Germany. Further justification for the choice of each of the country is provided in the next chapter. After the case analysis of these countries, attention will turn to the UAE.

The countries chosen will be analysed with a policy perspective in line with the above definition of a national innovation ecosystem, as well as other factors. These include R&D investment and educational excellence. Analysing these factors will enable conclusions to be drawn about the nature of each country's ecosystem and functioning.

3   Comparative country analysis

Conducting an analysis of the top-ranked countries according to different innovation indices will enable the development a framework of current practices in countries that have either activated their national innovation ecosystem or display the components of a national innovation ecosystem. By analysing countries that depict a higher innovative performance and are considered knowledge-based economies, this study can uncover best practices for the UAE to adopt to develop an education-based national innovation ecosystem.

This chapter will critically review the national innovation ecosystems in different countries using the definition developed in section 2.6. These countries have been selected based on three indices that measure the rate of national innovation: the GCI, GII and BII. These indices give different rankings for each country, making for an interesting comparison. The ranking differences could be due to different orientations of each index or different methodologies. These indices and their differences are described below.

Global competitiveness index

The GCI uses 12 pillars to measure countries' performance (World Economic Forum, 2018). It measures around 138 countries' performance based on the 12 pillars: institutions, infrastructure, macroeconomic environment, health and primary education, higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness, market size, business sophistication and innovation. In addition to these pillars, the GCI factors in each country's stage of

development. The index considers three primary development stages: factor-driven, efficiency-driven, and innovation-driven. Figure 3.1 shows the interrelation of the pillars with the three stages of economic growth. According to the GCI, the 12 pillars are not mutually exclusive and are interdependent, which means that a negative result in any one pillar will negatively impact the other.
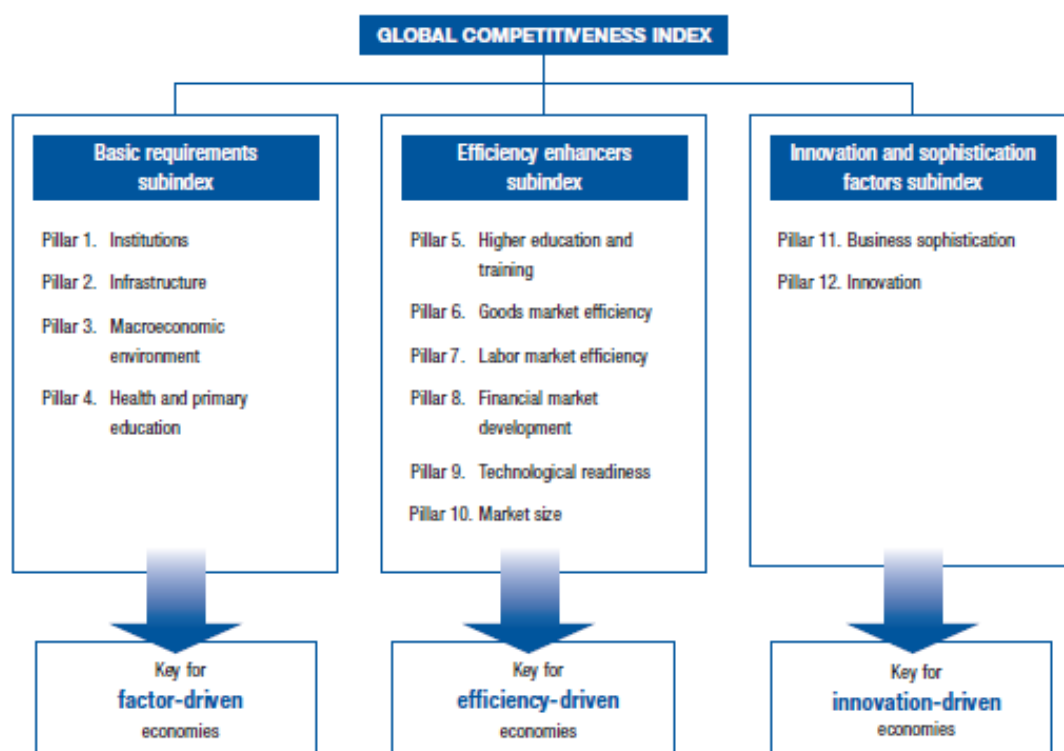
Figure 3.1: Twelve pillars of measurement for the global competitiveness index

(Source: Global competitiveness index report 2017–2018. Retrieved from http://www3.weforum.org/docs/GCR2017-2018/05FullReport/TheGlobalCompetitivenessReport2017%E2%80%932018.pdf)

Global innovation index

The GII was launched in 2007 as a means to measure and quantify the innovation taking place in societies across the globe (University, INSEAD and WIPO, 2018). It develops an innovation efficiency ratio based on seven pillars: institutions, human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs and creative outputs. These parameters are used in the development of the innovation index, which is a ratio that determines the innovation output rates of an economy. Each of these seven pillars has subpillars, which are depicted in Figure 3.2.
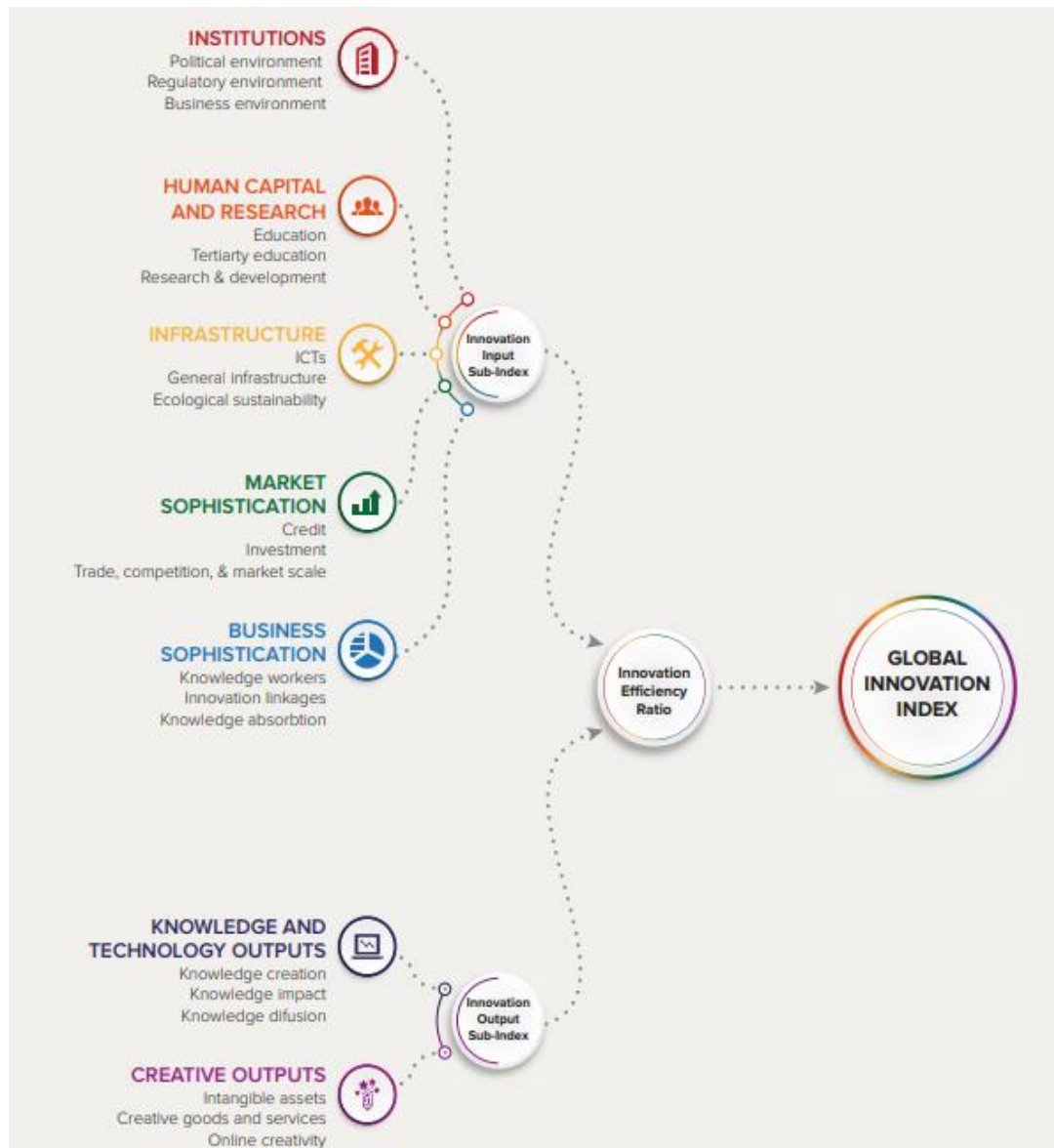
Figure 3.2: Seven pillars of measurement for GII

(Source: Global innovation index report 2017–2018. Available from
http://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2018.pdf)

Bloomberg innovation index

The BII analyses more than 200 economies using parameters like R&D investment, manufacturing value-add, productivity in terms of gross domestic product (GDP) and the number of persons employed, high-tech density, tertiary efficiency, researcher concentration and patent activity (Jamrisko and Lu, 2018).

Choice of countries

Because the indices have their own measurement, methodologies and parameters, the countries have different ratings. Figure 3.3 represents the top countries according to each index (only the top rankings are shown).

(a)

	Economy	Score[1]	Prev.[2]	Trend[3]
1	Switzerland	5.86	1	....
2	United States	5.85	3	....
3	Singapore	5.71	2	....
4	Netherlands	5.66	4	....
5	Germany	5.65	5	....
6	Hong Kong SAR	5.53	9	....
7	Sweden	5.52	6	....
8	United Kingdom	5.51	7	....
9	Japan	5.49	8	....
10	Finland	5.49	10	....
11	Norway	5.40	11	....
12	Denmark	5.39	12	....

(b)

Global Innovation Index 2018 rankings

Country/Economy	Score (0–100)	Rank	Income	Rank	Region	Rank	Efficiency Ratio	Rank	Median: 0.61
Switzerland	68.40	1	HI	1	EUR	1	0.96	1	
Netherlands	63.32	2	HI	2	EUR	2	0.91	4	
Sweden	63.08	3	HI	3	EUR	3	0.82	10	
United Kingdom	60.13	4	HI	4	EUR	4	0.77	21	
Singapore	59.83	5	HI	5	SEAO	1	0.61	63	
United States of America	59.81	6	HI	6	NAC	1	0.76	22	
Finland	59.63	7	HI	7	EUR	5	0.76	24	
Denmark	58.39	8	HI	8	EUR	6	0.73	29	
Germany	58.03	9	HI	9	EUR	7	0.83	9	
Ireland	57.19	10	HI	10	EUR	8	0.81	13	
Israel	56.79	11	HI	11	NAWA	1	0.81	14	
Korea, Republic of	56.63	12	HI	12	SEAO	2	0.79	20	
Japan	54.95	13	HI	13	SEAO	3	0.68	44	

(c)

Bloomberg 2018 Innovation Index

2018 rank	2017 rank	YoY change	Economy	Total score	R&D intensity	Manufacturing value-added	Productivity	High-tech density	Tertiary efficiency	Researcher concentration	Patent activity
1	1	0	S. Korea	89.28	2	2	21	4	3	4	1
2	2	0	Sweden	84.70	4	11	5	7	18	5	8
3	6	+3	Singapore	83.05	15	5	12	21	1	7	12
4	3	-1	Germany	82.53	9	4	17	3	28	19	7
5	4	-1	Switzerland	82.34	7	7	8	9	11	17	17
6	7	+1	Japan	81.91	3	6	24	8	34	10	3
7	5	-2	Finland	81.46	8	16	10	13	19	6	4
8	8	0	Denmark	81.28	6	15	11	15	26	2	10
9	11	+2	France	80.75	12	35	14	2	10	21	9
10	10	0	Israel	80.64	1	27	9	5	41	1	19
11	9	-2	U.S.	80.42	10	23	6	1	42	20	2
12	12	0	Austria	79.12	5	8	15	26	12	12	5
13	16	+3	Ireland	77.87	22	1	1	18	20	14	33
14	13	-1	Belgium	77.12	11	22	13	10	37	13	21
15	14	-1	Norway	76.76	19	37	19	11	23	8	14
16	15	-1	Netherlands	75.09	17	26	20	6	47	15	18
17	17	0	U.K.	74.54	20	40	23	14	8	18	15
18	18	0	Australia	74.35	14	46	16	17	17	3	20

Figure 3.3: Country rankings based on (a) global competitiveness index (b) global innovation index and (c) Bloomberg innovation index

Source: Global competitiveness index report 2017–2018. Available from http://www3.weforum.org/docs/GCR2017-2018/05FullReport/TheGlobalCompetitivenessReport2017%E2%80%932018.pdf

Global innovation index report 2017–2018. Available from

(http://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2018.pdf

Bloomberg innovation index 2018. Available from https://www.bloomberg.com/news/articles/2018-01-22/south-korea-tops-global-innovation-ranking-again-as-u-s-falls

The GCI ranks Switzerland, the US, Singapore, Netherlands and Germany as the top five countries. The GII ranks Switzerland, Netherlands, Sweden, the UK and then Singapore as the top five countries. The BII ranks South Korea, Sweden, Singapore, Germany and Switzerland in its top five.

The following countries were chosen as they were represented multiple times in the top five positions across the three indices: Switzerland, Singapore, Netherlands, Germany and Sweden. South Korea and the US were also chosen. Despite having a lower rank in other indices, South Korea was chosen because it ranked highest in the BII. The UK was not chosen because it ranked relatively low in the BII at 17th.**The South Korean miracle**

South Korea, or the Republic of Korea, has a total population of 51.66 million, a GDP of US$ 1,693.2 billion and a purchasing power parity (PPP) of 1.58% as of April 2018 (International Monetary Fund [IMF], World Economic Outlook, April 2018). Figure 3.4 represents the economic growth of South Korea based on data retrieved from the IMF

from 1980 through to 2021 (projected). From an underdeveloped economy in 1980, the South Korean economy has developed substantially over a short period of time. In 1993, South Korea was listed among lower-income economies showing promising growth and potential (Nelson, 1993).
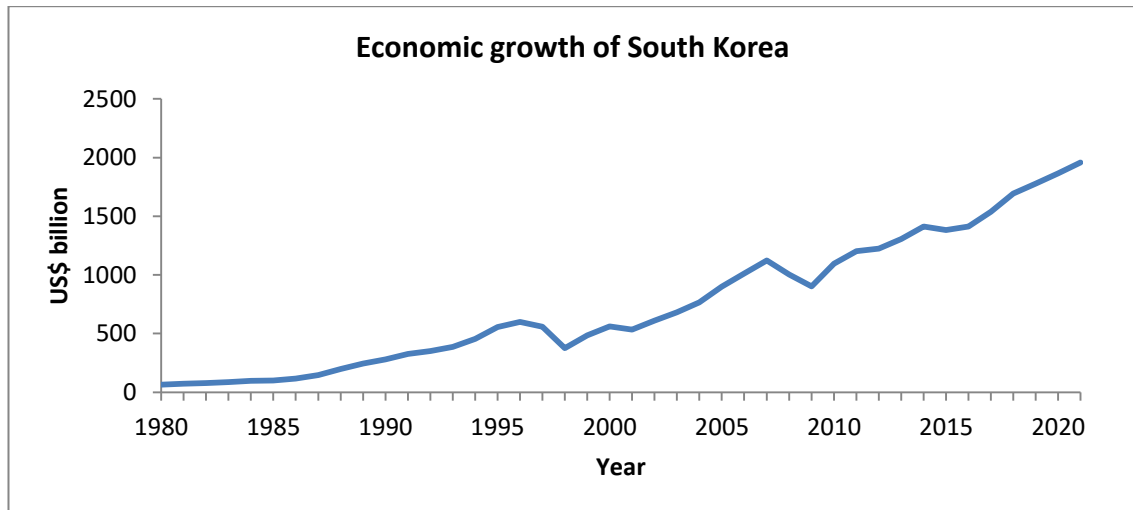
Figure 3.4: Economic growth of South Korea (1980–2021) (Constant prices/real GDP)

Source: IMF

Even by 1993, South Korea had shown tremendous growth and was classified among the fastest developing economies (Kim, 1993). According to Kim, the primary growth of Korea was due to increased industrialisation and R&D investment. Kim also identified several macro and general factors that led to South Korea's growth:

1. Human resource development by building technological capabilities through education, and the commitment of the Korean culture towards education due to previous high illiteracy rates.
2. Longer working hours, which could be responsible for the rapid growth of technological capabilities.
3. In the initial stages of its economic development, Korea relied almost exclusively on foreign technology exports, which Korea's policy, at the time, favoured. There was a significant influx of technology from foreign states and this allowed Korean firms to grasp knowledge through reverse engineering, according to Kim.
4. In the defence arena, South Korea maintained healthy relations with the US, and this relationship allowed for effective technology and knowledge transfer between the two economies.

5. National security defence concerns, according to Kim, may have led to the Korean Government investing heavily in the machinery industry as a means of survival. This also created the drive for diversifying production into industrial electronics.

6. The strategy established by the Korean Government to increase the size of the market, promote exports and reduce imports may have played a significant part in the development of the economy. Some of the industries that were enhanced with this strategy were consumer electronics, automobiles, steel, shipbuilding and other industrialised sectors.

7. The Korean Government increased the creation of large firms, implemented a reward scheme for economic performance and penalised bad economic performance, thus, establishing a strong drive for growth. The Korean Government penalised not only bad economic performance of these firms but also penalised ineffective management.

8. According to Kim, 'the Korean Government also set forth exports as something of a life or death struggle to achieve economic growth goals with the small domestic market' (Kim, 1993:363).

9. The Korean Government noticed the lack of R&D investment, and, therefore, established the Korean Institute of Science and Technology (KIST) and several smaller R&D organisations with the objective to meet the industry demands.

From a microeconomic and firm perspective, several large firms that South Korea built also influenced the rapid acquisition of technological capabilities that were all driven by the need to liberalise the economy from an economic and social standpoint (Kim, 1993). In addition, Kim also noted that R&D activities and university–industry collaboration increased, which further propelled the economy into tremendous growth. Although unprecedented growth was witnessed in South Korea by the early 1990s, Kim noted that there was no robust national system of innovation. But, there were policies in place, which hinted at an innovation system in its infancy.

In 1996, South Korea joined the OECD, which was an important part of its liberalisation strategy (Carroll, 2016). According to Carroll, the OECD membership of South Korea was not only a turning point for the country, but also for the OECD, as South Korea was the first Asian country to join OECD at the time, even though its economy was not fully developed.

The OECD (2000) recognised the development of South Korea and its transition to a knowledge-based economy. The OECD identified several new policy agendas for South

Korea in an attempt to build a strong national innovation system, which was in its transitionary phase by 2000s. According to the OECD report, by 2000, Korea was playing catch-up with the other countries in terms of economic growth and had shown signs of development towards a sustainable model of a knowledge-based economy (OECD, 2000). However, for it to achieve a complete transition, several issues needed to be addressed:

- Developing new policies in the science and technology innovation segment to increase R&D efficiency
- Enhancing the development of the research capabilities in the country by increasing funding, developing centres of excellence and developing technology specialists through the education system
- Reforming the government research institutes to carry out long-term research and innovation
- Enhancing system linkages and knowledge diffusion by creating global linkages, establishing intermediary firms in the private sector to bridge the gap between the public and private sectors, increasing technology and innovation diffusion and promoting networking
- Increasing the demand for human resources in science and technology and integrating a better recruitment scheme in the public and private organisations
- Promoting the innovation capabilities of SMEs by providing access to research funding and other resources, and increasing the knowledge flows
- Developing a robust cluster promotion policy to strengthen the communication and system linkages and lead the impetus to build better technological products
- Promoting the initiatives that enhance the regional and local innovation activities, and enhancing central evaluation with coordination between government ministries and agencies.

In 2005, the national innovation system of South Korea was stronger at producing patents and other technology outputs in comparison with another emerging nation, the Netherlands (Park, Hong and Leydesdorff, 2005). However, there was a decline in shipping and steel industry patents and innovation outputs, as well as an undeveloped biotechnology sector. Another study that analysed the patents generated by South Korea found a strong predominance of larger firms in the market. These firms lead radical innovation because their products have had to compete with worldwide brands and products (J. H. Wang and Tsai, 2010).

In 2010, Eom and Lee (2010) studied Korean university–industry collaboration. Their results suggest a strong positive influence of governmental policies on promoting university–industry collaboration, especially in newcomer economies. There was no correlation between increased collaboration and R&D intensity in the general South Korean economy, but there was a positive correlation when only considering the innovative firms versus patent generation. This means that there was still a rapid change and evolution taking place in the economy of South Korea in 2010, and it appeared to be transitioning to a knowledge-based economy and still formulating its national innovation system (Eom and Lee, 2010).

An exploratory case study conducted on South Korea's transition found that the catching up of its innovation system has all but been saturated (Choung, Hwang and Song, 2014). The authors also stated that although the economy of South Korea is still in a transition phase, it is in its post-catch-up phase of development. According to the researchers, the market that once thrived on the assimilation and imitation of foreign technology is now facing pressures to increase the development of new and innovative products and solutions (Choung, Hwang and Song, 2014).

Another study found that the national innovation system of Korea has already evolved into a triple helix model, which is marked by the development of complex university–industry–government channels of communication (Yoon, 2015). However, there is an almost exclusive contribution from larger firms and government strategies to this rapid evolution. Yoon states concern over the lack of participation of SMEs in the innovation system and states that the country will need to develop policies to enhance voluntary collaboration and promote a more sustainable model of innovation (Yoon, 2015).

In terms of education policy, South Korea is consistently improving its education system, which can be seen through the implementation of several policies (OECD, 2015). To improve learning and education equity, South Korea has implemented and plans to implement initiatives that will increase the rate of entrepreneurship and research. In addition, according to the 2015 OECD report, Korea is also creating an environment that fuels innovation by reducing the stress of being judged by tests at the middle and elementary level (OECD, 2015). It is also looking into changing the budgeting system so that disadvantaged students can have access to education.

3.1.1 Key takeaways from South Korea

South Korea has come a long way from the early 1980s when it was just starting to show signs of economic growth and development. The rapid industrialisation in South Korea has led to its classification as a developed economy. Early in the economic transition, the government mobilised several strategies that propelled the country into a state of rapid industrialisation, which was initiated by the need for economic liberalisation and the process of imitation. This resulted in a strong development and innovation drive, fuelled by the concept of reverse engineering and building technological capabilities. The country actively promoted the development of large corporations, which are at the centre of their innovation system and fuel much of the university–industry collaboration. However, there is a gap in innovation capacity where SME involvement is lacking, and the imitation market has already saturated. Since joining the OECD in 1996, South Korea has continually adopted more technologies and successfully transitioned to a knowledge-based economy. Although it seems to have addressed most of the concerns of the OECD (2005), there remain a few areas where improvements can be made: the creation of complex system linkages and pathways of communication, and the promotion of sustainable innovation systems by integrating SMEs and increasing the rate of voluntary R&D collaboration between universities and industries. In terms of cluster development, the Korean Government has launched plans to develop an innovation town and start-up hub in Western Seoul by the year 2020 (Korea JoongAng Daily, 2018); if developed and functional, the hub will enable South Korea to incorporate SMEs and increase diversity on the innovation front.

3.2 Germany: From beet sugar to luxury cars

Germany has a total population of 82.8 million and a GDP of US$ 4,211.64 as of April 2018 (IMF, World Economic Outlook, April 2018). Figure 3.5 represents the economic growth of Germany based on data retrieved from the IMF from 1980 until 2021 (projected).

Economic growth of Germany
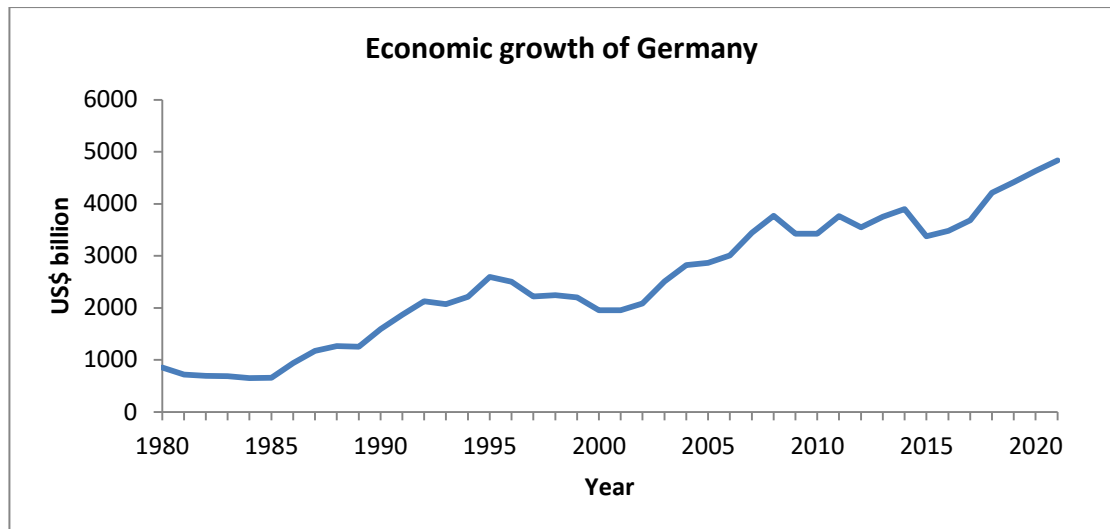
Figure 3.5: Economic growth of Germany (1980–2021) in US$ (Constant prices/real GDP)

Source: IMF

According to Keck (1993), Germany developed sugar from beet juice as early as the 1700s. As part of social innovation, Germany was the first country to develop the research-oriented university, which has become an integral part of today's economic world and all of the national innovation ecosystems. In fact, one of the pioneers of the national innovation system, Friedrich List, was a German national. However, in Europe, Germany was considered a latecomer, at least in the 19th century, due to the political conflict that had shaped the country. During the political unification of Germany (mainly the East and West), there was a conflict between promoters of innovation and production and the promoters of the old autocratic order. While this was unfolding, the German nation sought assistance from other states like Britain and Belgium to provide technological capabilities in the form of machinery and skilled labour. This drive enabled Germany to import technologies like the steam engine, locomotives, cotton, wool and linen manufacturing industries from Britain and human resource capabilities from Belgium and Britain. According to Keck, the early German government played a major role in the catching up of German technology and innovation through initiatives like government-funded learning and development programmes, construction projects (railways, canals and roads) and the development of the civil service.

Although there were several research universities in Germany during the early 18th century, the true development of the technology-based research university came in the 19th century (Keck, 1993). In essence, there was a focus on developing an individualistic personality rather than gaining skills. However, there was a devotion to science and development at the core of the ideology that shaped Germany's early education system.

The belief was, according to Keck, that when an individual devoted their time to science, they developed an individual manner of thinking, which then fuelled innovation. By the mid-19th century, Germany had a strong research orientation and university and laboratory presence. Thereafter, the research level in Germany rose tremendously, especially in fields such as medicine and physics. By the turn of the 20th century, Germany had developed one of the most advanced education systems in the world. The industrial development of Germany started with the beet sugar industry and rapidly expanded to include pharmaceuticals (including one of today's largest pharmaceutical firms, Merck & Co.), chemical, mining and metal processing, iron and steel, machine construction and electrotechnical industries.

The rapid industrialisation in Germany began to show economic results by the beginning of the twentieth century. At this time, Germany was already on track to catch up with developed nations like the US and Britain (Keck, 1993). However, World War I and World War II, which shook the country and the world, led to an economic crisis for the German economy. After the wars, Germany engaged in intensive R&D activities across all major industries, and the economy was able to recover. The university–industry collaboration was booming, according to the rate of patents that were published. Furthermore, the government designed policies that promoted the cooperation between universities and industries in biotechnology, manufacturing, microelectronics and robotics. In addition to the increased collaboration between universities and industry, Keck reported that industries consistently hired top-performing researchers. In the following years, there was significant growth in Germany's economy that has shaped the developments that we see today. However, in 1993, Keck called for better university–industry collaboration and improvements to the higher education system.

According to the OECD (2015), the Programme for International Student Assessment (PISA) scores for students in Germany were above the OECD average, with higher performances in mathematics, science and reading. Another study found that the transition of labour from university to industry is more standardised and effective in Germany (Jacob and Weiss, 2010). The perception of education is also notable in Germany. For example, graduates from top universities usually choose entrepreneurial and innovative fields for their career (Bergmann, Geissler, Hundt and Grave, 2018). The same study showed that students from universities with a more innovative climate are more likely to move into innovative and entrepreneurial careers.

3.2.1 Key takeaways from Germany

Germany was one of the founders of the OECD and has shown consistent economic performance. It is one of the most advanced countries in the world and is leading in innovation and product development in many industries, becoming known for its cars and engineering capabilities. From a cultural standpoint, individualism and innovation are favoured in the country, which could be a driver for economic growth.

Although the country has good R&D investment and collaboration between universities and industries, no information was found regarding its cluster development. Germany has established its technical capabilities and innovation system, but it needs to look into extensive cluster development to promote its position and strengthen its innovation ecosystem.

3.3 Switzerland: The land of watches, banks and CERN

Switzerland has a total population of 8.541 million and a GDP of US$ 741.688 million as of April 2018 (IMF, World Economic Outlook, April 2018). Figure 3.6 shows the GDP growth of Switzerland from 1980 to 2021 (projected) based on data retrieved from the IMF. While the growth curve fluctuates, the trend has been positive for Switzerland.
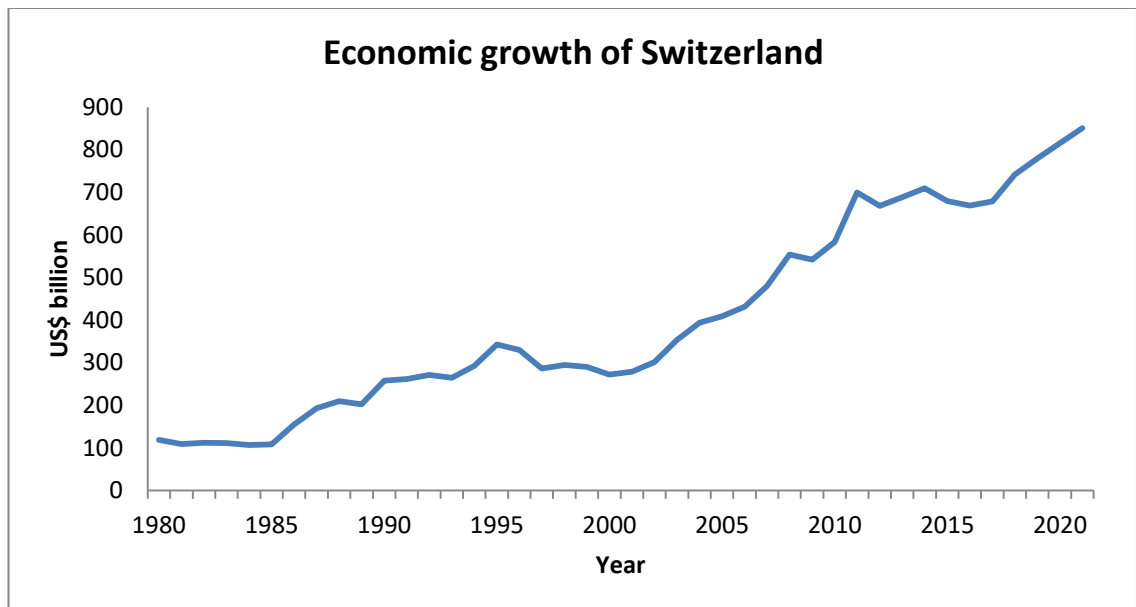
Figure 3.6: Economic growth of Switzerland (1980–2021) in US$ billion (Constant prices/real GDP)

According to Keck (1993), Switzerland and Germany share a similar growth pattern in terms of rapid industrialisation and economic growth. The OECD (2017b) has stated that since the economic crisis in 2009, the Swiss economy has stabilised and is in a state of

steady growth. However, the growth taking place is gradual and is not causing an increase in the absorption of spare capacity (OECD, 2017). It is also not leading to any increase in the rate of productivity growth. Although the country's innovation and R&D systems are top ranked among the other OECD member states, there is no widespread knowledge transfer or sharing.

To put the Swiss context in perspective, Wilhelm (2003) noted that the innovation and knowledge-sharing measures in the country are not as well-developed as in the rest of the world. By the year 2003, the author noted that there was no innovation policy that the country adhered to. Despite this, there had been a considerable political focus on the diffusion of technology and knowledge into industry. The Government of Switzerland is deeply immersed in creating knowledge and dispersing it in the regions' industry, so basic and advanced research taking place in the country's universities is mostly government-supported. The government has also established several governmental research institutes that consistently engage in knowledge transfer from one university to the other. These governmental research institutions have autonomy, and the government can focus on creating a culture of innovation in the country through integrated educational advancements (Wilhelm, 2003).

Woerter and Roper (2010) determined that R&D investment in Switzerland declined between 1994 to 2005. This decline may have been due to firms' reduced expectations for returns from innovation in response to market conditions. Alternatively, the decline could have been due to an incapability to transfer knowledge from university or research to industry (Woerter and Roper, 2010).

Since the decline reported by Woerter and Roper (2010), the trend in R&D investment in Switzerland has been positive. The OECD (2017) reported that Switzerland had become one of the highest spending countries in terms of 'R&D spending, high-quality innovation and innovation performance' (OECD, 2017:41) since 2010. Although the country is performing well in terms of R&D spending, the government support for business R&D is the lowest among all EU countries (Arvanitis et al., 2017 as cited in OECD, 2017). That is not to say that businesses do not conduct R&D in the country, but rather that it is highly focused into a particular industry (OECD, 2017). The OECD (2017) also indicated that more than 30% of the R&D is carried out by Swiss pharmaceutical firms.

With respect to gender, there is a wide gender gap that is present in Switzerland than in any other EU country (OECD, 2017). Although the education system of Switzerland is touted as one of the best in the world, there remains a gender gap in the high-skilled sector (SECO, 2017 as cited in OECD, 2017).

The educational system of Switzerland is such that it promoted lifelong learning, according to OECD (2017). The system is divided into two sections: general, which is the academic section; and vocational, which provides industry skills. In this way, the Swiss education system provides individuals with sufficient skills to perform in industry.

3.3.1 Key takeaways from Switzerland

Switzerland is famous for its alpine region, its banking industry, its watches and for the European Organization for Nuclear Research (CERN), an organisation that conducts important research in physics. Being politically neutral has led the country through a stable economy, except during the economic crisis in the early 2000s. Despite the economic crisis, the country has managed to recover substantially, and although growth is not dramatic, it is steady. The country spends a significant amount of its budget on R&D; however, R&D is not widespread across all industries. Unlike other countries, Switzerland has a diffusion education system, and although it is regarded as one of the best in the world, there does not appear to be complex knowledge-sharing pathways between university and industry. The country does not have a clear national innovation system, and a lack of substantial research exploring the Swiss national innovation system was noticed. The lack of an innovation policy hampers the ability of the country to use all its resources and create substantial innovation. Although the innovation levels are some of the highest among the EU countries, the lack of proper diffusion channels means that the country cannot reach its full potential. Zurich is generally considered the ICT cluster in the country, but in the absence of sufficient university–industry collaboration, the cluster cannot reach its full potential. Overall, there is little diffusion of knowledge between the university and the industry, and hence, the country cannot realise its true potential for technological change.

3.4 Singapore: The land of the USB and transportation

Singapore is an East Asian country with a GDP of US$ 349.659 million and a population of around 5.661 million as of April 2018 (IMF, World Economic Data, April 2018). Figure 3.7 shows that there has been steady economic growth in Singapore since 1980. Although there have been some fluctuations in its economy, the current and projected growth is strong.
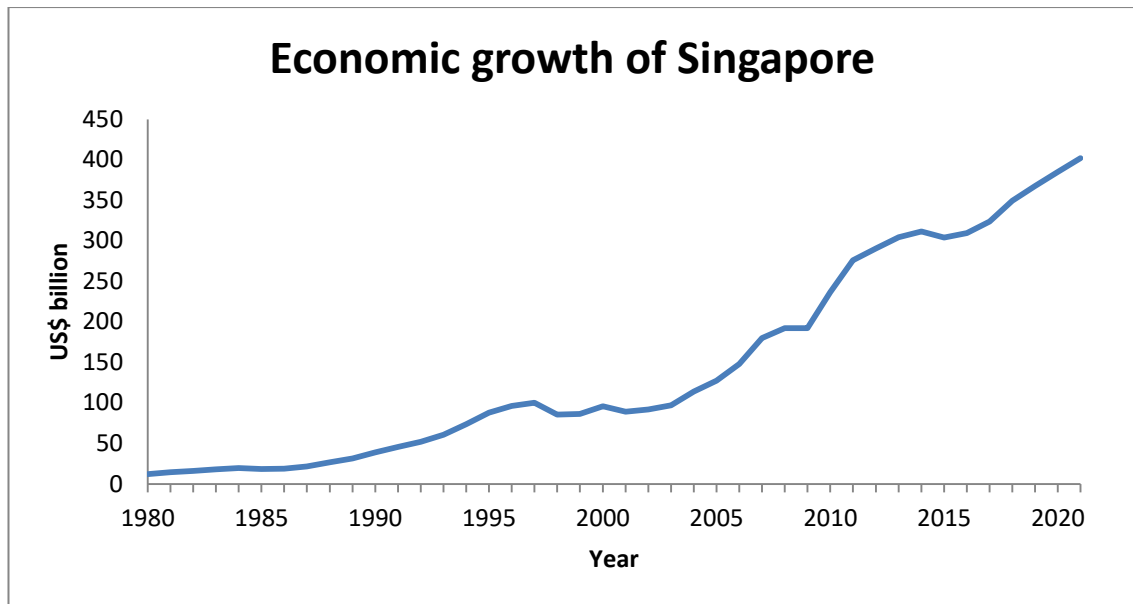
Figure 3.7: Economic growth of Singapore (1980–2021) in US$ billion (Constant prices/real GDP)

The OECD (2013) stated that Singapore was relatively late to undergo industrialisation and has achieved unprecedented growth. Its economy is the third-largest in the world, a result accomplished by rapid technological development and restricting. According to the OECD, the government has played a crucial role in building Singapore's position in the R&D sector, with policies targeting the same.

Singapore is a small country, so its domestic market is relatively small. Therefore, it has had to rely on global and regional markets to fuel much of its growth. One of the primary steps that the early Singaporean Government took was to open its market for international foreign investment. This makes the Singaporean economy one of the prime examples of how openness can fuel innovation. According to the OECD (2013), the major share of investment in the Singaporean economy was from the European region, followed by the Asian region.

The OECD (2013) stated that Singapore has developed its innovation and competitiveness due to two reasons: its focus on building educational capability and its global openness. In terms of its education system, the country focuses on building skills that can match the changing global market and innovative environment. Its firms have been exposed to the global market and deal with competitiveness on a global level. As a result, Wong (2003) states that because many of Singapore's large corporations are MNCs, they have demanded high-quality products and process improvements, especially in manufacturing and logistics. This also lends to Singapore's status as having one of the best land and sea transport systems. Wong states that the country was

essentially forced to develop high-quality transport systems or risk losing to the global competition.

The OECD (2013) stated that the innovation infrastructure of Singapore is one of the most advanced among the Asian countries, and the government consistently works towards building new innovation capabilities. The country set up two clusters to replicate the success of Silicon Valley in the US. Through the early 90s, the country developed two Science Parks (I and II) consisting of ICT companies and private and public research organisations. Later, the country developed the One North cluster, which brought together R&D facilities, IP firms, VCs and other related parties in close proximity (Wong, 2003). According to Finegold et al., (2004), the goal of One North's development was to establish complex but informal pathways of sharing knowledge and to fast-track scientific and technological progress. The OECD (2013) stated that 'One North represents the most ambitious R&D infrastructure support project attempted by the government to date' (OECD, 2013:203).

In addition to the One North cluster, the country has also established a site where innovations can be tested before they are released into the market. This enhances the acceptance of technology and strengthens the knowledge-sharing pathway.

The OECD (2013) stated that links and sharing of information across various stakeholders is very strong in Singapore. Wong (1999) stated that this developed with the aid of the government and the large MNCs that wanted to enhance their business processes. This presents the evidence of a strong knowledge-sharing pathway in the country.

In the early days, the university–industry collaboration was weak in Singapore. However, the collaboration and knowledge-sharing between the universities and industry have increased substantially since the early 2000s (OECD, 2013). This occurred because of an increased focus from universities on the commercialisation of research and the development of better, marketable innovations. The most common collaborations in the country have been between local firms and local higher education facilities such as universities.

Wang (2018) found that the Singaporean Government is playing an increasingly major role in its development as an innovation hub by creating and implementing specific policies that mitigate the deficits of the older system of innovation.

The education system of the country is driven by efficiency and creates a culture of innovation. There were three phases that led to significant changes in the education system of the country: survival (1959–1978), efficiency (1979–1996) and ability and aspiration (1997–present) (OECD, 2010b). During the survival phase of the country's education system, the quality of education was weak, and the country was producing enough manpower to fuel its industrial needs and educating as much of the population as possible. The second phase brought changes to the educational philosophy of the country as it shifted to skills-based learning and development. In addition to changing the output generated by the education system, it also moved towards creating an adaptable system that changed based on the individual. This individualised approach meant a significant shift from its one-size-fits-all approach and led to a rapid decline in its high dropout rates. According to the OECD, the primary goal of this change was to create knowledge and skills in all sectors. The final phase came about with the directive to transform the nation into a knowledge-based economy. The OECD stated that this change was due to the openness of the country and the resultant global competition that the country faced. The focus was shifted towards capacity building and ensuring that there was sufficient creativity, innovation and research. In line with this, the country launched a vision that encouraged thinking and learning as essential capacities for Singaporean people. The slogan of this movement is 'Thinking Schools, Learning Nation'.

Lee et al., (2008) stated that the third phase in educational development was designed to provide students with greater flexibility in terms of time and areas of study and to foster a culture of innovation supported by a strong learning drive. In addition, Lee et al., (2008) identified significant changes in the way the teachers are incentivised to ensure that the teachers were being compensated accordingly and are motivated to teach. Cluster development was not limited to industry, as Singapore revamped the traditional structure of schools and developed educational structures around geographical areas. The top-down system of management was removed, and a group of leaders were established to manage each school cluster. Every cluster has its autonomy and focuses on inspiring the students to perform well.

The incorporation of technology into the education system has also led to significant improvements in the same. The use of streaming as an important feature of the education system has proven to be beneficial as it allows students to study at their own pace and encourage learning and development.

Singapore has come a long way to build an education system that motivates and encourages learning, creativity, and innovation. It has done so, according to OECD (2010), by maintaining a close collaboration with policymakers, researchers and educators. This has created a strong feedback loop, which consistently feeds new information into the system and enhances the education system in the country. In addition, there is a strong alignment between the goals of interrelated stakeholders in Singapore. This enhances the effectiveness of any new implementations. As the education system is tightly linked in the country, a change in one sphere results in a change in all spheres, unlike in systems, which are more disconnected with one another (OECD, 2010).

The way that Singapore instils core problem-solving skills and innovative capacities can be seen in the way it teaches mathematics. According to the OECD (2010), the primary responsibility of the teacher is to develop what is known as 'maths sense'. Rather than focusing on one right answer, the focus is on developing skills that lead to the right answer. In addition, Singapore has established a model learning method where abstract mathematical ideas are transformed into tangible models of various shapes and sizes. This enhances the learning of the subject on a deeper level and encourages creative thought. The human resources required in the country matches the manpower requirement. Finally, the system of education is under consistent review and improvements are made on a regular basis.

Overall, the country has displayed strong growth and development, especially in the technological aspect of its growth, by creating an open economy and by establishing a unique but highly effective education system.

3.4.1 Key takeaways from Singapore

However, while the positives clearly outrank the negatives, the innovation system of Singapore is far from perfect. The culture and the social norms of the country reduce the chances for many individuals to enter entrepreneurship due to the high opportunity cost. Additionally, although there is a strong knowledge-sharing pathway in the country, it can certainly be improved. While the economy of the country remains open, as it will presumably do so in the future, the country needs to ensure that it is not compromising on building internal capabilities and capacities, rather than just relying on international skill and investment.

Singapore has certainly shown superior resilience and strength when it comes to development and leading for change. However, while it may be the superior country in relation to its neighbours, it still lags behind the major advanced economies.

Singapore's education system is one of the most advanced in the world. Its focus on students and improving the system from within has led to several innovative changes. By transforming the system from teacher-led to student-led, by integrating technology into everyday learning and by developing innovative methods of teaching, the country has taken steps towards creating a love for learning and innovation. As the current education system in the country is well-integrated and closely aligned, the implementation of new policies and procedures is seamless. The development of autonomous educational clusters seems to be an innovation in itself. By working with researchers and policymakers, educators can develop and establish system enhancements across the system.

Having a closely coupled system enhances the quality of education and capability building. However, Singapore is a small country. What is possible in Singapore may not be so in other larger countries with broader school systems. Finally, Singapore enjoys a political stability that enables its strong education system.

3.5   The US: Garage start-ups to multimillion-dollar companies

The US currently has a population of 328.434 million and a GDP of US$ 20,412.87 million. Figure 3.8 shows the economic growth of the country from 1980 to 2021 (predicted).
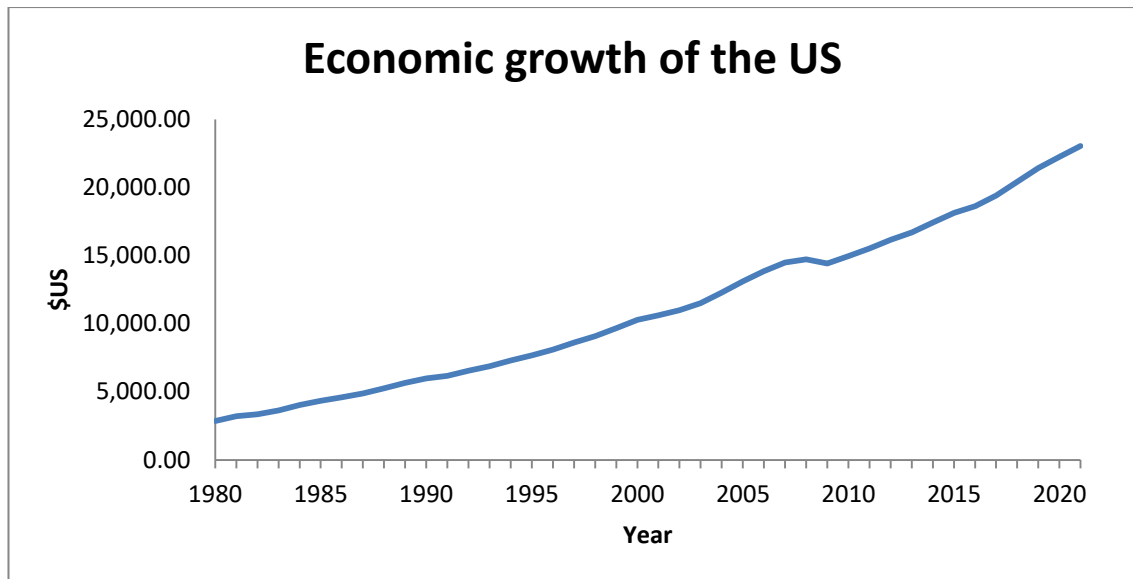
Figure 3.8: Economic growth of the US (1980–2021) in US$ (Constant prices/real GDP)

The economic growth of the US has been mostly exponential, with minor fluctuations towards the late 2000s. Several innovations have come from its Silicon Valley cluster, which promotes ICT R&D. Notable innovations include Apple, Facebook, Google, Hewlett Packard and Tesla, to name a few.

Mowery and Rosenberg (1993) carried out a comprehensive review of the entire system of national innovation of the US before, during and after the war era of the country. Substantial change has taken place in the country with regards to its national innovation system during the timeframe investigated. During the twentieth century, the university and industry sectors engaged in informal knowledge and information sharing, which resulted in substantial industrial research development.

By the end of the 1930s, the US had an already established research and academia system (Mowery and Rosenberg, 1993). This was because there was substantial support provided by the federal government for enhancing non-agricultural R&D. Before World War II, the US economy did not rely on R&D growth in manufacturing and industry. During the war, innovation surged; it was not driven by the need for capacity building and knowledge development, but by national security reasons. Then, a collaboration formed between the federal and the private sector for R&D, despite not being driven by any particular strategy, and was a key influencer in leading R&D during the post-war era. Much of the country's R&D budget was spent on military R&D, which required a supply of relevant skills. However, caution is given against the idea that it was a higher military budget, which led to the growth of the nation's economy (Mowery and Rosenberg, 1993).

With the establishment of antitrust laws, large firms had to increase their value proposition in the market and carry out innovation and research. This created the impetus for firms to launch extensive corporate R&D investment. As a result, the development of new products and services took shape in the US and led to a wider diffusion of knowledge.

Mowery and Rosenberg (1993) noted that during the post-war period, much of the efforts were focused on developing technology policies, which strengthened its position on the global front.

Adams et al., (2005) stated that in the US, the size of the scientific team and the specialisation and division of labour has risen since the early 90s. There has been an increase in collaboration with local industries and foreign universities. However, domestic collaboration has not increased as much as foreign collaboration. This meant that the location of the team became dispersed, which may have been because of advancements in telecommunications (Adams, 2005). Foreign research has been increasing due to advancements in the research enterprise and international capabilities in the US (Adams, 2005). Collaboration across cultures brings together various skills that a domestic environment cannot provide. However, Adams (2005) suggested that universities and research institutes are forced to find international support as an alternative to a lack of domestic, federal funding. This points to a lack of internal channels or pathways knowledge-sharing between the university sector and firms in the country.

Another trend, noted by the OECD (2011), is that there is a lack of apprenticeship programmes in the US. This could reduce the seamless transfer of knowledge from university to industry and force individuals into odd jobs that do not have an innovative yield. The country could establish a complex pathway of sharing information by creating robust apprenticeship schemes, which enable recent graduates to gain industry knowledge and help in the transfer of knowledge from one sector to another.

The OECD (2011) stated that the system of education in the US had shown considerably lower performance in relation to the other member states. In addition, due to the number of states in the US and the lack of a unified education system, individual states report a variety of performance rates. In addition, the 2011 OECD report stated that despite the lack of a high-quality education system in the country, there is a significant technological innovation present.

Deckter et al., (2007) stated that better patent laws, and the general culture of patenting a research outcome rather than publishing it, could be one of the reasons why

technological innovation seems to flow into the US at a higher rate. This could be one of the reasons for the high rates of technological transfer from university to business. In addition, Deckter et al., (2007) found evidence of more innovative behaviour in the US in terms of risk-taking, which could explain the higher rates of innovation in the country.

The OECD (2011) found that spending on education is far greater in the US than other member states. However, this could be due to the large size of the country. Despite the higher spending on education, the poor performance of the country's education system is notable. It could be stipulated that due to the presence of natural resources in the country, it focused on developing the means to use the same towards its economic success. In comparison, some of the OECD member states such as Finland, Singapore, and others that have a better education system, had to develop capabilities through skills and knowledge to be able to compete in the global marketplace.

A survey by the OECD (2011), found that children in the US tend to overestimate their skills. A higher self-perception of skills can lead to a lack of drive to improve self-learning. The report stated that there is a culture of providing praise to students for mediocre effort in the country. In addition, the report pointed out that the teaching quality in American schools is lower than the other member state countries (OECD, 2011).

The lower teaching quality in the US could be because the profession is not as highly respected as other countries like Finland. Teacher appraisals take place as observations of performance in a classroom setting (Douglas and Douglas, 2006); however, Bingham and Ottewill (2001) stated that this form of appraisal can be inaccurate as the person's performance may be affected by the process of observation. It could also be hypothesised that the culture of enhanced self-perception present in children extends to adults as well. That is, just as children were identified to have higher self-perceptions where they were rewarded for mediocre behaviour, the teachers could be practising the same.

The 2011 OECD report stated that teachers' pay in the US is less than the other OECD countries (OECD, 2011). Furthermore, teaching is often viewed as a career that the lower-class members use to move up to a higher socioeconomic rank. This might imply that the selection of teachers is limited to people from lower-income families looking to enhance their economic position, rather than from individuals who value teaching as a knowledge-based profession.

The management of schools and universities differs considerably in the US compared to the other OECD member states (OECD, 2011). For instance, the education system in

other countries has a centralised, bureaucratic approach and therefore, a more regulated education system than in the US. However, in the US, autonomy is granted to every school, and their management is carried out district-wise. Although the size of the country is substantially larger than the other member states, having a more centralised education system can provide clear benefits in terms of streamlining the system. However, to do that, the country will have to undergo significant changes to its curriculum, assessment system and management system. In addition, the primary change required is the quality of teaching and the way the personnel flow is created to the schools. A significant shift in mindset will be required if the country must encourage individuals to view teaching as a knowledge-based profession rather than just a means to move from one social class to the next. Doing so will shift the accountability of success in education to the system and teachers who can then work together to produce better results.

The OECD (2011) reports that there is an attempt to better the education system of the country by adopting common core educational standard across the states. This is an attempt to unify the input for the educational system and achieve some centralisation of the curricula and assessment methods, at the very least. In the future, this has the potential to unify the output that is generated by the schools and universities, thereby reducing some of the discrepancies in the educational performance of the states within the country.

3.5.1   Key takeaways from the US

The US risks lagging behind the most advanced education systems unless it can find a way to ensure that: its assessments evaluate what students should be taught, instructional materials that are available match the content that teachers are supposed to be teaching, teachers are being prepared to teach what the state expects students to learn, there is a pool of potential teachers who are up to the task; the standards for admission to the institutions that prepare teachers are high enough to attract those who value teaching; the programmes of those institutions are designed to attract young people who could choose to be doctors and architects and engineers; young people are incentivised to work hard in school; the credentials that young people gain from school match the needs and expectations of employers and colleges. The US has a variety of initiatives underway to address many of these challenges in areas including assessment quality, instructional materials and support, recruitment of high-calibre teaching candidates, alignment of teacher preparation with classroom needs and the alignment of standards for education with the expectations of employers and colleges. The US needs

to pay close attention to the coherence of these initiatives as they continue and develop, and to support effective implementation at the state and local levels.

No explanation has been found to understand how the country with a relatively poorer education system can have such a high innovation rate in the world.

3.6   The Netherlands: The birthplace of wi-fi and microscopes

The Netherlands has a population of 17.08 million and a GDP of US$ 825.45 million. Figure 3.9 shows the economic growth of the country from 1980 to 2021 (projected).
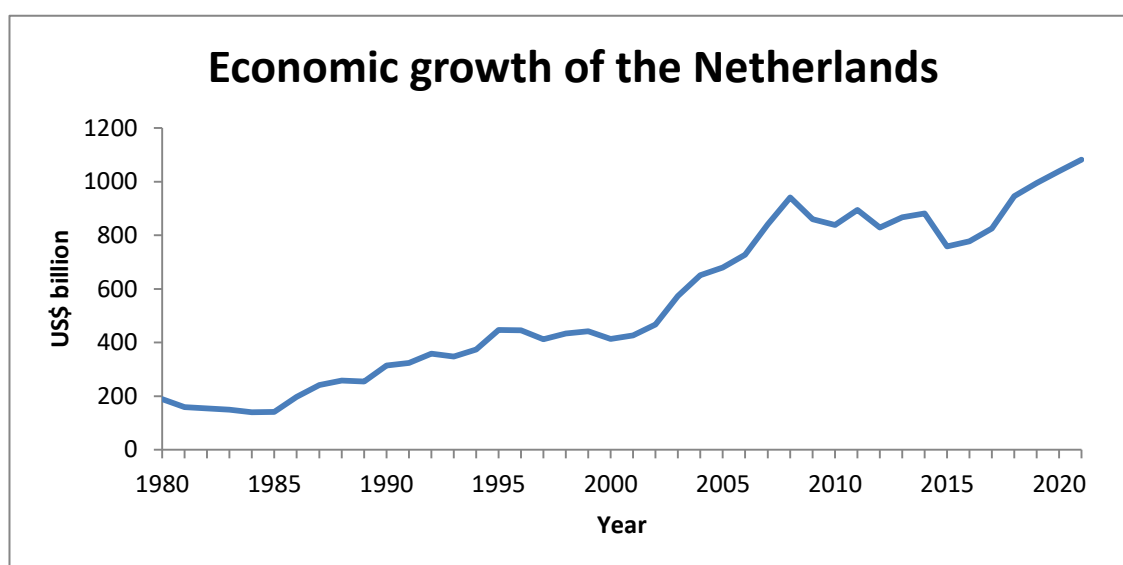
Figure 3.9: Economic growth of the Netherlands (1980–2021) in US$ billion (Constant prices/real GDP)

In 2007, an empirical study conducted by van Beers et al., (2007) found that the Netherlands sees less involvement by international firms in terms of R&D collaboration. In addition, there is a need for academic research and spillover to act as crucial drivers of innovation. However, van Beers et al., stated that there was a general reluctance from firms to share their knowledge with public research institutions, resulting in a reduced amount of R&D collaboration than expected.

According to Stiekema (2005), the Dutch government has stated that its goal is to improve the rate of innovation taking place in the country. The government of the Netherlands was advised to adopt key steps to achieve the goals:

1. Establish a government body that was solely responsible for policymaking and governance of the national innovation system of the Netherlands. This must be

carried out at the national level to successfully transform the Netherlands into a knowledge economy.

2. Allocate more resources for R&D efforts. This means that the country should increase its budget for R&D to facilitate more research and gain a leading position among European countries.

3. Increase the rate of students in science subjects. A decline in the number of science students in the country could seriously cripple the country's innovation capabilities and thereby hinder its plans to transform into a knowledge-based economy.

4. Reinforce its position within the EU to reap the benefits of an integrated system of innovation.

5. Enhance its focus and collaboration to make the most out of innovation. That is, the country needed to enhance its rate of R&D collaboration and form dynamic networks of communication to generate greater results from university and industry.

6. Increase the amount of research taking place in industry. The country needed to assume that industry will play a significant role in facilitating innovation as it charts its way to a knowledge-based economy.

7. Increase technology start-ups to promote collaboration and innovation.

8. Bring in external researchers who can transfer essential knowledge into the country.

9. Streamline the availability of research funding to a wide range of areas, not just those that require immediate attention.

10. Incorporate its plan for a knowledge-based economy in its coalition agreement with the EU.

Following the above advice, Stiekema (2005) notes that there have been considerable changes to policy in the Netherlands to improve innovation outcomes in the country. However, no other analyses of the suggested measures could be found to support this claim.

With respect to culture in the Netherlands, Bekkers and Bodas Freitas (2008) found that academic researchers placed a greater emphasis on the development of knowledge transfer channels from university to industry than industrial researchers did. The authors also found that firms only engaged in R&D when their strategic goal was to gain an advantage over the market by early entry and capture, or if their goal was to be considered innovators. Much of the research was in the biomedical or computer sciences sectors, with an emphasis on product development and improvement. Furthermore,

many firms that engaged in R&D with universities did so with the aim of obtaining patents, which facilitates the adoption of knowledge. This was especially true for the material sciences and chemical engineering sectors.

In terms of the education system, the Netherlands is one of the top-performing OECD countries (OECD, 2014). The 2014 OECD report noted that the country is performing much better than the OECD average based on the 2012 PISA cycles. In addition to the standard subjects such as mathematics and science, the performance of Dutch students in creative problem-solving was higher than the OECD average. Teachers received considerably higher pay in the Netherlands than other OECD countries. There is great autonomy awarded to schools in the country with an education board that governs the country. However, a primary limitation is that the teaching workforce is older than 50 years of age on an average. If this trend continues, there will be a shortage of teachers in the country. One reason for this demographic within the teaching profession may be that there is a stringent process for evaluating teachers in the country, which ensures that only the most qualified teachers are teaching in the classrooms. The 2014 OECD report identified that teaching is a well-respected profession in the Netherlands. Teachers are highly respected, well-compensated and passionate individuals who choose to teach because it is considered a knowledge-based profession. Despite the robustness of the education system, the rate at which students take up tertiary STEM (science, technology, engineering, mathematics) subjects is low compared to the other OECD countries (OECD, 2017a). The most common tertiary fields of education are business, administration, law, health care, media and journalism. The country has the lowest rate of tertiary graduates in engineering and technology among all the other OECD countries. The Netherlands is one of the few countries that provides vocational training in addition to educational teaching, and the representation of females is almost equal to males. However, in the case of STEM fields, the female population is underrepresented in comparison to other OECD countries.

3.6.1 Key takeaways from the Netherlands

The amount of information available about the Netherlands' national innovation ecosystem is scarce. However, the information available points to a healthy system with a good educational backbone. The R&D collaboration between the university and industry sectors needs to be strengthened, and complex pathways need to be developed for knowledge and information sharing. The focus should shift from developing innovations that anchor the firm in the industry as a pioneer to the exploration of new avenues that generate innovative solutions.

3.7 Sweden: Agriculture, renewable energy and equality

In 1993, Edquist and Lundvall stated that Sweden had begun heavily investing in its R&D and had the highest number of patents registered in the US at the time (Edquist and Lundvall, 1993). The authors noted that despite being an agrarian country in the 19th century, the country exported mining and forestry products, which were indicative of the country's engineering capabilities. Due to this, the engineering sector of Sweden saw an increase in the employment rate, and before long, the country was developing innovations to optimise metallurgical processes.

Today, Sweden has a population of 10.12 million and a GDP of US$ 538.575 million. Figure 3.10 represents the growth of the economy from 1980 to a projected value in 2021.
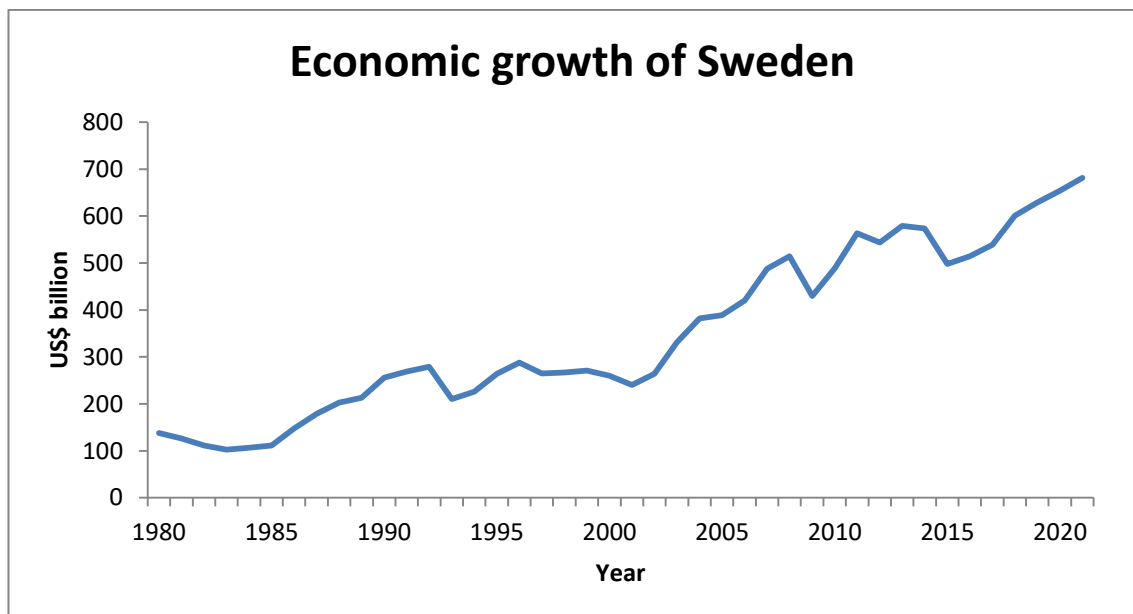
Figure 3.10: Economic growth of Sweden (1980–2021) in US$ billion (Constant prices/real GDP)

Although the innovative performance of the country seems to be in a good position, the GDP has all but been fluctuating. However, according to Sweden.se (2018), the percentage of GDP spending on R&D efforts is considerably higher than in other countries. Figure 3.11 displays the percentage of GDP spent on R&D efforts in Sweden.
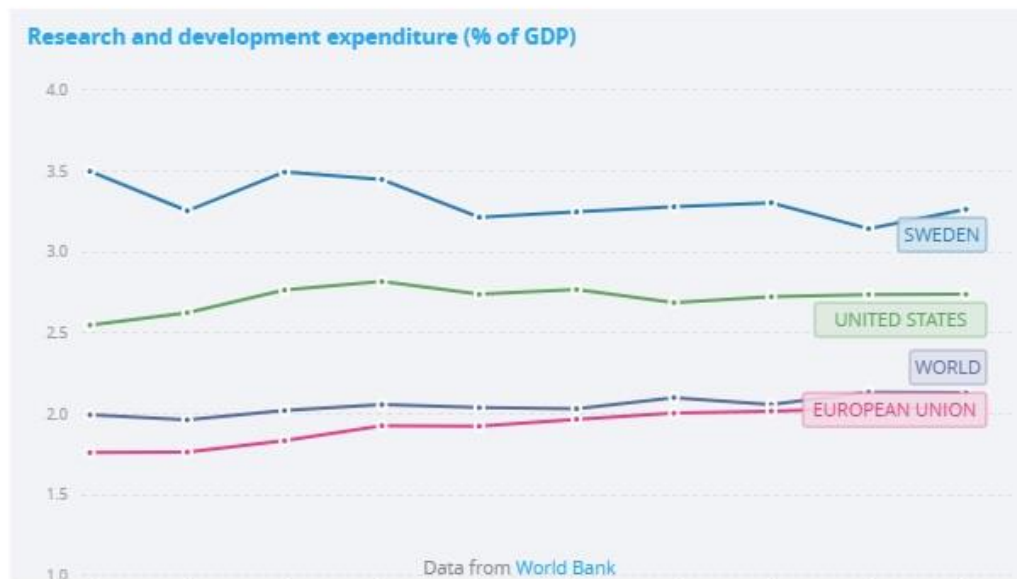
Figure 3.11: Percentage of GDP spending on R&D in Sweden

Sweden.se (2018) states that the welfare state has been one of the key drivers of innovation in Sweden. The welfare state provides a safety net for entrepreneurs to rely on if their new business fails. This system can facilitate experimentation and risk-taking, which are crucial for innovation to take place. In addition, there are several government agencies that provide funding for essential research in the country. Two of the leading innovation sectors in the country are life sciences and green energy.

According to the OECD (2018), innovations take place in all sectors of the Swedish economy. In the agricultural sector specifically, there are several policies that drive innovation to ensure that productivity and competitiveness of the sector. The high rate of innovation in Sweden is also due to the economy being based on innovation and being highly competitive. The 2018 report from the OECD also stated that Sweden consistently provides economic incentives to promote firms engaging in R&D. In addition, the country places emphasis on renewable energy; around 50% of its energy supply comes from renewable sources such as wind, biomass and hydroelectric power.

In terms of university–industry collaboration, Okubo and Sjöberg (2000) stated that the policies in Sweden promote collaboration between universities and industry. However, the focus is shifted from the industry calling out for collaboration to the university. The policy promotes the researchers to seek and obtain collaborative partnerships with firms. This also enables more technological diffusion in the country. In addition, the country is promoting knowledge-based production and enhancing the mobility of researchers between the university and industry. Research is originating from engineering, life

sciences and pharmaceutical biotechnology firms. Furthermore, Sweden has substantial university–industry collaboration, where more than one-fourth of the publications were found to be published because of joint R&D efforts. In Sweden, there is a complex knowledge-sharing pathway that exists to make sure that enough knowledge is distributed to industry from the university sector.

The OECD (2018) report stated that the education system in Sweden is one of the best in the world and among the OECD member countries. When evaluated by business leaders, the quality of education in the country is ranked highly. This portrays the fact that the country's education system can meet the needs of the competitive marketplace and develop knowledge and skills in the population. However, the 2018 OECD report outlined an issue: the rates of tertiary education in Sweden are declining and are below the OECD average. The reason for this is stipulated to be the lower advantage that a tertiary education offers; the salary for someone with tertiary education in Sweden compared to a non-tertiary educated person is less than the OECD average.

In terms of the structure of the academic industry, the OECD (2018) outlined that Sweden affords a great deal of autonomy to schools and their management, even for decisions such as teachers' salaries. Although educational quality is overseen by the board, the system is decentralised. However, policies are aiming to increase the salaries of the teachers to attract more teachers to the profession. In addition, Sweden is allocating greater financial resources to schools with poorer learning outcomes.

3.7.1 Key takeaways from Sweden

Sweden has become synonymous with gender equality in all aspects of life. In terms of innovation too, the country is pioneering among the other OECD member states. Spending a relatively higher percentage of GDP on R&D efforts displays a commitment to enhancing innovative competitiveness. The country's education system has been touted as one of the best in the world, marked by high-quality education that focuses on providing useful skills to individuals. Despite being a decentralised system, student performance is remarkably great.

Since agriculture plays a significant role in the country's economy, it fosters innovative bonds between universities and industry to lead innovation in the agriculture sector. Other sectors that promote innovation are the life sciences, technology and the pharmaceutical industry. The country also has incentivised R&D practices and encourages the university to form collaborations with the industry as opposed to the other

way around. With a focus on renewable energy, the country is leading in innovation, education and equality.

3.8 The UAE's transformation to a knowledge-based economy

The UAE has launched the National Vision 2021, which outlines the country's aim to become one of the leading countries in the world. An important aspect of this vision is the transformation of the UAE's commercial and oil-based economy to a knowledge-based economy, along with developing a first-rate education system. As stated on the National Agenda, the Government of the UAE has outlined key priorities like driving R&D, increasing the rate and standard of education and driving innovation to enable its transformation into a highly competitive knowledge-based economy.

The OECD (1996) has defined a knowledge-based economy as one reliant on the production of knowledge and information as well as its distribution and use. As an economy transitions towards being knowledge-based, the need for skilled labour increases and unskilled labour decreases. The companies operating in this transitioning economy pay more for knowledge rather than manual work. Broadly speaking, the shift from an industrial or commercial economy to a knowledge-based economy is characterised by an accumulation of knowledge and an increase in technical progress. Science has been identified as the primary producer of knowledge and new technologies. According to the report, the scientific system needs to work on three fronts: R&D (production of knowledge), education and training (transmission of knowledge) and the transfer of knowledge to organisations to allow them to exploit such knowledge and add to the economic growth of the country. Some key indicators of a knowledge-based economy have been identified in this report. Although knowledge cannot be quantified, the report suggested looking at the (i) country's investment in R&D activities, (ii) the rate of employment of technically skilled labour like engineers, (iii) patents and (iv) international balances of payments for technology (p. 31).

A positive relationship between national R&D expenditure and business innovation has been identified (Voutsinas, Tsamadias, Carayannis and Staikouras, 2018). According to the Federal Competitiveness and Statistics Authority (2016), the UAE spent around 0.955% of its GDP on R&D activities in 2016. Although much of the national data about the UAE's expenditure on R&D activities cannot be tracked due to lack of complete disclosure, it was noted that the country's R&D expenditure had significantly diminished, along with its transfer of foreign technology and the creation of new knowledge (Ahmed and Abdalla Alfaki, 2013). Calling on the UAE to increase its spending on R&D-related

activities, Ahmed and Abdalla Alfaki (2013) also suggested increasing the investment in education, which in turn contributes to national R&D activities.

Ahmed and Abdalla Alfaki (2013) noted the UAE's efforts to diversify its economy and move away from a heavy reliance on hydrocarbons. They also stated that there was an effort to increase the participation of UAE nationals in the workforce of the country, a process that has been defined as Emiratisation. As the UAE has been moving to diversify its economy, it has gained the position of the most diversified marketplace in the Middle East (D'Mello, 2018). It can be concluded that the UAE is transitioning into a knowledge-based economy.

Productivity is an essential aspect of economic growth. Measuring productivity and competitiveness has been outlined as a critical aspect of identifying the knowledge rate of returns by the OECD (1996). With economic advancement and a better understanding of the knowledge flows in an economy, productivity and competitiveness are terms that have become intertwined. This interdependency is evidenced by the World Economic Forum, which has designed the GCI to understand where each economy stands in its level of productivity. Competitiveness has been defined as a measure of a country's productivity in terms of its policies, institutions and other parameters (Cann, 2016). According to Cann, there are 12 distinct aspects that are used in the measurement of a country's economic productivity or competitiveness, and they are illustrated in Figure 3.12.

The rank of the UAE in the GCI is 17th of 137 economies ranked in 2017–2018 (World Economic Forum, 2018). Countries can be categorised into several stages of economic growth. According to the report, the UAE has been categorised as being an innovation-driven economy. Figure 3.13**Error! Reference source not found.** depicts the erformance of the UAE for each of the pillars seen in Figure 3.12 for the year 2017–2018.
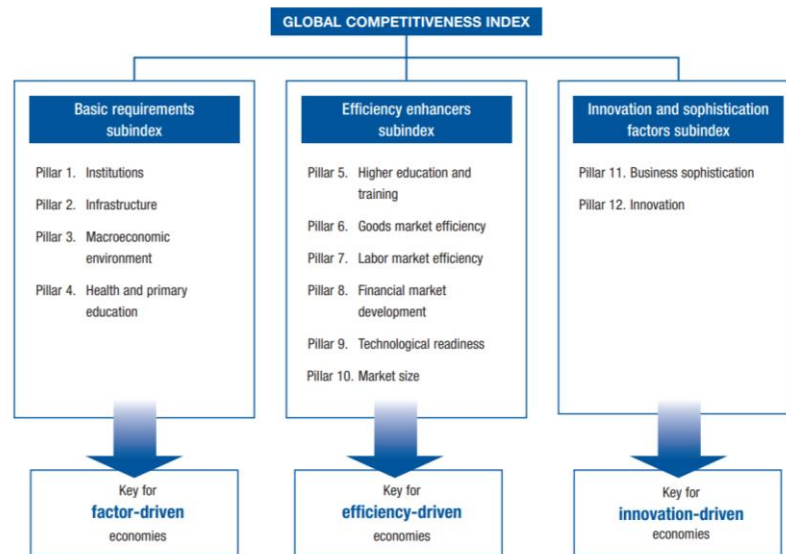
Figure 3.12: Twelve pillars of measurement for GCI

(Source: Global competitiveness index report 2017–2018. Available from
http://www3.weforum.org/docs/GCR2017-
2018/05FullReport/TheGlobalCompetitivenessReport2017%E2%80%932018.pdf)

The overall rank of UAE in sub-index C is 20 out of 137. Within this category, the UAE ranks 25th in terms of the innovation pillar, out of 137 economies. The UAE has shown considerable improvement, and the report credits this to the increased diversification of the economy. The report has suggested that the UAE upgrade its education quality, as it currently ranks 36th out of 137, if it hopes to increase its overall rank and competitiveness index.

Science and technology play a significant role in the economic development of a country. Development in science and technology can help mitigate many of the issues that impede economic growth and development.

Performance overview

Index Component	Rank/137	Score (1-7)	Trend	Distance from best
Global Competitiveness Index	17	5.3		
Subindex A: Basic requirements	7	6.0		
1st pillar: Institutions	5	5.9		
2nd pillar: Infrastructure	5	6.3		
3rd pillar: Macroeconomic environment	28	5.6		
4th pillar: Health and primary education	33	6.3		
Subindex B: Efficiency enhancers	17	5.2		
5th pillar: Higher education and training	36	5.0		
6th pillar: Goods market efficiency	3	5.6		
7th pillar: Labor market efficiency	11	5.2		
8th pillar: Financial market development	24	4.8		
9th pillar: Technological readiness	24	5.8		
10th pillar: Market size	29	4.9		
Subindex C: Innovation and sophistication factors	20	4.9		
11th pillar: Business sophistication	13	5.3		
12th pillar: Innovation	25	4.6		

Figure 3.13: Performance overview of the United Arab Emirates on the global competitiveness index pillars

(Source: Global competitiveness index report 2017–2018. Available from
http://www3.weforum.org/docs/GCR2017-
2018/05FullReport/TheGlobalCompetitivenessReport2017%E2%80%932018.pdf)

In an effort to improve its GCI ranking, the UAE must augment its knowledge-based innovation, as this has been identified as the primary indicator of a higher GCI rank (Gackstatter, Kotzemir and Meissner, 2014). Gackstatter et al., (2014) have posited that when an economy develops a sound and structured education and research system, it invariably increases its absorption of innovation and knowledge developed in other economies. The researchers identified a direct link between the R&D expenditure and GCI rank of the countries investigated.

Sweden, which ranks as number one in the GCI, spends as much as 3.3% of its GDP on R&D (OECD, 2018) as opposed to the 0.95% that UAE is spending on its R&D. By increasing R&D expenditure and increasing its private and public sector contribution to R&D, the UAE might move closer to realising its goal to transition into an innovation-based economy.

Overall, there is a lack of data available regarding innovation in the UAE. An empirical analysis will be carried out to understand the position of the UAE and where it stands compared to the countries explored throughout this chapter.

3.9 Analysis and conclusion

The purpose of this chapter was to create a detailed understanding of how other countries ensure that they have a competitive and knowledge-based economy. For this purpose, the following parameters were considered:

1. Does the country have complex pathways of sharing knowledge, technology and information?

2. Does the country ensure that there is a sufficient integration of education and learning with its innovative drive?

3. Does the country display effective and sustainable university–industry collaboration?

4. Does the country promote effective cluster development?

5. Does the country, through its educational system, promote the culture to innovate?

Following the setting of these criteria, seven countries were analysed based on the available information. The results of the expansive discussion are given in Table 3.1.

Table 3.1: Comparison of countries

Countries	Complex knowledge-sharing pathways	Integration of education and innovation	University–industry collaboration	Cluster development	Culture to innovate
South Korea	High	Low	High	Low	Medium
Germany	High	High	Medium	Low	High
US	Low	Medium	Medium	High	High
Sweden	High	High	High	Low	High

Singapore	Medium	High	Medium	Medium	Very Low
Switzerland	Low	Medium	Low	Low	High
Netherlands	Low	Low	Medium	Medium	Medium
UAE	Low	Low	Low	Low	Medium

In Table 3.1, no country is perfect in terms of having an innovation system that facilitates its shift to a knowledge-based economy. Education plays a major role in the system, and university–industry collaboration is what creates the diffusion of technology. Except for Singapore, the culture to innovate in the countries is good. Germany promotes a culture of individualism, whereas Sweden provides a blanket of safety for failed ventures. The US promotes higher self-perception, which could lead to greater innovation, and South Korea has an increasingly competitive environment. The Netherlands and Switzerland have a strong culture to innovate as well.

This summary has provided core insights into where each country stands in relation to the criteria for measuring a successful knowledge-based economy. The UAE can use these data as a benchmark to develop its own innovation ecosystem. For instance, the Government of the UAE can adopt the incentive scheme of Sweden and provide funding support to researchers. It can also establish clusters such as the one in Silicon Valley, US, to promote R&D. However, the primary purpose of this examination is to allow the UAE to identify the disadvantages in the systems of the other knowledge-based economies and develop a system that can function with minimal limitations. For instance, the low cluster development in Sweden could have limited its economic growth, and the lack of complex knowledge-sharing pathways in the US creates issues for the diffusion of technology.

4 Methodology

This chapter focuses on the research philosophy that underpins the research design, approach and strategy of the thesis. A methodical approach is adopted for data collection and sample selection that is well-suited to the purpose of this study. The process for developing the study framework will be detailed. This chapter will lay a strong foundation for understanding the processes, outcomes and discussion points of this thesis.

4.1 Research philosophy

According to Creswell and Creswell (2018), research philosophy is a worldview or a combination of different perspectives to approach research. Saunders, Lewis and Thornhill, (2012) stated that the philosophy of research is related to the nature of knowledge as well as its development. It embodies the researcher's perspectives and world view or assumptions about the nature of the reality itself. It is important to outline the research philosophy at the commencement of a study as it lays a stringent framework and prevents deviation (Easterby-Smith, Thorpe and Jackson, 2015). It also facilitates the development of a comprehensive research design. This research philosophy serves as a guide or provides the researcher with a direction to approach their research.

There are different stances of research philosophy, known as research paradigms (Lincoln, Lynham and Guba, 2011). Two main paradigms represent two different views. The former is known as ontology, and the latter is called epistemology (Easterby-Smith, Thorpe and Jackson, 2015).

Ontology focuses on the nature of being or the reality itself (Saunders et al., 2007). This branch of research philosophy views social phenomena through a scientific lens and considers them as entities. From the ontological perspective, the social reality is external to the researcher; it has no effect on the social actors (Saunders, Lewis and Thornhill, 2012). This philosophical point of view gives the researcher a quantitative approach to the study and demands a more quantifiable outcome. This paradigm is derived from natural scientific methods, where the subjects of investigation are stable and do not display any form of human emotion.

Conversely, epistemology encompasses the study of the nature of reality (Scotland, 2012). Epistemology studies the aspects of reality that demand interpretation. The objective reality that is studied in quantitative terms can then be construed by application of an epistemological paradigm. An epistemological approach considers the appropriate knowledge that is related to that field of study (Saunders, Lewis and Thornhill, 2012).

With these two points of view, ontology and epistemology, the researcher is well positioned to make assumptions about reality and decipher some meaning out of it. Keeping in mind these two broad classifications, research philosophy is further divided into four subcategories. These include positivism, transformative, interpretive and pragmatic (Saunders, Lewis and Thornhill, 2012).

Post-positivism, as stated by Phillips and Burbules (2000), originates from the positivist point of view and relies primarily on empirical observations and quantitative data. The studies that are conducted within this paradigm formulate a set of propositions or hypotheses from an existing theory that is then tested by empirical observations. Thus, at the end of the research, the hypotheses are either accepted or rejected. This type of research is scientific and primarily based on statistical analysis (Tashakkori and Teddlie, 2010). Phillips and Burbules (2000) argued that objectivity is important in this approach. However, the studies often fail to reveal the absolute truth.

According to Creswell and Creswell (2018), post-positivists try to uncover the cause–effect relationship behind every phenomenon. Post-positivism contradicts the traditional belief of the absolute truth that was prevalent in the positivist paradigm. This approach is reductionist as it reduces the reality to smaller sets or units for experimentation. Therefore, it develops numeric scales for measurement (Creswell and Creswell, 2018).

Mertens (2010) stated that the research of any social phenomena needs to be contextualised in a broader political sphere that can help the researcher understand the levels of domination and oppression that operate. The primary aim of this type of research is to bring change and betterment to the life of the subjects or participants. Therefore, social issues are addressed through this type of research. In transformative research, the participants often help design questionnaires and assist with data collection and analysis. Thus, their voices are important in this type of research.

The transformative stance is generally adopted for research into discriminatory practices, societal oppression and inequality (Creswell and Creswell, 2018). For example, it may be useful for studying feminism, racism, LGBT communities and people living with disabilities. The theories that fall under this paradigm are critical theory, feminist perspectives, queer theory and disability theory. The purpose of transformative research is to bring some form of transformation, emancipation and change in the society (Tashakkori and Teddlie, 2010).

The nature of research and its inherent approach change significantly based on the approach chosen. As noted by Saunders, Lewis and Thornhill (2012) if one chooses to

study the topic through an ontological perspective with a positivist view, the research will produce a large amount of quantitative data, and it will be a conducted on a large scale. Conversely, if the researcher is adopting an interpretive approach that stems from an epistemological point of view, the researcher will be focused on subjective analysis. The latter form is useful, especially when the topic under scrutiny has subjective values and includes any kind of social behaviour. In these cases, the laboratory method adopted in the natural scientific method is not as useful, as it simply fails to understand the subtleties of the social context.

Pragmatic philosophy is the fourth type of research philosophy that forms the basis of mixed-method research. This approach adopts a combination of numerical and subjective data that help to understand social reality in detail. While quantifiable methods help to measure variables, the interpretive approach assists in gaining understanding (Tashakkori and Teddlie, 2010; Morgan, 2007).

Because this research focuses on understanding the UAE's current innovation ecosystem and what changes can be implemented to improve it, an interpretivist approach is chosen. The interpretive and pragmatic methods are suitable as they provide room for qualitative analysis of the quantitative data. The quantitative data collected for this study will uncover the real picture of the UAE's innovation ecosystem. Importantly, the quantitative data will be descriptive. Although the research is primarily based on the qualitative data and draws from an epistemological stance, the inclusion of quantitative data will help gain more fruitful research results. The following section discusses the research approaches that flow from the philosophical standpoints discussed above and justifies the selection of a mixed-method approach for this study.

4.2 Research approach

In general, a research approach can be divided into two categories: inductive and deductive. These two approaches take completely different directions (Creswell, 2013). Deductive reasoning moves from general to specific. This means that certain propositions or hypotheses are derived from already existing theories that are tested based on empirical evidence. If there is a vast amount of research available on a topic, a deductive approach is advisable, because a strong base for the research is available. Alternatively, the inductive approach moves from particular to the general (Saunders, Lewis and Thornhill, 2012). Thus, it lays the foundation for the development of grounded theories. An inductive approach is more suitable for novel research topics or where little

prior knowledge is available. In the inductive approach, data is gathered first and then analysed while reflecting on the theoretical and conceptual constructs.

Saunders, Lewis and Thornhill (2012) stated that the availability of time for the research is a factor. In the deductive approach, it is easier to complete the research within a short timeframe, although some effort is directed towards setting the research around a pre-existing theoretical model. Conversely, inductive reasoning necessitates a lengthy period of data collection and exhaustive analysis. An important consideration at this conjunction is the amount of risk that the researcher is ready to accept. However, a deductive approach sometimes gives rise to problems such as the return of the questionnaire and thereby suffers from a low response rate.

Research into the UAE's innovation systems is relatively new, and there is little literature available on the topic. The literature that exists focuses on the innovation ecosystems in other countries. Hence, an exploratory research design is a suitable choice for this study. The UAE's innovative ecosystem, whether it exists or needs to be established, is yet to be explored. A mixed-method approach is suitable in this study because it enables descriptive data collection for the current state of the country's system and allows valuable insights to be drawn from the qualitative study to enable the activation of the UAE's national innovation ecosystem. While collecting quantitative data, the study also considers the qualitative analyses and draws on a more subjective approach based on interpretive philosophy. This will be discussed in greater detail in the next section.

4.3   Research design

The research design serves as the blueprint or general guide for research (Saunders, Lewis and Thornhill, 2012). It guides the researcher, helps answer the research questions and attain objectives. The research design covers the minutest details of the research, starting from the formulation of the research question, study of the existing literature, through to the methodology, data collection and analysis. This sequential process is depicted well in Figure 4.1, the research onion.
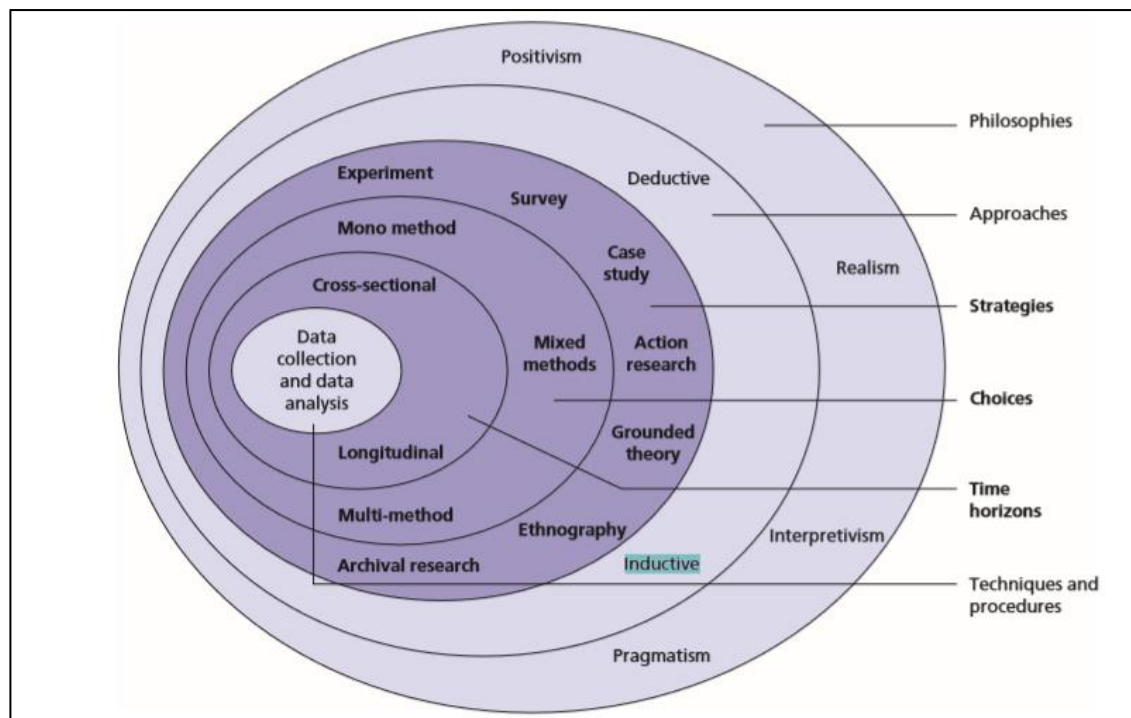
Figure 4.1: The research onion

(Source: Saunders, Lewis and Thornhill, 2012)

The specific research design depends primarily on the purpose of the research, whether exploratory, explanatory or descriptive. According to Saunders, Lewis and Thornhill (2012), the research can be divided into seven forms, based on the aims and objectives. The seven forms of research are a survey, case study, experiment, action research, grounded theory, ethnography and archival research. Because the current study flows from a pragmatic approach, that is, a combination of both qualitative and quantitative study, the mixed-method design seems more suitable. The purpose here is an exploration of the UAE's innovative ecosystem system and to bring in a robust system in a place. While it considers different quantitative aspects, this form of research also assists in explaining human interactions and behaviours.

Plano Clark (2010) defined mixed-method research as the third methodological movement. Initially, it was understood as a mix of at least one form of the qualitative approach and one of the quantitative approach. However, now that perspective has shifted. As Greene stated in 2007, this type of research involves 'multiple ways of seeing and hearing' (Greene, 2007:20). Tashakkori and Teddlie (2010) state that mixed-method research has evolved, and can be considered a distinct methodological orientation that has developed its own paradigm, techniques and concepts.

Johnson, Onwuegbuzie and Turner (2007) have given a comprehensive definition of mixed-method research, where qualitative and quantitative approaches blend at every stage. From the adoption of perspectives to data collection, analysis and interpretive techniques, both numerical values and subjective analyses are considered. Creswell (2014) outlined several components for designing mixed-method research. These are the core characteristics of a mixed-method research design:

- Both qualitative and quantitative data are collected and analysed with respect to the research questions and hypothesis.
- The research result contains both quantitative values and qualitative understanding.
- The logical procedures of mixed-method research are organised into a specific research design for carrying out the study.
- The study frames these procedures within the complex theoretical framework and philosophy.

Creswell and Plano Clark (2010) stated that mixed-method research is not suitable for all research. Qualitative studies are appropriate when the research is directed more towards the exploration of an issue. Often, the complexity of the social setting makes quantitative research inappropriate and adopting multiple perspectives may not lead the study in the right direction. Thus, at the planning stage, it is important to determine the design of the study. The adoption of a mixed-method design depends on several factors, as stated by Creswell and Plano Clark (2010). Assessing the availability of time to collect different types of information is an important consideration. In addition, resource availability for the collection of various forms of data is another factor. Lastly, the researchers also need to appraise whether there is skilled personnel to undertake the study.

Johnson and Onwuegbuzie (2004) stated that qualitative and quantitative data generally flow from two different perspectives. However, this does not mean that they cannot converge. According to Creswell and Creswell (2018), this format of the study shows that the research questions have quantitative, qualitative and mixed elements. Thus, a mixed-method approach will integrate both forms, and the researcher will state what kind of information is required for the nature of the research.

For gaining an in-depth understanding of the UAE's national innovation ecosystem, a mixed-method approach is suitable. This study seeks an understanding of the measures that can best promote a successful national innovation ecosystem in the UAE. Following

this, research questions are formulated that are directed towards an understanding of the fundamental question as outlined above. These questions look for the current condition of (educational) innovation-based ecosystem in UAE, the need for the creation of a sustainable innovation-based ecosystem and identify the various factors that affect the development of the ecosystem. Thus, a mixed-method research design is adopted for measurement and assessment of the different aspects of the UAE's innovation ecosystem. The next section will shed light on the sources of data collection and how the sources change the type of information that is collected.

4.3.1   Primary and secondary sources

The type of data used to conduct a particular study depends on the research questions that the researcher seeks to address (Silverman, 2013). There are two types of data sources: primary and secondary. The data that are collected directly from study participants constitutes the primary source of data. Data that are obtained in this process are usually considered raw data. Secondary data include previous research, government reports or any existing literature done in the given sphere. However, Saunders, Lewis and Thornhill (2012) state that the data used for any kind of research are usually a mix of the categories. In addition, tertiary data could include online research, catalogues and indices. These categories often overlap.

Silverman (2013) stated that the primary sources of data can often be misleading as they may be biased and contain errors. This is because the primary data may have subjective flaws or be blemished by prejudices and belief systems of the respondents. However, Easterby-Smith, Thorpe and Jackson (2015) also note credibility issues with secondary data because they can be outdated and do not hold relevance in the present context.

An advantage of secondary data, according to Saunders, Lewis and Thornhill (2012), is that it is easily accessible as most organisations publish their own data and store a variety of information to support their operation. Government bodies often conduct longitudinal surveys, and these statistics can be a useful source for obtaining secondary data. Comparative studies are often based on a secondary source of data. Secondary data can form the basis for any kind of research, and most research combines primary and secondary data to answer a research question.

Robson (2002) has generated a classification system for secondary data, although its categories are not comprehensive and do not capture the wide-ranging variety of data. A clear illustration is given in Figure 4.2.

Secondary data

- **Documentary**
  - **Written materials**

    Examples:
    Organisations' databases, such as personnel or production.
    Organisations' communications, such as emails, letters, memos.
    Organisations' websites.
    Reports and minutes of committees.
    Journals.
    Newspapers.
  - **Non-written materials**

    Examples:
    Media accounts, including TV and radio.
    Voice recordings.
    Video recordings.
- **Multiple source**
  - **Area based**

    Examples:
    Financial Times country reports.
    Government publications.
    Books.
    Journals.
  - **Time-series based**

    Examples:
    Industry statistics and reports.
    Government publications.
    European Union publications.
    Books.
    Journals.
- **Survey**
  - **Censuses**

    Examples:
    Governments' censuses:
    Census of Population, Census of Employment.
  - **Continuous and regular surveys**

    Examples:
    Government: Family Spending, Labour Market Trends.
    Organisation: BMRB International's Target Group Index, Employee attitude surveys.
  - **Ad hoc surveys**

    Examples:
    Governments' surveys.
    Organisations' surveys.
    Academics' surveys.

Figure 4.2 Types of secondary data

(Source: Saunders, Lewis and Thornhill, 2006)

Locating the secondary source of data is extremely important (Saunders, Lewis and Thornhill, 2012). The literature on an existing topic can be obtained from various articles, journals and books that contain valuable secondary data. They also provide the researcher with an idea of what sort of secondary data is available on the topic and help locate the original source. Newspapers and magazines often provide data by summarising various governmental surveys and reports. Tertiary sources like catalogues and indices can be used to help locate secondary data. General internet searches are another source of information; however, it is important to assess data quality, and data must be sourced from authentic websites.

Ghauri and Grønhaug (2005) noted several advantages of using a secondary data source. Secondary sources can be less expensive and require fewer resources to collect than primary data sources. The researcher can collect data themselves and have sufficient time to link them appropriately as per the requirement of the study. Stewart and Kamins (1993) commented that data collected from secondary sources are reliable and are of good quality. Collecting secondary data is also unobtrusive and can help avoid the sensitive nature of social situations. In the case of longitudinal and comparative studies, collecting secondary data is more feasible. The researcher can compare data obtained from primary sources or through a survey with the secondary source. This often leads to

the discovery of a new pattern or produce unexpected results (Saunders, Lewis and Thornhill, 2012).

However, Denscombe (2007) argued that primary data are more closely connected to the particular research questions and objectives when collected by the researchers themselves. The information derived from other sources has been collected for another purpose and may not be pertinent to the particular research study. Thus, secondary data can fail to answer the questions completely or might only partially meet the research objective. Saunders, Lewis and Thornhill (2012) also noted that also the definitions and concepts that are developed in other studies may not always be suitable or relevant. Moreover, getting access to secondary data is often expensive. Reports or market studies are rarely available free of charge. Also, there is no absolute control over the quality of the data that is derived from other sources.

Primary data can help the researcher to gain new insights and provide greater control over the quality of data collected (Easterby-Smith, Thorpe and Jackson, 2015). Thus, the researcher can be more confident in the outcome of the research. Also, the research questions that are formulated can be better answered using primary data. The researcher can ensure the data collection process meets the research objective. Studies that rely more on the primary sources generate an original form of data.

Creswell and Creswell (2018) stated that primary data collection is suitable for both quantitative and qualitative research. In the case of the former, utilising the primary source can generate a huge amount of data, especially through surveys, which can be statistically analysed. The collection of primary data in qualitative studies can help the researcher to capture data on the respondents' attitudes, values, beliefs and practices.

Saunders, Lewis and Thornhill (2012) noted that observation is often neglected as a method of primary data collection. There are two types of observation: participant observation and non-participant observation. The former is used in social anthropology and sociology, where the researcher fully engages with the life and activities of the participants and studies them closely. The engagement involves the immersion of the investigator in the research setting. The purpose of participant observation is to understand the symbolic interactions of the subjects, the meaning they attach to a particular action and the identity they derive from the performance of such action. In contrast, structural observations are more systematic and structured. The focus is on quantifying the behavioural aspects and conduct of the subjects.

Primary data can also be gathered using semi-structured or in-depth interviews. A group interview can also be conducted by the researcher (Saunders, Lewis and Thornhill, 2012). In contrast to structured interviews that make use of standardised questionnaires, semi-structured interviews cover varying aspects and themes of the research. In-depth interviews are unstructured, which offers the researcher a thorough understanding of the topic and research setting. Easterby-Smith, Thorpe, and Jackson (2008) stated that irrespective of the type of interview, it is important that the researcher is adept at asking questions and knows the correct approach. The researcher must ask open questions and allow the respondents to give their answers freely. The questions that are to be asked are 'what', 'why' and 'how' in relation to the particular social phenomena. In addition, the researcher must also ask probing questions to understand the thoughts and feelings of the participants.

The data collected from the primary sources can be analysed both qualitatively and quantitatively. The quantitative data is analysed using statistical tools, and qualitative data is transcribed and organised to reveal a pattern that may emerge out of it.

For this thesis, both primary and secondary sources assume importance. The design of this study allows the merging of quantitative and qualitative data. While quantifying the nature of innovation ecosystem of UAE, the study also focuses on the various social, cultural, political and governmental factors that affect, positively or negatively, the sustainable (education) innovation ecosystem in UAE. This blended qualitative and quantitative approach is closely related to the mixed-method design that is adopted for this study. This approach will help develop an integrated result that will help to gain a better understanding of the UAE's innovation ecosystem. The following section will detail types of data and their relevance for this study.

4.3.2 Quantitative and qualitative data

Quantitative data, according to Saunders, Lewis and Thornhill (2012), is a major component of every study, irrespective of its design. Quantitative data is quantifiable, measurable and numerical. It can range from simple frequency counts to more complex data like test scores, cost and price. Quantitative analysis is usually conducted and presented using graphs, charts and statistical programmes like SPSS Statistics, SAS and Microsoft Excel. Quantitative data can help measure variables, establish correlation and analyse dependencies. The statistical relationship between the concepts or elements is complex and is based on statistical modelling.

Brown and Saunders (2007) stated that quantitative data can be categorised into two main forms: numerical and categorical. Categorical data cannot be reduced to numerical values but can be grouped into different sets based on certain characteristics. This form of classification helps to identify categories and sort them in different rank orders to assist with analysis. Therefore, categorical data can be subdivided into nominal and descriptive data as it is not possible to define the categories numerically or assign any rank to them. This form of data simply calculates the frequency of occurrence of each of the category of variables. However, the categories need to be mutually exclusive and unambiguous. In contrast, numerical data can be quantified or counted. Hence, numerical data offers more precision than categorical data. Numerical data analyses require a wide range of statistical tools. Numerical data can be further classified into an interval or ratio data level. For instance, one can measure the interval or the gap between two variables. In contrast, the ratio analysis allows the calculation of the ratio between the variables.

Understanding the distinctions between different types of data is important for undertaking quantitative analysis (Saunders, Lewis and Thornhill, 2012). It helps the researcher choose the most suitable measurement scale and generate data that is appropriate for the purpose of the study.

Easterby-Smith, Thorpe and Jackson (2015) define qualitative data as non-numerical. Qualitative data are primarily derived from in-depth interviews. As discussed, the data generated through observation of subjects in their natural environment are qualitative in nature. These data contain detailed nuances of the participants' actions and attempts to understand their rationale. Interview transcripts, notes written during the participant observation, videos and other related documents provide useful qualitative data. In contrast to quantitative data, qualitative data can be analysed by using the interpretive method. Data collection in this way incorporates the meaning behind the information generated. The three major differences between qualitative and quantitative data are depicted in Table 4.1.

Table 4.1: Differences between qualitative data and quantitative data

(Source: Healey and Rawlinson, 1994)

Quantitative data	Qualitative data
• Based on meanings derived from numbers	• Based on meanings expressed through words
• Collection results in numerical and standardised data	• Collection results in non-standardised data requiring classification into categories
• Analysis conducted through the use of diagrams and statistics	• Analysis conducted through the use of conceptualisation

Mixed-method research collects both quantitative and qualitative data. The main objective of such convergence is to adequately answer research questions (Creswell and Plano Clark, 2010). Therefore, it is important that the researcher is aware of the procedures used in mixed-method research. Mixed-method studies involve the collection of qualitative data by using creative techniques like taking pictures. It also assesses the need for quantitative techniques so that they are not used beyond what is required for addressing the research questions. The authors also emphasised the method of collection of two types of data. It is important that the researcher determines whether a single method will be used for data collection (like a survey questionnaire) or multiple methods (like focus group interviews and a questionnaire). The order of data collection also needs to be determined in convergent design (Creswell and Plano Clark, 2010).

Onwuegbuzie and Teddlie (2003) stated that in mixed-method data analyses, analytical techniques are employed for both qualitative and quantitative datasets. The data can be analysed at one or multiple stages of the study. Once data analyses are done, interpretation considering both the quantitative output and qualitative findings and assessing how they meet the purpose of the research. Teddlie and Tashakkori (2009) called this interpretation-deducing task as inference and meta-inference. Conclusions are derived from both the quantitative and qualitative aspects of the study. Teddlie and Tashakkori (2009) noted that the quality of inferences in mixed-method research is improving.

Both quantitative and qualitative data will be used in this study to uncover various issues in the national innovation ecosystem of UAE. The results will inform how the UAE Government can ensure superior economic growth and development driven by innovation. Ideally, the data collected should show how the UAE's internal processes, efforts to increase the entrepreneurship rate and other factors are contributing to the

development of the country's ecosystem. In addition, the data will also uncover areas where the UAE is lacking, as supported by the literature review.

Claims and recommendations will be made using the results of the quantitative and qualitative data analyses. This will be backed by evidence from the literature review and the qualitative data. Building upon the theories and trends discovered from interviews, this research will then present a roadmap that the Government of the UAE can utilise for the development of a sound national innovation ecosystem that is driven by educational reform and exponential economic transformation. The next sections discuss the research setting and sampling process, which constitute two major aspects of the mixed-method research design. The next section will draw out some important facts and figures that substantiate the selection of the research setting.

4.4   Research setting

The research setting refers to the locale of the research from which the sample is selected for data collection. Population refers to the entire universe that is covered under the area of research. For any study, it is not possible to study the entire population. Thus, a subset from the population is drawn that adequately represents the entire population. The locale of the research helps the researcher to contextualise the research topic and understand the characteristics of the place. Several external factors, like the political scenario of the country, the economic growth rate and the cultural and social conditions, play an important role in this conjunction. The conditions have a profound effect on the country's stage of development and its endeavour for a better future. In this light, UAE has been selected as the research setting to analyse the feasibility of an (education) innovation ecosystem.

As discussed in the literature review, the National Vision 2021, that UAE has recently launched, depicts the country's endeavour to become a leading nation. One of the most important aspects of this vision is UAE's transformation to a knowledge-based economy from the traditional picture of an oil-based economic system. Connected to this comes the idea of developing a top-class educational system. Both public and private sector education in the country has been focusing on the practical application of knowledge. As mentioned in the National Agenda, the priorities of the country will include an investment to drive R&D activities, improving the standard and quality of education system and fostering innovation. These are essentially focused on transforming the country into a knowledge-based economy.

In accordance with this vision, Ahmed and Alfaki (2013) noted that the UAE is trying to expand its economy and moving away from its dependence on hydrocarbons. Their study also noted that the country is focusing on Emiratisation. Through its various efforts to upgrade the economic system, D'Mello (2018) noted that UAE has now been positioned as the most diversified marketplace in the entire Middle East. The World Economic Forum in the year 2018 ranked UAE 17th out of 137 economies on the GCI. Thus, the culture of the country promotes innovation and development. According to a report published by McKinsey (2016), digital transformation has also witnessed rapid growth in the UAE.

Given the above scenario, implementation of a robust national innovation ecosystem seems practicable in UAE. The present study is inspired by the vision and mission of the country and therefore, has chosen UAE as the research setting. From a policy perspective, the research aims to define the ideal national innovation ecosystem that can create sustainable programmes to drive the intended economic transformation. A national innovation ecosystem will serve the dream of the country and make it a self-sufficient and growing economy. Such an ecosystem will enhance knowledge-sharing activities, promote alliances between the clusters and the academic institutions and develop new products. This sort of collaboration will also enhance the optimal use of scarce resources.

As evident from the UAE's willingness to invest in R&D activities, the collaboration between clusters and academic institutions or other organisations should be smooth. This collaboration will facilitate the integration of the educational and learning courses in a way that will have a practical application. This will help develop and strengthen the country's innovation ecosystem. As the knowledge-sharing activities gain momentum, the system will achieve its full capacity, and this, in turn, will augment the vision of the nation.

From a cultural point of view, the UAE is the best setting to undertake this sort of research. The country is striving hard in terms of innovation and is investing considerably in R&D. A high rank in terms of competitiveness and innovation is evident. Continual improvement is also observed in the country's endeavour to foster a better learning environment that will suit current needs. Rather than confining the educational system to pedagogical learning, it is focusing more on the practical application of knowledge. This indicates that the country's social, cultural and political atmosphere is conducive to the growth of a national innovation ecosystem that can create sustainability and march the nation towards the realisation of its cherished goal.

4.5 Sampling process

Creswell and Plano Clark (2010) stated that in mixed-method studies, most of the decisions regarding data collection are dependent on the sampling method and strategies. It is important to choose a representative sample to answer the research question. In qualitative studies, a purposeful sampling method is used, which involves the intentional selection of subjects who meet the characteristics and conditions of the study. This research attempts to understand and answer the central research question using semi-structured interviews with a sample size of 24 professionals.

The interviewees are key stakeholders and leaders of the education sector, entrepreneurs and VCs. These key stakeholders are divided into two categories: main actors that drive the innovation ecosystem and observers who benefit from the innovation ecosystem. Table 4.2 identifies which stakeholders will be placed into which category:

Table 4.2: Categories of stakeholders

Main actors	Interested observers
Education sector professionals	Entrepreneurs (especially those in the technology sphere)
University professors	
Deans/heads of universities	Venture capitalists
Deans/heads of schools	
Senior professionals from regulatory bodies such as the Ministry of Education	
Senior officials from research grant/scholarship bodies	
School supervisors	
Teachers	

Including a range of sectors will help identify the underlying trends and issues in the current innovation system in the UAE. Gathering data from education professionals is important as they are primary actors who drive the national innovation ecosystem. This is because university–industry collaboration is one of the core pillars of a national innovation ecosystem.

Gathering data from VCs will provide insights into the nature of risk-taking and innovating among entrepreneurs and what makes the VCs invest. In addition, gathering insights from the education sector will inform the effectiveness of the current education system of the UAE and the level of knowledge creation required to fuel innovation in the country. Therefore, gathering data from both main actors and interested observers will generate a varied and rich dataset, which will help build a robust strategy for the future. The interview guide will be developed with the guidance of the Professor to avoid issues of reliability. Interviews will be recorded and later transcribed. The transcribed data will be fed into software such as NVivo and analysed.

4.6   Development of the interview guide and questionnaire

Kvale (2007) stated that there is no hard and fast rule for conducting an interview. Rather, the openness of the research is more important for the successful completion of an interview investigation. Aside from the dichotomy of qualitative and quantitative aspects of an interview, it is extremely important that the researcher is well-equipped and knowledgeable about the interview techniques. Gioia, Corley and Hamilton (2012) stated that social actors should be considered knowledgeable and rational beings who can express their thoughts, actions, emotions and intentions. Therefore, the authors condemned the application of pre-established notions and constructs to understand their experience. This means that the efforts of the researcher should be directed towards capturing the voice of the research participants. Rather than viewing the researcher as the most knowledgeable person, the emphasis is placed on the informants to extract the data in its truest form.

In the absence of prescribed rules for developing interview techniques, an opportunity for the open-ended field is created, which is directed towards assessment of the researchers' skills, knowledge, interpretive ability and intuitions (Kvale, 2007). Therefore, the development of the interview guide deviates from the standardised questionnaire format, giving rise to statistical procedures for analysing human subjects.

The first chapter outlined the research questions that are being addressed by collecting both qualitative and quantitative data by interviewing the participants. The development of the interview guide is based on the extensive literature review, which helped identify variables for this study. Quantitative analysis has been used to understand how to promote a national innovation ecosystem in the UAE. The other research questions have been addressed by collecting qualitative data from the subjects and analysed by using interpretive analysis.

As stated by Gioia, Corley, and Hamilton (2012), the central research question typically influences the development of the research guide. The authors stated that the interview guide should be thorough and will not contain leading questions. However, an element of flexibility should always be included maximise data collection and help to ensure its quality.

The interview guide for this research has been developed based on the core research questions and the central constructs and concepts. However, flexibility has been given to the interviewees or the respondents so that they can give additional information. Therefore, the guide has been developed so that the researcher can assess how to approach the interview and gain valuable insights on the research topic from the interviewees.

4.7   Data collection

Miller and Tsang (2011) outlined several methods for qualitative data collection. These include survey questionnaires, experiments, observations, focus groups and interviews. There are many subcategories under these broad classifications. For example, the interview method can take the form of an in-depth personal interview or a group interview. The selection of these methods largely depends on the inherent purpose of the study and the design of the research. Saunders et al., (2012) noted that the interview method is particularly suitable when the researcher seeks to draw a vast amount of qualitative data from the respondents. Silverman (2013) commented that the interview method is particularly suitable for undertaking qualitative research as it draws out the intricacies of the social situation by asking the respondents open-ended questions. The open-ended questions give the respondents the freedom to provide their opinion and express their feelings as they are not predisposed to a set of responses from which they are required to choose.

According to Kvale (2008), a qualitative interview is the best method as it provides the researcher with in-depth knowledge about the topic from the interviewees. However, the power imbalance between the researcher and respondent may have a negative effect on the outcome of the interview. Rather than treating the respondents only as informants of the social situation, it is important to treat them as equals who play a major role in the research outcome (Gioia et al., 2012). Thus, the role of the researcher would be both a traveller and miner who will go the extra mile to capture the reality of the data and generate new information in the process. The interview method does not follow a uniform

set of rules or procedures but is a craft that has the possibility to generate new knowledge (Kvale, 2008).

Gioia et al., (2012) noted that the interview method has three significant characteristics:

- The informants or the interviewees are the agents who possess a vast amount of knowledge on the research topic. This view of the respondents as knowledgeable is in stark contrast with the view presented by Kvale (2008), who consider the researcher as being superior to the informants.
- The questionnaire or the interview guide is flexible enough so that the respondents can provide the required information along with their feelings, thoughts and value judgments. This will ultimately enrich the amount of information that is gathered.
- The researcher is required to approach the previous respondents after receiving a new set of information and seek better understanding and clarifications.

For this study, the interview method was chosen for collecting primary data, both qualitative and quantitative, from the respondents. A semi-structured questionnaire or interview schedule is used that will include both structured or closed-ended, and unstructured or open-ended questions, so that the interviewer can ask a relevant question, seek clarification and, therefore, gain a better understanding of the situation. The additional responses provide a clearer explanation and help the researcher explore the topic in detail. Gioia et al., (2012) stated that while being conducted in real time, the semi-structured interview method is ideal for gaining insight into the life of the study participants. The authors also noted that this method engages the researcher as well as the respondents and, thus, the flow of information and additional inputs becomes seamless, enriching the quality of data collected.

According to Creswell and Creswell (2018), the quantitative questions help to answer descriptive questions (including percentages), establish the relationship between the variables and seek predictive relationships between them over time. The survey method is preferred for conducting a quantitative study. However, in this study, a semi-structured interview and a questionnaire containing both quantitative and qualitative questions are developed. The core research questions have been analysed by quantitative methods, and the responses were solicited from different stakeholders.

To seek a better understanding of how to activate the national innovation ecosystem in UAE, the use of open-ended questions would be suitable, as this would give some flexibility in the approach to data collection. This would help with the analysis of the

conditions that affect the development of such an ecosystem and identify the factors that positively and negatively influence the system. Semi-structured interviews will help the researcher to probe the respondents' answers and ask pertinent questions that will strengthen the investigation. In-depth interviews bind the two parties, that is, the researcher and the participants have a face-to-face interaction, and a relationship of trust develops between them. When this trusting relationship develops, the respondents feel more comfortable about revealing their thoughts, feeling and value judgments. However, the respondents should be informed about the purpose of the study, and a debriefing should be conducted before the start of the interview process (Kvale, 2008).

According to Silverman (2013), the selection of a representative sample is extremely important for the purpose of data collection. A sample size of 20–30 professionals has been selected that include main actors and interested observers (see Table 4.2). Gathering data from academicians and education professionals helps to understand the level of university–industry cooperation that constitutes one of the main pillars of the national innovation ecosystem. It also helps in understanding the education curricula and the extent to which it is conducive to the growth of innovation in the UAE. From interviewing these professionals, the effectiveness of the UAE education system in supporting innovation has also been analysed. The qualitative data gathered from interviews with education sector professionals are rich and varied. It can be used during future strategy development regarding the national innovation ecosystem. The interviews conducted with the VCs helped to understand the willingness of entrepreneurs to take risks.

The interviews that have been conducted do not contain any leading questions. This strategy has helped the respondents express their true opinions and judgments regarding the national innovation ecosystem and the various factors that directly or indirectly affect it. This interview method naturally translated into an interpretive study.

4.8   Pilot study

Silverman (2013) has recommended conducting a pilot study before the launch of a full-scale investigation. Thus, before the in-depth intervention, it is important that the researcher carefully assesses the questionnaire. This helps the researcher to identify any ambiguity or vagueness and provides an opportunity for further amendments and modifications. The primary aim of this groundwork is to assess feasibility, time horizon and improve the design of the interview guide prior to the actual data collection. Pilot studies are usually done with a very small sample to test whether the questions are

properly understood by the respondents and generate the required response. Ambiguous questions are then removed, replaced or rephrased as per the findings of the pilot study. The pilot study is outlined below.

4.8.1 Introduction to the pilot study

The primary objective of this pilot study is to evaluate the effectiveness of the interview guide that has been developed and identify any areas for improvement. The interview guide has been developed by the researcher and is based on a robust theoretical background, but it is important to identify areas for improvement in the interview guide and validate the same before carrying out the main study.

Another reason for the pilot study is to allow the researcher to gain confidence in administering the questions (Silverman, 2013). Conducting this pilot study will reveal any gaps in the questions, the ease of understanding the questions, and will reveal any questions that generate similar answers (Bryman and Bell, 2016). With this information, the interview guide can be refined for the main study.

4.8.2 Selection criteria for the pilot participants

Three participants were selected for the pilot study: two for establishing the face validity and one for establishing the construct validity. The primary selection criteria for participants was that they are one of the stakeholders in the UAE's innovation ecosystem and that they are the subject matter experts in their fields.

4.8.3 Findings from the pilot interviews

For establishing face validity, participants were simply asked to evaluate the questions based on a prior understanding of the research topic and objectives. They were asked to evaluate the interview questions based on the following criteria:

- Are the questions easy to understand?
- Do you think the questions can generate the desired information?
- What do you think is the shortfall in the questions?
- Do you think the allotted time of 30 to 45 mins will be enough to answer the following questions?
- Do you think any of the interview questions are leading to a particular response?
- Are the questions leading to the reveal of classified information?

Some responses to the pilot study questions are given in Table 4.3.

Table 4.3: Summary of Key Responses

Question	Responses
Are the questions easy to understand?	Both participants noted that the questions are easy to understand and present an accurate picture to the interviewee.
Do you think the questions can generate the desired information?	The participants noted that these questions will generate the desired information, if not more, during the interview. One of the participants also stated that the questions are sufficiently broad, which will enable the participants to generate a broader response.
What do you think is the shortfall in the questions?	While one of the participants stated that there were not any visible shortfalls, the other participant noted that there is no question to capture the scope of the individual's work or context. The participant outlined that the answers would differ based on where the person is working, and so the questionnaire needs to include questions that first develop the context of the individual and then lead to the main questions.
Do you think the allotted time of 30 to 45 mins will be enough to answer the following questions?	The participants seemed to think that the time allotted would be sufficient.
Do you think any of the interview questions are leading to a particular response?	Both participants stated that there were no leading questions, from their perspective, in the questionnaire.
Are the questions leading to the reveal of classified information?	The participants noted that the questions should not lead to any revelation of classified information. The participants noted that interviewees should be able to answer all the questions in detail while responding to the questions.

Following the two interviews to establish the face validity of the questionnaire, another interview that mimicked the main study interview was carried out. This also helped the researcher establish the construct validity of the questionnaire. Furthermore, a question to establish the context of the individual was added to the questionnaire according to the suggestion from the first pilot interviews.

Table 4.4 outlines the responses received for the second pilot interview. Some of the responses are edited for clarity, length, and grammar.

Table 4.4: List of Key Responses

Question	Responses
Introduction and what links do they have to the national innovation ecosystem of the UAE.	I work with the Dubai Future Foundation, which has the very difficult task of making Dubai future-ready. That includes the society as a whole, the government, multinationals and the private sector and the society itself; the community itself.
	Since this is a very big mandate, we run a lot of initiatives to ensure that the leaders in the government are prepared for technology disruption and create mind shifts, technology, business models and human resource capabilities for the future.
	The role that my organisation plays is as the facilitator and an enabler, especially for the private sector, which is why we have developed an ecosystem called the Area 2071.
	The reason for this Area 2071 is to allow the companies and the government sector to co-create innovations. While the government in the UAE is a strong advocate of innovation and growth, it cannot achieve all the objectives alone.
	We are not necessarily investing in ideas so much as we are investing in creating ecosystems for ideas to gain traction, and where innovators can come together and experiment on new technologies and new business models.
	We're doing that through a variety of things. We do it through the entrepreneurship visas that are only issued exclusively through us and 2071 to a specific cadre of entrepreneurs and innovators. Through these licenses, they can find a cheaper alternative to the usually high rent office spaces, which are found in Dubai, for example. So, we're trying to hack the system in a way where we're trying to make it easier for people to establish companies. So, all of that pulls into our role to facilitate innovation.

I think that pretty much covers where we sit within the innovation ecosystem. We report directly to a local mandate under the white government.

Our interpretation of this is we need to become exporters of innovation. That's how we become a leading nation. So that's our interpretation of languages.

In your opinion, what are the three main focus points that the government should tackle to improve the innovation ecosystem?	I think the approach the government has taken in the past, which is 'let's play the role of facilitator, an enabler', that's a very good one, because that's the future role of government anyways.

But, if you look regionally at South Korea, Singapore, even Malaysia to some extent, the business model for government, there has been really to build an ecosystem around it to encourage ideas to exist. Everything from the building blocks of universities, the support, the scientific research, the research and development support the government gives from funding to ease of access to technology; that is the building blocks of creating ideas, because you're creating and you're giving.

You're providing [the] potential for entrepreneurs to have access to these things. So, everything from the building blocks, which are the universities and the schools, all the way to incubation, acceleration and funding.

The biggest example is how the Singaporean Government has an investment arm that matches up to 80% of any VC investment that's done in any Singaporean start-up. This is a very big signal, not just to regional VCs, but global VCs, that the Singaporean Government is very serious about its own efforts, and they believe in what's coming into that ecosystem.

When you do something like this, it's about signalling to the world that you are very adamant and you trust the product that's coming out of your country.

We've helped the government here in Dubai not just to achieve their goals with TEDx and DFA, but create a mind shift within the government itself. Why should we work with start-ups |

And one of the biggest questions we ask of them in TEDx is: why couldn't you come up with companies like Uber or Airbnb, you know? And simply the answer is that their mandate doesn't allow it. But their mind, their mindset is not there yet. So the mindset, strategically, is also very important, which is why we try to do that through a lot of the other initiatives like The Future Academy, where we train leaders, we train government employees to think about future trends and future tech and how it can be relevant for them.

We need to think of the UAE as a landing pad or zone for the world's biggest experiments. The most ambitious entrepreneurs need to be able to experiment with future tech, whether it's a, you know, a four kilometre hyperloop pipeline that tests on expand, transporting certain types of goods, and maybe even human beings, which they can do in the States or anywhere else in the world. We can be the first place to do this, right?

Once you start signalling to the world that you want to do this, that's when you become potentially a place for very exciting new business.

We don't just accept innovation, we're testing it, we're trying it and we're exploiting it externally. That becomes a very important thing. And one of the projects, hopefully, which we are working on, is to create experimentation zones for the world's biggest technologies to come and, test their technologies here. So, we're providing, we're building the infrastructure for them. And we're leveraging what Dubai already has: everything from dedicated free zones to other sites in the way that could cater to these experiments, these physical experiments. And what we're trying to push area 2071 to be is the design thinking hub for these experiments, where they can go and deploy in other parts of the world. So, we're trying to create this this big, big, big this big piece together.

What are the major government processes and the drawbacks that would affect ideas?

I mean, that's a great ambition that we just talked about, right? And it sounds very good, but, when it comes to reality, there are some restrictions with it. So, for example, government, existing government regulation, or lack of regulation, can create a lot of frustration for entrepreneurs, even for multinationals. And even for government, by the way, sometimes they have teams sitting with

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us, and they want to push certain agendas, but they can't because their own entities have regulation[s] that they can't influence, which is why we created regulation lab as a neutral zone. So, there's existing regulation that causes frustration, but there's also another space where there's lack of regulation.

One of the projects that I remember I worked with the executive office on was licensing of social media-based businesses.

In the States, eBay and an Amazon are the reigning platforms for e-commerce. But the region is slightly different. They exist, but if you look five years ago, it was mostly Instagram, Twitter, Facebook, that were pushing a lot of the e-commerce initiatives. And these were simple, you know, baking shops or online jewellery, handmade crafts, things like this. And there's a famous chain into I called home bakery; I'm sure you know the story. This actually started off on Twitter, and then she accelerated.

But the problem with these guys was, and even a close friend of mine had a bakery, she's at home, and she was on Instagram and her fear, just like most of the these entrepreneurs' fears was, if we get caught, what happens. There is no regulation against us. But there's no regulation for us. So, we're in a grey zone.

So, the sector could have been very financially viable yet was not supported until later because it was in a grey zone. Now, the SME has a license for them, and they regularly check on them. But even then, there are bits, it was a bit slow, and it doesn't cover all sectors. So even grey areas, when it comes to the regulation, are still quite dangerous.

Sometimes it's better with regulation, and sometimes it's even worse. Because they push it to a regulation that is similar to the status quo, like what's happening with the social

I agree, you bring up an excellent point, which is the way we even look at how regulation should be different.

media, then you came to 15, 000 or something like that. So that's also like they kill it in the end. Sometimes then it's better for the entrepreneurs without regulation. But that's a step, a huge step to go for it.

I mean, the procurement and contracting processes sometimes can be quite hindering. Right. And that's, that's a globally known thing about government in general, not just here.

And some of the government entities, to be fair, have been making very good strides in simplifying their procurement process with start-ups.

So, we have to give them credit for that. But some of them are still quite behind. Even the procurement process, but the contracting process is quite long.

Yet, there are initiatives now to bring all of that to a central location and the Dubai government on blockchain of it, which is excellent, but it's still taking time. That doesn't just affect the government entities as a whole, but it also affects their ability to work in contract with some new suppliers, like start-ups, right.

So, there's regulation; there is the mind shift there. So, the mindset these are hurdles, and I think the, to a large extent, the market itself.

Even the end users are not always ready for a lot of these innovations, whether they are software, whether they are products, mainly because they don't know how to use them or they don't understand them, and they don't understand the technology that's underlying them. So, these three factors are still quite hindering to the work of innovation, not just with government, but generally the entire ecosystem here.

So, I wanted to get your thoughts and assess accessing talent, retaining talent in the UAE. And what should the government do?

So you mentioned at the beginning, one thing which is the entry visa, but

When it comes to nationals, they are more of an exciting new generation that's coming up that's actually hungry for more, which is quite refreshing to see.

And I think what needs to happen from government is, just as the regional governments of Singapore is trying to do, and South Korea, they're pushing them more and more towards what I like to call frontier sciences, or frontier education and frontier careers, that have to do with technology.

just like when I say talent, I will put it in three different buckets: the nationals is one, the people who are living here, and the third is the talent that is not here that we want to come here.

Coding is a big thing that we see happening across the world. It's an excellent skill set to have for any new set of generations that are coming out, simply because you just can't afford not to have it in the future.

I think the education curriculum in the country and in the region generally needs to change. It's quite nascent. And it's very; it's a little bit behind in terms of what we want to push on the students. And it's not a joke. When you hear an engineer who graduates after five years of an engineering course or degree, and then says, 'a lot of what I learned even in my third year has become obsolete'.

And these are computer genius engineers, they are computer scientists, mechanical, electrical engineers, but mostly on the software side, because it's moving, it's moving at such a rapid pace.

We have some excellent education institutions here, but even then, we need to push emerging tech as courses.

AI [artificial intelligence] should not be this, this ambiguous monster that no one knows about, right? If we can break it down, you can make people understand what it is. We have the basic foundations for education towards AI, which needs to supplement it.

Even blockchain, machine learning, natural language processing—all these can be broken down into courses and curriculums that can be taught to students in university. And if you look at flat iron labs, if you look at General Assembly, they all offer courses that are usually taught at an Ivy League level, or even courses that focus on the areas we just mentioned now, for very affordable prices.

And we need to, we need to have some kind of mechanism where we give access to Emirati students to these courses, because that's what's going to make them very competitive as a competitive labour force in the future, and monetisation targets will become a lot easier to achieve once you build that passion for them in these sectors.

The multinationals, they're usually very entrepreneurial and if we try to utilise that passion for entrepreneurship, that they haven't pushed towards emerging tech with technology, they can become very, very competitive. I met a few cohorts of Emirati students who are super passionate about technology.

Imagine if you replicate that example across a bigger population, they'll be very competitive. And then the second bucket you talked about is the expatriates.

So, there's two things when it comes to expats. There's the part where Dubai in the UAE, generally in the region, are considered beacons; beacons of progression, the hope of having a good life. And that's what people continuously flock to do, by the way, nonstop, and it's not going to stop anytime soon. I understand that there are certain cultural risks of nationalising a lot of people or giving them long-term access. But we do need to start thinking about people who have contributed for a very long period of time, about integrating them within the society or at least giving them access to the country for a longer period of time.

We need to give the people who are starting long-term careers, businesses, investments, we need to give them social stability in order for them to not just be here by themselves, but also their families. Because in the end, we all gravitate towards family.

The second aspect, when it comes to expats, needs to be a bit more flexible to encourage them to follow different paths.

And that goes back to your visa regulations, and what you are allowed to do under that visa. But to be honest, a lot of people do things on the side anyways, even if they have a solid visa, but it just needs to be a bit more flexible to allow them freelancing opportunities, because Dubai is an expensive place to be in.

So, your thoughts on the education system to serve the innovation

When I was in university, and [in] my final year, I tried to create a business that takes university students in their final year and gives them something called life skills. As simple as: How do you

ecosystem? And also, how connected are the education stakeholders or the stakeholders with the industry?

open a bank account? What does this credit card mean versus that credit card? What does an interest rate mean? A personal loan versus a credit card loan? How do you go buy a car? What are the steps that you need to look at these life skills that enable you to be a functioning human being before you have a formal education that you can transfer into your job?

And the reason for that is I grew up here, and as many services we have access to, we don't understand them. I remember the first personal loan I took; I could have had a better deal at it if I had just done my homework a little bit more. But I wasn't trained to think that way.

Which brings me back to the century of education system; it should go more towards teaching critical thinking, teaching students to be more worldly outside of your course material. How can you become a human being who has a lot of empathy towards what's happening in, you know, thousands of miles away in Africa, in South America? How can you become more politically aware, socially more aware of the community you live with?

But, also to question a lot more than just absorb that, right? These things make someone a lot more open to new ideas. It pushes them to become encouraged to adopt new ideas, and that's in essence what an entrepreneur is, right? But it also creates a very compassionate community, whether they're a minority or they're expatriates, right? And that's what education plays a huge role in, right? It's preparing the next generation for something that they're ready for. And, the example I mentioned about the engineers who graduate, it's a real example; a lot of them graduate, and they feel that their third-year courses are obsolete; they don't need them; they wish they never took them.

And it won't be long before universities start getting serious competition from the likes of flat iron labs and General Assembly, because these guys are providing education courses that are super competitive compared to the university. So, let's look at some of the other employers globally.

In Google, they dropped the requirement for a bachelor's degree. And you know, this, yeah, it's a huge signal to the world that guys, we're not looking at this anymore; we're looking at mindset, and

we're looking at the skill sets that you recently acquired. I remember, I was lucky. When I first started, my first job was in PwC [PricewaterhouseCoopers] and one of their recruitment criteria was hire the mindset, train later. And so that's that; that's the motor right there and always apply. But still, it was refreshing to see that they just wanted you for your mindset.

And that's very important; that's why the points I mentioned earlier are super important to ingrain within university, but even at a high school level, or even out of grade school level. Even the way that we deliver education now, right? It's not sustainable, right? It needs to be delivered a lot more differently.

Real life experience needs to happen at a much earlier stage.

If you want to change something in the education system, where will you start? Primary, secondary or tertiary level of education?	Honestly, I would start with the higher education level, mainly because we have such a huge youth bulge that are coming up that need immediate access to jobs. And this is where I would plug in certain types of education curriculums that are focused a lot on technology, but even looking at cultural sensitivities and religious sensitivities, because we have a lot of these issues in the Arab region, still, where we're not very tolerant to each other.

But also linking the universities directly with more government funding that goes into R&D and linking the university and the higher education ecosystem with the private sector, and the innovation ecosystem, linking it directly.

So, having incubators, accelerators within these universities, available to graduates, tech companies and entrepreneurs; that can help further, and we can help push their agendas later on. |
| There are two types of cultures: the individualism culture or the conductive culture. I wanted to get your thoughts | The thing that makes the UAE a very, very exciting place for me and a lot of people is how international it is. |

about culture. What could be done to change that culture?

You meet different nationalities and different personalities on a daily basis, which is really exciting, but it can be overwhelming as well.

And there's a fear, which is a cultural fear, because I've lived here for a long time I really understand, which is the UAEs national population is a very small population compared to everybody else, which is a very legitimate fear for both the individuals and the government.

But, if you look at where the UAE is versus global cities like New York, like London; they all started the same way, they all started like international melting pots.

But what's missing in the UAE is that these melting pot components are not completely melting with each other, right? There're still barriers between these nationalities and these cultures, and we need to really defuse these barriers, because that's what creates a very strong and cohesive community.

So, we have the ingredients, we just need to push more for them to meet, to collide, to interact more with each other; and I know this because I'm close to a lot of UAE nationals and, of course, a lot of experts who are both Western and Asian, and I understand the clashes even between them.

So, from a cultural perspective, is culture hindering us going on to being an innovation ecosystem?

The Arab culture, in general, is very like a family-oriented culture, right, where the individual, you know, skews towards family and all goes towards family. And while I think that's good, I think there needs to be a healthy balance between pushing individuals to be individuals, but also part of the family.

Because, I think a lot of the time the youth, they get subdued under the wing of family, yeah? To either work with family business, or, you know, stick to family all the time, not venturing outside and learning outside, for example, or getting a job outside, and that limits the potential of the individual, right, as much as I understand the priority of keeping your family together.

Around the world, like in terms of foreign, I wanted to get your opinion here. What has been done? And in the UAE, in terms of who's responsible for the agenda? Where are we in terms of innovation?

It's a challenging question, because we don't have a lot of R&D, as you know, and I think in order for us to even start—I mean, places like the States, London, France, even Spain, Germany, there's like 50 to 60 or 70 to 80 years' of research and development stock, which we cannot compete with.

Yeah, you have national champions I would say, like Emirates, like DP World and the like who are pushing. We're pushing the R&D agenda within their portfolio.

And to be honest, I believe that they're representing the bulk of the R&D agenda. And Dubai, I'm not too aware of that agenda so that's why I can't really comment on it. But, from my experience, it's these national champions that are pushing the agenda more and more.

From Table 4.4, it has become clear that the questions are open-ended and are generating a lot of information that is of potential use in the main study. The primary observation following this pilot study is that there is good scope for the participants to respond suitably to the questions and generate the desired information. In conclusion, it has become evident that the research instrument is sound in terms of face validity and construct validity.

4.9   Data analysis

According to Silverman (2013), while undertaking the data analysis, there are several important aspects for the researcher to keep in mind:

- The data must be analysed objectively by looking at the perspectives of the respondents and trying to draw inferences.

- The sequential stages of data collection should be followed to understand chronological development and understand changes.

- Contextual understanding is most important; the opinions of the respondents might vary depending on the setting or the context.

- A comparison must be drawn to different sets of data, be it externally or internally.

- Regardless of the specific applicability of the research outcome, the researcher must also look for generalisation of the data.

- Lateral thinking can be useful to uncover any underlying theoretical pattern in the datasets.

Gioia et al., (2012) laid down guidelines for analysing data. Initially, the data that is collected needs to be coded and then transformed into theory-centric second-order data. This structured data then helps capture the emergent pattern or theme.

This research aims to identify any issues in the national innovation ecosystem of the UAE and how the UAE Government can improve the conditions to ensure superior economic growth and development driven by innovation. The data collected provided an understanding of the country's internal processes, its efforts to encourage entrepreneurial endeavours and various other factors that are contributing to the development of the country's ecosystem. The data also depicted key areas where the UAE is lacking (e.g., the education curriculum) that is substantiated by existing literature.

Based on the above analyses, the researcher has provided certain recommendations for the changes that need to be implemented. Building upon the theories and trends discovered via the interviews, this research will then present a roadmap that the Government of the UAE can utilise for the development of a sound national innovation ecosystem that is driven by educational reform and exponential economic transformation.

Furthermore, a road map will be presented that identified the essential concepts introduced and studied in this research. This will be followed by a country map depicting the proposed national innovation ecosystem with all the key players and areas identified in this research.

Finally, a logic model was developed, showing the inputs that can be used for each recommendation in terms of resources. The intermediate outcomes were presented, and the long-term outputs were predicted. An example of such a logic model is presented in Figure 4.3:
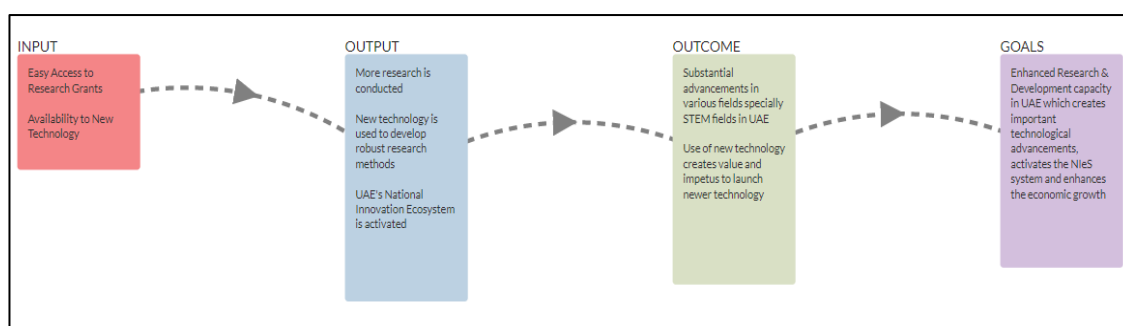
Figure 4.3: The logic model

The theory of this research is to develop a framework for the UAE to activate its national innovation ecosystem using enhancements in education, which will be measured, in the long term, by the development of key performance indicators (KPIs) for each of the implemented recommendations.

4.10 Validity

Validity is the effectiveness of the overall study measures on the aspects proposed for enhancing the investigation, as stated in the research objectives (Yin, 2017). Creswell and Miller (2000) stated that researchers are required to depict the credibility and integrity of the qualitative methods employed. Kvale (2008) noted that validity is the credibility and powerfulness of data that has been collected and presented in the research.

Saunders et al., (2017) stated that validity measures the extent to which the measurement tools are measuring what they intend to measure. According to Glaser and Strauss (1967), in a grounded theory approach, the test of validity is implemented at every research stage. Thus, the research project is rendered valid. It is extremely important that the researcher takes the issue of validity seriously, especially in qualitative studies. Kvale (2008) stated that since the qualitative studies employ interpretive methods, it is important for the researcher to ensure that the research outcome is not affected by bias.

Creswell and Miller (2000) have laid down several methods by which the researcher can ensure the validity of the research outcome. These are discussed below:

- Triangulation: In this method, the researcher uses varying sources of information to see if the results are consistent. This method is similar to triangulation that is done in the military to locate a point in space. Across data, across methods and across theories are the four forms in this regard.
- Disconfirming evidence: In this case, the researcher tries to find evidence to negate the results. If a negating result is not found, then the research is considered valid.
- Researcher reflexivity: The research outcome is often affected by the researcher's personal bias, belief system, assumptions and value positions. Before conducting any research, the researcher is required to disclose these so that the reader can have a better idea of the research findings and understand the perspective.
- Member checking: This process involves the inclusion of the informants or the respondents into the validity measurement process. This process is also known as member validation (Kvale, 2008). For narrative accuracy, the data and the interpretive analysis are shown to the respondents to ensure the correctness and precision of the information. However, it is important that the participants do not interfere in the analysis and only assure the data credibility (Saunders et al., 2017).

Another process that can be used for validity testing is peer debriefing. In this process, an external member is employed, be it a peer or a colleague, who is aware of the research, its purpose and objective. This external peer member serves as the guide and directs the researcher in conducting the next step of the research project (Lincoln and Guba, 1985).

In this research, the question of validity is addressed as there exists a substantial gap in the existing literature. The method of triangulation is used to check the validity of the research. This has also helped to sort the data and identify possible patterns, excluding the areas of overlap. In addition, member checking has been applied in this study. A transcribed copy of responses is given to the participants requesting their review. Hence, any disparity in understanding has been eliminated. In addition, by conforming to ethical practices, the researcher also disclosed his personal details, including religion, assumptions, value positions and biases. This validity check, as conducted through the lens of the researcher, helps to understand how sociocultural forces shaped their analysis and interpretation.

4.11 Reliability

In contrast to validity, reliability refers to the consistency displayed in the processes of data analysis and interpretation (Silverman, 2013). Reliability relates to whether, given the same set of data, another researcher will arrive at the same conclusion. Low-inference descriptions are recommended to ensure reliability. In this method, the responses obtained during the process of an interview are transcribed word-for-word so that any sort of researcher bias can be eliminated at the outset.

Easterby-Smith et al., (2008) have proposed asking three primary questions to allow the researchers to check the reliability of their data. These are as follows:

- If measured on a different occasion, will the data produce the same result?
- Given the same set of data, will the other researchers produce the same research outcome?
- Does the raw data have sufficient transparency for sensemaking?

The reliability of the data is ensured by using the verbatim transcription method. This restricts the effects of the researcher's biases and provides room for possible corrections by the participant where necessary. The appendix section of this study consists of detailed transcripts so that the transparency of the data can be upheld. Furthermore, the data that is collected for the purpose of this study is gathered by the researcher himself. Hence, the overall value and quality of the data are ensured.

4.12 Ethical issues

Ethical issues are one of the most important considerations in academic research. Silverman (2013) stated that codes of research ethics have been formulated to protect

the researcher's valued endeavour from any possible threat and infringement. Although the codes may vary from country to country and between the disciplines, there are general principles or guidelines that summarise these codes of research ethics. These are as follows:

- It is extremely important that voluntary participation is sought from the respondents. This means that they are not coerced to provide their response and express opinions. The participants are given the right to withdraw themselves from the research.
- Confidentiality should be maintained, and the participants should be provided with adequate protection and safety. This will also help the participants to engage in the study more closely and express their opinion and judgments.
- Informed consent from the subjects should be obtained by the researcher prior to the launch of the study.

Easterby-Smith, Thorpe and Jackson (2015) laid down some aspects that can give rise to the question of research ethics in an academic context. The authors stated that individual background, knowledge and experience can lay the foundation for quality research. However, these attributes can also affect research findings. The background of the researcher may consist of race, class, caste, religion and gender, which shape the perspectives of the researcher and give rise to biases and value judgments. Therefore, it is important that researchers are required to disclose their personal standpoint so that the reader can understand their perspective and assess the study in that context.

Bell and Bryman (2007) have outlined key principles in research ethics. These are depicted in Figure 4.4.

Figure 4.4: Key principles of research ethics

(Source: Bell and Bryman, 2007)

Saunders et al., (2012) stated that the most important issue for research ethics in academic studies is plagiarism. Easterby-Smith, Thorpe and Jackson (2015) define plagiarism as the act of presenting someone else's ideas or work as your own without acknowledging or citing the original source. Park (2003) stated that often in academic institutions, students engage in the unethical practice of stealing material from others or buying a professional research paper from a research service company. Often, the content of another paper is directly copied, or another student's work is submitted. All these are immoral practices and are considered an offence in academic research.

In this study, particular attention has been given to ethical considerations. Before the commencement of the research, the participants were informed that the purpose of the research is purely academic and educational. Confidentiality has been maintained throughout the data collection process, and the respondents were assured that their responses would only be used for meeting the purpose of the study. Anonymity was maintained to ensure privacy and so that the respondents could freely participate in the survey. A transcribed copy of responses was provided to each of the respondents for review, and any mismatch in understanding was corrected. This was done to avoid any misrepresentation. The responses were stored in a password-protected computer hard drive. All the participants filled out the consent form and agreed to adhere to the terms and conditions of the research to prevent any unauthorised access.

5 Data analysis

5.1 Introduction

Qualitative data was collected from 24 participants through semi-structured qualitative interviews working in various sectors within the current innovation system of the UAE. Although 20–30 participants were initially selected, theoretical saturation began occurring following the 20th interview. Four additional interviews were carried out to ensure validity, but upon confirming the theoretical saturation, the interview process was concluded. Each of the participants was assigned a code to protect their confidentiality and anonymity. A thematic analysis approach was adopted, which enabled the development of a priori and emergent codes from the data. The analysis was carried out using NVivo, and the results are provided below. This chapter provides the results of the data analysis. In addition, the chapter provides an insight into the profile of the participants to outline their experiences and to justify their inclusion in this study.

5.2 Participant profiles

The sample of 24 participants was selected using a purposive sampling method. Table 5.1 gives the codes assigned to each of the participants, along with their area of work.

Table 5.1: Participant profiles

Participants	Designation/role/ background
Participant 1	Chief strategy officer
Participant 2	Business partner
Participant 3	Start-up mentor and coach
Participant 4	Managing director
Participant 5	Head of innovation
Participant 6	Entrepreneur
Participant 7	Director
Participant 8	Owner of a holding company
Participant 9	Entrepreneur, working in government with a focus on robotics as an ecosystem
Participant 10	Student and researcher on innovation ecosystems
Participant 11	Entrepreneur
Participant 12	PhD scholar

Participant 13 Chief executive officer (CEO)

Participant 14 Strategic management background, financial sector

Participant 15 Part of the government innovation

Participant 16 Professor

Participant 17 Professor

Participant 18 Professor

Participant 19 Entrepreneur

Participant 20 Representative of a private management consultancy

Participant 21 Financial advisor

Participant 22 Ecosystem development and entrepreneurship development

Participant 23 Entrepreneur

Participant 24 Investor

Table 5.1 shows that the participants are involved in various capacities in the innovation system of the UAE. There are several participants who work in the education sector, along with business owners and entrepreneurs. Furthermore, several government officials who work towards the development of the innovation ecosystem in the UAE also participated in the study. This demonstrates that the participants are not only experienced but are involved in the innovation system of the UAE.

5.3 The UAE's focus on innovation

An important result relates to the state of the current national innovation system in the UAE. This was largely outlined by the participants' responses as they spoke about their role in the UAE's national innovation system and further outlined the focus of the UAE. Therefore, this code emerged during the data analysis. It is essential to determine the current scenario in the UAE to be able to take informed steps to activate the country's national innovation ecosystem.

The overarching finding from the data was that the UAE has placed consistent emphasis on innovation. This was outlined by Participant 1, who stated that:

> Innovation is at the core of that aspiration of the UAE as a nation to become one of the leading countries in the world by 2021 and to become the best country in the world in 2071.

Furthermore, Participant 15 also noted that when the Year of Innovation (2015) was launched by the President of the UAE, several initiatives were launched, including the

development of a national innovation strategy. In the same light, Participant 14 outlined that the role of the Government of the UAE is critical. They said:

> The government takes on the responsibility to look into interesting ideas. So, you have those open forums where you can submit ideas, but it's not really their (the government's) job, and governments are not supposed to vet ideas. They're not supposed to put funds from their own pocket. Yet, the UAE is doing it because there is really goodwill. And there is a very high commitment to advance the country.

Thus, there is considerable focus on innovation as a driver to advance the nation towards becoming a knowledge-based economy. Several innovation-focused initiatives have taken place, and the government is providing funding to foster innovation in the country.

The role of the UAE's government towards supporting innovation became clearer when the government launched a directive mandating that 1% of the public sector budget will be directed towards innovation. Participant 15 highlighted:

> His Highness Sheikh Mohammed announced that all federal government entities, ministries; they need to dedicate 1% of their budget towards innovation. This addresses the issue that a lot of people say: 'Oh, we don't have the money to work on projects or to research or to launch something new'. This announcement from His Highness gave them a push.

Participant 18 also added that His Highness had driven innovation by offering million-dollar prizes for those undertaking innovative projects involving drones or robotics. Such initiatives clearly demonstrate the country's commitment to innovation have received much attention from leaders and the government.

The push towards innovation is also achieved by the UAE Governments' financial support for innovative start-ups. Participant 15 outlined that the government has reduced initial start-up fees, and students are not required to pay anything for their new initiative. In terms of innovation funding, Participant 19 stated that:

> Things like the MVR space, System, Centre fees are great initiatives, and what these sorts of government entities do is that it forces the government entity to go into the country and find talent and fund research; because the centre has a purpose that they need to fulfil. So, long-term centres, like Space Centre, for example, now we have a Ministry of Food Security; another great institution that

has their own internal mandate to meet an internal mandate, they have to fund research.

While Participant 15 focused on start-up funding, Participant 19 discussed funding for R&D initiatives taken by several government entities. In terms of innovation research, the country has made significant strides, evident from the investment in R&D and start-ups. The government is innovative, and if the development process is evaluated over the years, there have been considerable efforts and notable developments within a short period of time compared to other countries in terms of innovation.

In addition to financial support and a positive push from the government, innovation initiatives have taken place. For instance, Participant 13 noted:

> Hub 71 is an initiative to drive innovation technology in the country, and our mission is to place Abu Dhabi on a global map of technology.

Participant 15 also outlined that the MBRIC has applied significant innovation initiatives in the public sector. Participant 15 said:

> We have a business model that consists of three main pillars: the enrich pillar, the experimentation pillar and the enabling pillar. With the enabling pillar, we look at the federal government employees; we equip them with the innovative tools and methods to kick-start the innovation journey within their entity and we have the public sector innovation diploma within the splitter. So far, we have four cohorts who have graduated more than 100 people from the diploma. Starting from September next year, we will launch our fifth cohort. And then, in every cohort, the participants are required to work on innovative projects that will help them and their entities. The second pillar is the experimentation. This is a pillar we're starting to activate more this year, whereby we encourage government employees, the federal government in place to start testing their ideas, before taking them to, before scaling them up.

It is evident that the Government of the UAE has implemented several initiatives and that these serve as significant drivers of innovation in the country. The initiatives implemented by the MBRIC have focused on driving innovation both in the public and private sector. The MBRIC is encouraging a culture to innovate in the country by encouraging students to work on innovative projects, and by experimenting with new ideas before wide-scale implementation. Furthermore, Participant 15 highlighted Innovation Week:

which started off as a week in 2015. It was just a week and now it's expanded to a month, given the demand that we have, we try to reach schools, universities, as well as our grandmothers and grandparents at home, and to educate them what innovation means. We also have the edge of government exhibition, which is part of the world government summit, and its place in the entrepreneur because we bring public sector innovations from around the world.

Thus, the MBRIC has put in significant effort and taken up innovation at different levels with different agendas and at different stages. These initiatives, along with Hub 71, clearly depict the country's focus on innovation, creativity, and continuous development.

In terms of regulatory policies and framework, the UAE has made significant progress. For instance, Participant 2 stated that there exists considerable discourse around innovation policy and innovation agenda, which has led to increased awareness about the importance of innovation in the country's development. Thus, there are substantial movements around the innovation ecosystem in terms of R&D efforts, funding and regulatory policies. Further, Participant 13 highlighted the UAE Government's initiative to manage and retain talent in the country:

I think we started to see a lot of great government initiatives around entrepreneurship visas and the kind of long-term visas and so forth to address that gap, and I'm sure [that] sort of an initiative will support on attracting the kind of a lot of good investor[s].

Although several initiatives, innovation programmes and government policies exist, the conditions may not be positive enough to activate a national innovation ecosystem. Challenges do exist, and they may hinder the establishment and growth of such a collaborative ecosystem. For instance, Participant 17 noted that:

Currently, there is no certificate that exists that prepares somebody to teach innovation entrepreneurship, or there [are] no formal requirements.

In the absence of such courses or development programmes, the country will lag behind in terms of entrepreneurial skills that can lead to the establishment of innovative start-ups and business ventures. Participant 24 stated:

We've got so many initiatives that are launched, but the value is not there in terms of scale.

In other words, the participant stated that the country has done much for incubating, shaping and accelerating the future; however, it has not focused on scaling the future. In addition, Participant 24 stated that there has been considerable investment in innovation programmes, but with little return on investments (ROI). The primary reason, as highlighted by the participant, is that the focus is directed towards developing tools and technologies rather than changing the mindset of the people. Participant 24, therefore, described a cultural dimension that failed to inculcate innovative zeal among the individuals, to motivate them to look for alternatives; to move away from the traditional pathways to achieve something exceptional and contribute towards the development of the country. This aspect will be discussed in the following sections. However, the opinion provided by Participant 24 contradicts Participant 15, who emphasised that the government has taken the initiative to foster lifelong learning:

> His Highness Sheikh Mohammed, along with the Minister of Higher Education, launched an initiative to promote the concept of lifelong learning. This is important, and this would cause a big cultural shift.

Thus, the UAE has made considerable progress in fostering innovation in its attempt to position itself as a knowledge-based economy. However, as understood from the participants' responses, it still needs to strengthen its education system to incorporate programmes related to innovation and entrepreneurship to increase R&D initiatives in the country. A cultural shift is also required to instil a creative mindset among individuals and to encourage them to engage in innovative efforts, increase collaboration and build the foundation of the innovation ecosystem. These aspects will be discussed in the following segments.

5.4   University–industry collaboration in the UAE

One of the fundamental aspects of an innovation ecosystem is that research can be best achieved through collaboration between industry and academia. Academic institutions deal with the production of knowledge, which is then applied by industries and thus, the collaboration between the two can successfully drive R&D and provide an impetus for the formation of an innovation ecosystem. This code that was generated provided insight into the current nature of university–industry collaboration that is being carried out in the UAE.

Several respondents highlighted the current scenario of university–industry collaboration in the UAE. For instance, Participant 13 stated:

I went to the Petroleum Institute, which is an affiliated university with the oil and gas industry. So, all the training that we went through was to prepare us to go and work at the oil and gas industry.

Participant 5 also highlighted the Alchemy project in the UAE that helps:

transform our universities to become institutions that graduate not only successful students who then go into the private sector, but also graduate companies and founders and create an environment fertile enough for them to actually think about what needs are unmet in the world and to serve those needs, as opposed to being completely disjointed from reality, which is the case in many universities now.

In addition, Participant 9 also talked about RT research and technology organisation that serves to bridge the gap between university and industry. The participants added that in the US and Europe, such collaborations do exist, and since the UAE takes ideas and concepts from those countries, it is foreclosing. Thus, following the opinion of the respondents, such initiatives will be observed more in the near future.

While the participants emphasised the importance of industry–academia collaborations, it also highlighted collaborations taking place across the universities. For instance, Participant 16 highlighted the collaboration between Khalifa University and other academic institutions for R&D activities. However, Participant 16 noted that universities outside the UAE, like in Germany, are conducting networking meetings that are bringing in experts from technical fields and the business world so that they can brainstorm together and:

'create a business plan to take an idea and move it out'.

According to Participant 16, such collaborations can yield better results and can, therefore, be explored by the universities.

Another significant aspect of collaborative initiatives is the push from the UAE Government that has increased the level of collaboration between the industry and academia. For instance, Participant 18 stated:

Regarding the collaboration between the university and the industry, thanks to the initiative by the UAE Government, recently, the Government of the UAE has issued a very important law or system, which is called free zones. This is a very important initiative toward innovation and entrepreneurship. So, with this, we

have the liberty to open the Entrepreneurship and Innovation Centre at the university without going through the lengthy procedure or approvals.

The participant further added that:

This one actually will allow the student with their ideas to come up and build their start-up, and there will be a lot of work done by the government.

Moreover, Participant 2 noted that the government is also providing funds for such collaboration. For instance, the participant reflected that:

New York university of Abu Dhabi as an example of a leading university that has developed a campus here and has been heavily funded, both from a government point of view and privately by the Mohammed Bin Zayed Al Nahyan family.

However, Participant 5 stated that such funding is not sufficient and:

University's budgets are allocated based on the number of students they produce and output. A lot of efforts are on the way to transform or to give universities budgets around research, but they are very limited.

Thus, from the participants' opinions, it can be stated that there have been some initiatives around the collaboration between university and academia. Also, government funding has provided a stimulus for increased R&D efforts. However, such collaborations need to increase, and infrastructure is required to foster the growth of such collaborations.

5.4.1   Challenges in university–industry (R&D) collaboration

Identifying the challenges of university–industry collaboration is a crucial step towards mitigating them. The results indicate the presence of several challenges that hinder the extent of university–industry collaboration. For instance, Participant 12 stated that:

One of the biggest challenges when it comes to university–employer relations is confidentiality of information. There is a big issue when it comes to confidentiality, and employers are very afraid that some leakage will happen.

In addition, the participant identified two more challenges, from the perspectives of academia and industry (or the employer side). Participant 12 reflected that:

From the university's side, there may be some resistance to have the employers because they believe that employers don't understand theory, so they devalue

actually the knowledge that they have and the experience they have. From the employer's side, again, I feel that employers are too busy to give time for the society and to pay back to the community through universities, which may be an issue because if we continue thinking that way, we will actually make our life harder as employers, because the students will not be ready to take the next step. So, we will need a lot of training before they get used to the employment culture.

It appears that each of the parties involved in university–industry collaboration may deny the potential R&D contribution from the other side. In addition, little communication exists between industry and universities, which hinders teamwork and collaboration. As pointed out by Participant 12, a fear of confidential information leakage is another concern that thwarts such alliances.

Further analysis of the participants' responses revealed another major challenge: the universities are not focused on R&D activities, and the teaching philosophy is tied to traditional curriculum-oriented learning. As noted by Participant 16:

Universities here are really teaching universities; they're not research universities. So, I think when you are focusing on teaching, you're focusing long content delivery. Whereas, if you're focusing on research, you're really thinking exploratory. So, there is a little bit of conflict.

A similar opinion is also provided by Participant 14, who stated that the education institutions, be it schools or universities, are more focused on delivering on academic promise, that is, attaining degrees. Thus, there is no link between the activities undertaken by the universities and the tangible innovation results that [were] supposed to be seen in the UAE.

Furthermore, Participant 7 stated: '*we need to make a clear distinction between a university that's considered an educational university and research university*' and drive greater orientation towards R&D. Participant 7 also highlighted that R&D activities are considered risky, and the culture of the country undermines the importance of risk-taking. A risk-taking mindset is not infused in the education system in the UAE, and this hinders innovative ventures from individuals. Thus, the traditional curriculum-oriented content delivery has little influence on practical learning, and the students are not encouraged to try new ideas or take risks.

From the perspective of academia, one of the unique challenges in terms of university–industry R&D collaboration is pointed out by Participant 22: in the UAE, the university system, and even in schools, the turnover of teachers is very high. Thus, teachers and professors do not have the tenure time to continuously develop relationships with industry. Participant 22 added:

> The longer you have them within a physical place, the more these relationships get built and matured, and programmes become deeper and more meaningful.

A long-term association with the school or the academic institution provides opportunities to explore relationships with other institutions and, thus, builds networks to drive R&D initiatives. However, the high rate of teacher turnover impedes development of such alliances and, thus, hinders growth of R&D.

The lack of university–industry collaborations can also be attributed to a lack of governmental initiatives to transform the educational system to increase R&D activities. For instance, Participant 22 stated that the UAE Government should play an active role in facilitating such collaboration:

> It's important that the government continuously monitors the impact of such collaboration, and if it's not happening, then it should be launched to do that.

However, Participant 5 stated that historically in the UAE, the focus was not on innovation. Participant 5 highlighted that there was a very clear mandate from UAE leaders to graduates to serve the government to build the country. Thus, the focus was on creating an educated workforce, which led to the development of teaching universities, not research universities. Participant 5 added further:

> All of the university's budgets are allocated based on the number of students they produce and the output, and not lot of efforts are on the way to transform or to give universities budgets around research; it's very limited. So, universities like the UAE University are producing and getting research funding, but it's few.

In addition, the participant stated that in comparison to countries like the UK or the US, there has been little effort from the UAE Government to fund research or incentivise the private sector. Participant 5 also provided a similar opinion and stated that the UAE does not possess the legacy of connecting university and industry compared to other countries. They noted that the challenge is not in inadequate funding because there are investors and leaders who are willing to provide funding for new ideas. Rather, the problem is to connect universities and industry so that collaborations can form and R&D

can take place. However, in the absence of initiatives from industries and academic institutions and a lack of push factors, alliances between university and industry are rare.

Thus, although institutions such as the MBRIC and Alchemy project have made significant moves to drive innovation in the UAE, such initiatives are low. The two major players in building the innovation ecosystem are industry and the academia, who are disjointed and have made little collaborative efforts to foster research, innovation and development of new solutions. The government has provided funding to universities to conduct R&D; however, such financial support is not widespread. Moreover, the funding is directed to meet the university's R&D budget and is not intended for collaborative initiatives between the university and industry. In line with Participant 5, Participant 6 also stated that universities should look for funding sources other than governmental. Most of the public universities are fully funded by the government so they do not look for government funds. One way to improve collaboration is to offer incentives for increasing R&D initiatives. As stated by Participant 12:

> I haven't seen any very attractive incentives. So, I don't think they are incentivised enough to create original knowledge and then we and then having those patented, because if this was the case, then we would have seen a growth than that.

Participant 12 stated that there are some incentives like the carnival that provides 90% back to what is initially paid. However, these incentives are not enough to drive R&D collaboration. A similar view is provided by Participant 17, who stated that there are several obstacles that need to be addressed in the UAE. For instance, there is no serious attempt to promote R&D and projects between industry and the university sector, and there are no knowledge transfer channels between them. Universities in the UAE are not designed to solve real-life problems, so companies are not approaching universities to the same extent as in Europe and North America. According to Participant 17, a key hindrance is the lack of incentives. In other countries, universities often receive financial support from companies for R&D. Such support is not observed in the UAE.

Participant 23 also believed that a significant factor of successful innovation systems is having incentives for the researchers and universities to commercialise. These can be financial incentives or non-monetary awards and royalties to help drive innovation and R&D efforts. Thus, incentives, in the form of financing, reward or recognition are needed to encourage R&D collaborations and innovation activities. The government must play an active role to incentivise universities and companies to collaborate on R&D projects and offer rewards for groundbreaking innovations. Initiatives are currently fragmented

and confined to small pockets. Scaling up to a broader level is required, where different stakeholders can come together, brainstorm, generate new ideas, explore them and create innovative output. Therefore, a lack of incentives is one of the challenges hindering university–industry collaboration.

Participant 14 turned their attention towards the lack of resources for collaborative innovation initiatives in the UAE. According to Participant 14:

> In the UAE, nobody claims that responsibility, or that ownership. So, universities are not so keen into R&D. Maybe they lack the resources or the expertise.

Furthermore, Participant 14 stated that:

> Government is doing their own R&D in specific areas that are related to the government and not necessarily related to the advancement of a particular innovation in a particular sector, and the private sector is so driven by growth and profitability.

This indicates a lack of awareness among academic institutions and industry regarding the effectiveness of R&D collaborations. In the absence of an adequate R&D budget and financial support from the investors or governments, innovation fails to take shape. As noted by Participant 15:

> We've noticed that a lot of research is being done and there is some sort of collaboration with the outside institutions or external institutions, not in the UAE. So, there is research, but there is no connection between reality and the market. So, it would be nice; maybe we'll start with awareness and show people or show the importance of R&D.

From the opinion of the respondent, collaborations are not taking place internally. Alliances need to be formed internally, and collaborations need to take place among institutions, industries and sectors in the UAE to create a successful innovation ecosystem.

Participant 16 pointed out that gaining permission for R&D activities is a major challenge to the growth of collaborative initiatives between industry and universities. For instance, the participant stated that security clearance is a major deterrent against approaching universities to form alliances. According to the participant, there is also a lack of initiatives from academia. Very few universities in the UAE provide scope for interaction. Participant 16 noted:

> I know many universities don't have a policy where professors actually were given extra time for community engagement, and this becomes a challenge.

This indicates a lack of formal policy at the university and school level to encourage R&D activities. As noted earlier, schools are focused more on curriculum-oriented teaching, which does not provide room for innovation, exploration and creative ventures. In the absence of sufficient policy requirements, the academic institutions lag in innovative efforts and fail to inculcate inquisitiveness and risk-taking among the students to contribute to the greater good of the nation.

While there is a lack of enthusiasm from the universities, the initiatives from industry are also considerably low. For instance, Participant 16 stated that:

> The industry themselves finds it easier to get experienced people, the new interns; they're not really interested in working with young students.

In this sense, Participant 17 communicated a lack of genuine interest from industry, which impedes the formation of collaborative R&D alliances between them and universities. The participants also noted that in the UAE, R&D within companies is low, and international companies undertake research in their home country. This indicates a lack of genuine effort from both industry and academia to foster initiatives around R&D. The R&D activities that are taking place are mostly limited to small-scale innovations that serve specific industrial or academic needs. In the absence of a two-way effort, innovation projects cannot achieve their full potential and meet the goal of creating an ecosystem for the country.

Some R&D activities have started in the country; however, such initiatives are isolated rather than being collaborative. '*The industry, in general, doesn't know how to talk to universities*', noted Participant 9. Moreover, the universities in the UAE must have some flexibility to accommodate the industry's needs and requirements and prepare future generations for the industry sector. Teaching only the academic curriculum will not be adequate for meeting the constantly changing needs of industry. Theoretical knowledge must be supported with practical skills, experience and expertise so that the students can engage in R&D and create collaborations with the companies. These collaborations are needed to foster the development and activation of the innovation ecosystem.

To create collaborations and alliances between industry and universities, there must be incentives, either monetary or non-monetary. The role of the UAE Government has been emphasised; it needs to create a climate that fosters collaborative innovation in the

country. Moreover, innovation and joint initiatives can only grow if individuals learn the value of risk-taking throughout their education. The cultural climate in the UAE can also be considered a major obstacle for promoting innovation and stimulating university–industry collaborations.

5.5 Current challenges for creating an innovation ecosystem

5.5.1 Current visa and citizenship structure in the UAE

Several participants noted that one reason why innovation is not facilitated in the UAE is the lack of an appropriate visa structure for facilitating long-term research. For instance, Participant 10 said that due to a limited amount of local calibre, talent is often brought in from the neighbouring Arab countries, which then becomes expensive. Participant 10 noted that this expense was because there is no trial-and-error period in the UAE due to visa requirements for expatriates. When these candidates who are brought in from other countries obtain job offers from Germany, the US or London, they are more inclined to go there due to the opportunity to gain citizenship. Participant 10 noted that since citizenship is not an option in the UAE, which hampers the development of a greater innovation drive because:

> I actually think that until you get people to really feel that they belong, or that there is even a path to belonging, then they're not gonna, they're not going to invest their soul in the same way in the place.

Similar insights were provided by Participant 11, who said that the temporary nature of their residence in the country is a primary challenge for their engagement in innovation. Participant 11 said:

> It's hard for people to justify putting investing their life and time into something that feels impermanent. And it's that lack of permanence that discourages a lot of people to keep investing and keeping their assets and the assets cannot isn't necessarily just cash or were hard things it could be intellectual property. If people don't feel that this is their home, why should they do it here?

Participant 11 then gave the example of Singapore, which provides a pathway to permanent residency. This is different from full citizenship, but it helps people feel that they belong. Participant 11 noted:

> I think what Singapore has done is good; that they give you a path towards a permanent residency and at least that PR makes you know and know you have

a place to stay regardless now passport no passport, this is another topic for another day. But this is such a big psychological hurdle for people.

Participant 11 elaborated:

And the problem with being in a temporary state of mind is you also don't think about the best interest of the better. Right? It's just like, okay, I have a 20-year window; I want to make my money, save them and take them back home. Or if you're at the very dawn, you're literally sending the money back home, which is billions when you add it all up. I think this is something that I think needs to change.

Participant 5 also highlighted the fact that the temporary residence status in the UAE is a hindrance:

If you want to become a true innovation economy that brings the brightest minds from the rest of the world, those brightest minds will not just come for two or three years; they want to see that they're appreciated and valued. And also, that those countries as host countries also value them right now, across the board. Having met with a lot of CEOs and leadership, and entrepreneurs, they all expressed their concern that UAE is a great place to land to grow. But it's certainly not [a] place they called home to their always consider places like Canada, Australia or the US as the ultimate destination. And this is like a stopover point. They'll enjoy their time here; they'll enjoy the lifestyle benefits of being in a place like UAE. But they'll never want to live here for the rest of their lives, because there's no guarantee that they'll even be welcomed here. And to that point, permanent residency, as you know, as our colleagues in the cabinet have done recently, are very good step towards that it creates that protection layer and gives them that comfort. And as you can, as you know, they're willing looking to roll this out for everyone. I would encourage that, that entrepreneurs who have met a certain criteria, and their teams, and you know what Australia does really well, certain height, talent, what you call categories, right across the board, and Canada does this as well. And professions, they should be given permanent residency on the fly if they qualify. And that's why they've still been able to attract so many of the greatest minds in the world. Because they've, they've done that really well. They've done the migration piece really well. And that includes Canada and Australia. And I've seen how meticulous they are in terms of their selection of people. Really, they can allow most people to go there because they fulfil a gap in the market.

Elaborating, Participant 5 outlined that the mentality of expatriate innovators is also affected by the non-permanency of their stay in the country:

> The recurrent theme has been that, 'why should I have a mentality of contributing to a country that doesn't give me any ownership or stake in the game or skin in the game? My only skin in the game is what I put in and I take out'.

To rectify the situation, the participant suggested that the UAE needs to follow in the footsteps of Singapore:

> I think shift we need to do as a country is to how do we encourage for what Singapore has done really well, is the path to permanency.

Finally, speaking from the viewpoint of a researcher, Participant 16 stated that the rolling contracts that researchers have with universities and that they cannot retire in the university with tenure mean that they cannot direct long-term research. This is an issue, given that true innovative research is a time-consuming process. Participant 16 stated:

> Let me take researchers worldwide. If I look at talented researchers, you stay in a university because you have tenure, which means I can retire in the university. I've got a pension I can contribute with. Because we don't have the visa, you don't have tenure here. Right? So, you have rolling contracts. But that does not mean you can stay here as long as you want. So, this becomes a challenge also with research.

A similar point was raised by Participant 17, who said that:

> Research and development require time and, therefore, that doesn't get aligned, doesn't talk well to the visa issue here. Because most of [the] researchers, if they are experts, they are on two to three-year contracts. Okay, that brings uncertainty, which doesn't support the research require certainty required comfort require a good business environment.

In summary, one of the primary challenges identified in the UAE is the current visa and citizenship structure. Although the UAE has already taken steps to ensure that longer-term visas are provided, this still presents a challenge as research cannot be completed in a period of five years. This barrier is limiting the potential talent that is coming into the country.

5.5.2 Funding and cost of living

The cost of living in the UAE was described by Participant 10 as a barrier to innovative activity. Considering entrepreneurs, Participant 10 said that due to the high cost of living in the country, entrepreneurs cannot afford to try something new due to extremely high education costs. This issue becomes prominent when the entrepreneur or innovator has a family to support financially. Participant 10 also noted that entrepreneurs are usually unable to take out a salary from their business in the first few months, or sometimes even years. This is not feasible for people with ideas and no financial backing.

Looking at how businesses are being funded, Participant 11 said that many of these owners are previous founders who sold their company. The participant added:

> When I look at the funds that are doing this, the majority of them are former founders, who succeeded and sold their businesses and made a lot of money for they're using their own money. And because they're putting their own money, the other investors who invest with them say, oh, man who he's putting his returns from his sale of his company into this thing; he really believes in it. And because he's earned before, he'll know how to select what to invest in and what not to invest in. Right. So, I think we have a funding gap in the early stage, but I don't feel that we have enough investors who think this way.

Participant 16 noted that the cost of setting up a business is high, which prevents entrepreneurs from investing in a risky idea:

> The cost of setting up a business is so high, and I think really, when you're looking at entrepreneurs, people want to test whether the idea works before they start. That makes common sense, right? Why would I spend 10, 000 dirhams for a license and everything else will need to find out? It feels I would rather like to invest it slowly; see if it works perfect[ly], and then put in the money to build the business. We don't have that progressive chart here for various systematic reasons, and I think this discourages innovation.

Therefore, the cost of setting up a business and the cost of living are primary factors that hinder nascent entrepreneurs from engaging in business activity. Unless an individual has been a former founder and has sold their business and then reinvested that money into a new idea, it is not feasible for individuals without a strong financial backing to engage in meaningful innovation.

Further analysis of the interview responses also revealed that difficulty in obtaining funding is another hurdle for the development of an innovation ecosystem. It was also identified that the funds provided to nascent entrepreneurs by the government are not being distributed appropriately.

One of the challenges that entrepreneurs face is the lack of access to capital in the early stages of the business. Participant 11 described this issue in detail. Because venture capital firms only invest in businesses that have developed some traction, there is a funding gap that exists in the UAE's entrepreneurship scene. The role of banks was not favourable because banks usually act as an equity investor, but with high interest rates. Furthermore, after obtaining a loan from the bank, if the company defaults, the banks have first rights to the assets of the firm. Participant 11 said that they had not seen any firms that provide venture capital here in the UAE, and that:

> When you want to go and ask for an SME loan, it's a very painful process with a lot of documentation.

Augmenting the issue with the banking sector, Participant 20 noted that:

> The banking is very challenging, very basic. Yeah, banking, you know, so, our main companies based out of US, and banking here is very difficult for a small business relative to there, especially in terms of access to working capital or loans and financing, which banks do much easier elsewhere here. It's very difficult.

In essence, the procedures associated with banking and gaining access to capital are stifled in the UAE compared to other regions. This is a potential reason why innovators prefer to move to other countries with easier access to capital and funding.

The funding provided by the government may not be appropriately allocated, which leads to low levels of innovation. For instance, Participant 24 noted that the UAE Government spends a huge amount of money on innovation deployment programmes, but these do not generate the expected return on investment. Participant 24 said that these programmes do not lead to a change in mindset because they are short-term.

Participant 24 depicted a poor allocation of funding by giving an example of a fund that was launched:

> And now they've got an accelerator. And I was speaking to some of the start-ups that are going through the accelerator. This is not really an accelerator, right? It's something else, and you're paying lots of money to acquire, but the reality is this

money is going in, but the design of the programming isn't designed for entrepreneurship. It's designed by somebody to give money to consultants.

Where funding is available for Emiratis, the use of this funding is not being scrutinised. Entrepreneurs are not being held responsible for the use of these funds for innovative purposes. For instance, Participant 3 highlighted:

We have a lot of money available to start-ups, led by the Emiratis here today, like Khalifa funds … I know the funds are available for investments. But the availability of money for Emiratis makes them make a lot of erratic decisions and be less responsible.

This becomes an issue because, '*you don't want just another business owner, you want Emirati leaders to drive the country*', Participant 3 added. They also said that despite the huge investment taking place in the region, the success stories are not up to par. Participant 3 noted that despite the investment of up to 2.4 billion in eight years, only one successful 'unicorn' has emerged.

The high cost of living and setting up a business in the UAE, and the lack of appropriate funding to remedy this, are some of the challenges that limit the engagement of entrepreneurs with the innovation system. The funding that is provided is not solely for innovative purposes, and entrepreneurs are not being held accountable for the same. Finally, government entrepreneurship deployment programmes are not generating the expected returns due to their short-term nature, which then fail to bring about a change.

5.5.3 The mismatch between public and private sectors

The mismatch between the public and private sectors challenges the creation of an innovation ecosystem in the UAE. To put this in perspective, Participant 14 provided a detailed explanation of the phenomenon that they have witnessed in the UAE. Participant 14 said:

I can notice that there is a very limited intervention from the private sector and the innovation ecosystem. I mean, we hear a lot about government initiatives and what the government was trying to promote, both in the government sector and the private sector. But what we see on the day-to-day practical approached off the cover of the private sector towards innovation, it's very limited. So, I would, just to sum up, I would say that the private sector should play a bigger role in whatever the UAE Government is trying to achieve. But currently, they're very limited.

Similarly, Participant 20 outlined that there is no synergy between the government and private sector by saying that, '*government is far ahead in UAE and corporates are way behind*'. Participant 14 echoed this by explaining that the government's initiatives are run at government level only and do not trickle down to the private sector, who are actually keen on a partnership with the government. In addition, Participant 14 noted the private sector is not participating in the development of innovative initiatives because of a different focus. That is, the focus of the private sector is on growth and profitability, and the focus of the public sector is on innovation.

Participant 23 noted that the private sector does not seem capable of directing innovation due to a lack of appetite for risk-taking. Participant 23 highlighted the approach taken by the private sector:

> What they've done is they usually get machinery from other countries, like German or Japanese or something, and then they deploy them. And then they have like, a, like an assembly line, basically. Right? And then they have like a manufacturing line. They don't really get into the R&D of like, okay, let me design, you know, equipment to begin with.

Participant 14 added:

> It's actually very easy for the government to attract the private sector and to partner with it. And we hear a lot about [public–private partnership], private sector, public sector partnership, but so less of action. Then there's talking about the subject. The private sector is actually very hungry to cooperate with the government, especially in Dubai. Dubai have established a very rigorous, a very attractive infrastructure when it comes to the government that the private sector is so keen to work with the government. They're so keen to get into partnership with our government on any subject, let alone innovation, and progressing a particular sector or a number of sectors altogether.

According to the participants, the government has limited its focus on involving the private sector in R&D, which means that the private sector lags behind. As the government sector expands into innovation, the gap between the private and public sector increases. This disconnect could mean that the innovative products generated by the public sector are not accepted by the private sector due to a wide gap in the capabilities.

5.5.4 Other factors identified by participants

Several market-level factors were also identified as challenges in the UAE's innovation ecosystem. One of these factors is the cultural orientation that creates different expectations for students. Participant 11 said that:

> Many of us come from this old mentality that, you know, as a parent, we do a great job if our children become doctors and lawyers and engineers. But you don't hear about anybody saying I want my daughter or son to become an inventor; and entrepreneur.

Participant 5 also noted that the career orientation of parents is an influencing factor:

> If in your household, if, you know, father's an engineer, your mother's in teaching or something else; you certainly have a far more intellectual conversation than one where your father is in a government job and your mother's in a government job. And so that's where you nationals are disadvantaged, because they don't have a lot of role models and examples of what are other possibilities other than being in government or being in a family business.

This response depicts the influence of parents' jobs on UAE nationals, as they influence the dialogue that is established in the minds of the student, who may then aspire to follow in the parents' footsteps.

Highlighting the cultural aspect, Participant 16 noted:

> Even if I look at schools, it's generally expats [that] are separate from us; I mean, locals. And I think this is a disadvantage, in some cases, because the greatest creativity will [come from] mixing people together.

In other words, the schooling system, where the UAE nationals are not studying in the same schools as the expatriates, is limiting the potential creativity that diversity can bring.

Some participants said that when they see that innovators are being invited into the UAE, their primary concern is where they will conduct their research and who they will be working with, because locally there is not much research taking place. In essence, Participant 17 outlined:

> You don't see much of the research and development done within companies in the UAE. Most of the even international companies, big companies operating in

the UAE; unfortunately, the research and development is done in their home country.

Finally, several participants outlined that the legal and regulatory framework is tedious and not on par with the innovation dialogue that is being encouraged in the UAE. The legal requirements for innovative business ventures such as Uber and others need to go through a long process of documentation and approvals, which has the potential to discourage younger innovators who have ideas that challenge the status quo. Therefore, the legal and regulatory environment of the nation is also a hindrance for the effective implementation of an innovation ecosystem.

This section has presented challenges such as the current nature of citizenship and visas, the cost of living, setting up a business and obtaining funding for new ventures. These factors limit the potential of establishing an innovation ecosystem in the UAE. In addition, there is a mismatch between the public and private sector in that the public sector is conducting research at the government level only, and not integrating the private sector into the R&D process. Finally, cultural issues and regulatory and legal limitations were also identified as challenges. Without mitigating these challenges, establishing the innovation ecosystem in the country will not be feasible.

5.6 Inputs required for developing a national innovation ecosystem in the UAE

5.6.1 Financial inputs

Funding was one of the key elements identified by the participants as being necessary for building a national innovation ecosystem in the UAE. Participant 13 noted:

> Innovation, by definition, is all about taking risk[s], and trying the unknown. And that require[s] also financial backing, right? So, you need a thriving financial industry that is comfortable with the venture risk to push innovation forward. So that's a key element.

More specifically, Participant 13 said that for the ecosystem to work efficiently, there needs to be a much higher input of venture capital provided.

Participant 3 highlighted the importance of funding a business in the start-up stage to ensure that it successfully transitions into a seed. Participant 3 said:

> One of the things that we have identified is [it] actually takes a lot of time for [a] start-up to reach seed level. Seed investment is important. That's the first real guided capital that you would have in your business.

Furthermore, Participant 22 outlined that:

> Funding really is not at the level where it needs to be, especially from seed and growth and like, because even the funds that are here are looking for opportunities outside, rather than looking at how they can attract the outside to the UAE and actually the funded and base it here. They're happy to invest in our idea if it sits in Silicon Valley, if it's in Turkey, if it's in somewhere else, but they don't really have any programmes to say, well, I'm going to invest in you. But why don't you bring a percentage of your operations to the UAE so that conditions of funding could be looked at. And also, to create the critical mass of entrepreneurs in the UAE, the entrepreneur experience needs to be looked at.

Thus, the participant stated that the funding needs to be strengthened, and channels must be created for international funds to be brought into the country to enhance entrepreneurship development.

Participant 14 suggested that the government can use its current funding capacity to strengthen the venture capital sector in the country:

> So many people, so many, so many investors worldwide, they're more than happy to invest in the UAE, but they don't know the channels. So, they end up doing the obvious stuff: real estate, starting some small businesses here and there. But once they see, you know, a channel that is supported by credible bodies, very well known VCs, very well non-government buddies supporting those VCs, they'll be able to put their money like willingly and raise funds. And raising funds will be way easier.

Participant 14 noted that another option would be to include the banking industry:

> Maybe the banking industry needs to intervene; maybe the VC again needs to be self needs to be supported.

The role of the government in enhancing funding for innovation was also reflected by Participant 22, who stated that the country:

> Could look at … alternat[ive] funding models, which [the] government can actually get involved [in] here and create an entity, which is the one that's taking the risks, and facilitating those and be willing to lose in terms of funding. You know, we [are] willing to, to invest in ten ideas and have, you know, one that might actually

pay back. That's a big investment from the government, but it's a necessary one, because one or two of these ideas can grow quickly.

The government's role in enhancing funding as a way of legitimising innovative ideas was explored by Participant 19. They provided a comprehensive example of how, with enough government funding, the innovative venture will appear legitimate in the minds of others, who will then be encouraged to launch their own innovative ideas. Participant 19 stated:

Okay, now, what happens, just to give an idea, is that now that fund will fund seed-stage companies, mid-stage companies, you know, early stage companies, and as they start progressing through the valuation, you know, evolution that creates seeds and other innovators mind saying that, 'look, there's a company that started with five people. Now they are at 50 people, thanks to the backing of government funds' and the confidence in our private sector to fund increases. I've seen this. … Now let's say 2071, or let's say FinTech high fund invest in a company. Me as a family office, we look if the government is funding this, it must be real, [so] I will also fund it, and that's the most powerful thing.

Participant 16 outlined that:

We would like to pretend we are research-based, and that's according to the innovation index. But there are some challenges. So, let's look at again, things like government funding. Okay, so the amount of funding we spend is very low: 0.2% of GDP. I know that we had outlines like for the UAE, that we're going to spend more money, and we are doing it through the TFF and things like that. But that's not again, going to; yeah, it's going into outside start-ups and places like that. So, this is a big thing. And like I said, the last National Research Foundation was in 2014. And then, very little money was put out. We have another systematic challenge, which is we don't have enough critical mass of researchers.

Participant 22 noted the role that rich families can play in enhancing their children's innovativeness. More specifically, the participant said that when children of affluent families try to innovate and bring about new ideas, the family essentially forces them to abandon the idea while they continue to fund their own business. The participant also noted that when the venture capital route is taken, it creates a high-pressure environment that can lead to poor decision-making. The participant added that '*the more funding that can happen from the families themselves, the better off that these ideas have in terms of growth*'.

Finally, Participant 21 said that although the government can certainly provide more funding for businesses, the government could instead focus on cutting down the cost of doing business in the country. Participant 21 noted that:

> [Another thing] that the government can facilitate and provide, whether it's supporting or licensing cheap office space, a place for someone to work from … helping people connect globally with other entrepreneurs, innovators around the world, is reducing the cost of doing business.

The key elements that emerge from the discussion above include strengthening venture capital funding, provision of government funding and providing subsidies for entrepreneurs to help them manage their costs. As outlined in the preceding sections, one of the primary challenges of developing an innovation ecosystem in the UAE, in addition to lack of funding, is the high cost of setting up and running a business. If the government establishes initiatives, first to reduce the cost of setting up business, and then to provide easier access to funding, the country should see an increase in innovative activity.

5.6.2 Leveraging artificial intelligence technologies

The use of advanced technology, such as AI, was recommended by some participants. For instance, Participant 1 noted that there is great potential for the UAE to implement AI into its existing assets. They said:

> And when it comes [to] innovation in robotics, or like an advanced system to you know, with moving goods from air to land, sea, etc., the multimodal transports; this is the place where we can start. So, our approach, we should start in the area where we have some assets that we can leverage on to build.

In addition, AI technologies could be leveraged to render the manufacturing environment more efficient, as suggested by Participant 4:

> One way to do this is to introduce artificial intelligence or to introduce a new platform, a predictive analytics platform, to be able to predict when a part may fail based on all the unstructured information out there related to things that are happening in the world, or structured information related to wind, temperature.

5.6.3 Promoting a culture of entrepreneurship

One of the primary inputs and changes that are needed is to ensure that there is a change in the culture. Several participants suggested that this change should be brought about starting at the school level using education. For instance, Participant 1 noted that:

> Really, to make sure that through the childhood to a university level, the UAE national, the UAE talent, they can embrace … risk, and there is no problem to fail in an endeavour as an entrepreneurial endeavour … because so many people, they are having this taboo … like, 'if I'm going in business, I felt people they will portray me as a loser'.

In other words, Participant 1 outlined that the mindset of people needs to change to accept the risks and failures associated with highly innovative entrepreneurial endeavours. Furthermore, the participant outlined that an individual should not have to deal with the choice of either working on their start-up or studying in university. The country needs to build an initiative that allows the student to gain industry exposure as well as work on their innovative idea simultaneously. Finally, the participant noted that the 'gamification of entrepreneurship' needs to be carried out during higher education.

Exposure to the core aspects and principles of entrepreneurship through education is important during the early stages of the youth. In this light, Participant 11 highlighted:

> I find that a lot of the youth are being drawn to general employment and aren't going down the entrepreneurship path. I think what would help a lot is early on in the development and education of the youth is to introduce entrepreneurial concepts, expose them to innovators, to leaders that have succeeded and also fail[ed], because we learn a lot from our failures. To show them, you know, when you put your mind to it, and you try to solve problems, that you can do great things. And maybe it can be great in terms of financial success, but maybe it's great for humanity and society. So, I think that's [what] we said first about having an entrepreneur-friendly regulatory framework environment. And then, number two, having entrepreneurship exposed at an early age to our youth.

Accepting that failure is part of the entrepreneurship process was also emphasised by Participant 13:

> I think what we need to realise is for the talented Emiratis, the guys who are working hard, in most cases, they would have great opportunities [to] get a government job or to get that good, or to get a private sector job. Now we

understand that government jobs are more favourable for a lot of our young talent. And that is something. That's an area … we need to kind of think about seriously when we talk about innovation and entrepreneurship. And the reason is a sort of, kind of comfortable government job [can] sometimes persuade people away from taking the risk and try[ing] … Because the one thing that we need to understand [is] that building innovation … will involve a lot of failure, right? And how we become comfortable with failure and setbacks is also [an] important part of that.

In essence, the participant noted that young UAE nationals might seek government jobs that are stable and provide an opportunity for the individual to give back to their country without the risk of failure and uncertainty that is usually associated with innovative, entrepreneurial ventures.

According to Participant 17, innovative entrepreneurship can be taught as a certification course, which is currently under development:

See; currently, there is no certificate that exists that prepares somebody to teach innovation entrepreneurship, or there [are] no formal requirements. And people with an engineering background or certain businesses [with] an entrepreneurial background has been used to teach the current faculty and teachers in the UAE who have inherited the requirement to teach the course by the ministry. Their needs have been addressed actually quite intelligently. So, the ministry has agreed with Stanford [University] not only to work on the development of the course, but to work on the development of the faculty who teach that course. And, in order to ensure that there is a standardised approach to teaching innovation in the UAE, Stanford [University], in collaboration with the Ministry of Education, have developed a teaching guide for that particular course.

Such initiatives could allow the UAE to develop a youth that understands the intricacies of the entrepreneurship and innovation processes. By shifting and transforming the education system to ensure that the graduates and new talents are aware of the risks and embrace them, the UAE can generate an innovative workforce to help activate its innovation ecosystem.

5.6.4 Research and development funding

Several participants outlined that the UAE needs to focus its attention on R&D and support it financially. More specifically, several participants suggested strengthening the R&D in universities in addition to providing funding. For instance, Participant 21 noted:

> You can think about funding R&D at universities, etc. because there are bright people who have come out of schools today. But they did they can't they don't have the ecosystem that they would love to have to innovate. So, funding R&D, and then creating these partnerships with the corporates, … the government needs to push this.

Participant 21 suggested that, in addition to enhancing the R&D in the universities, the universities need to form partnerships to facilitate innovation in the country. However, this initiative needs to be encouraged by the government.

Participant 19 noted that the government needs to establish innovation centres that have a clear mandate to carry out extensive R&D, which will then attract funding. Participant 19 highlighted:

> I think things like the MBR [Mohammed Bin Rashid] Space Centre are great initiatives. And what these sorts of government entities do, is that it number one forces the government entity to go into the country and find talent and fund research. Because there's a purpose, you know, that centre has a purpose that they need to fulfil. So, long-term centres, like [the] Space Centre, for example, now we have a Ministry of Food Security; another great institution that has their own internal mandate to meet, and to meet an internal mandate, they have to fund research.

From this response, it can be understood that Participant 19 suggested establishing research centres with clear mandates, which will then attract funding, rather than making funding available and calling for more R&D.

Participant 5 noted that the role of the government in enhancing R&D funding is more crucial than ever. They provided the examples of the UK and the US, who have been the 'primary funder and investor in the beginning stages', and 'created massive amounts of funding, whether that's for defence purposes in the US' which has then 'led the private sector to follow when they've seen results'. Participant 5 elaborated by providing the example of how the internet as we know it emerged from the Defense Advanced

Research Projects Agency (DARPA) or the Intelligence Advanced Research Projects Agency (IARPA), developed for military purposes:

> I don't know if you've heard of DARPA or IARPA; these were the founding places of the internet, if they are the ones who created institutions as great as Stanford [University], right? Because you had a government research agenda that funded all of these things, and a government military research agenda that controlled that. And then you got all this output of internet for computing systems, chips and a whole lot of other things that [have] now transformed the world. Now, if you don't have that agenda in, we could do it in place, like artificial intelligence, right? These are new areas. But that has to be driven by a very clear requirement from the government to lead it.

Participant 4 outlined that instead of limiting the research to the UAE itself, R&D initiatives needed to be expanded internationally, which could then be used to leverage the advancement of the sectors back in the UAE. Participant 4 suggested:

> We should be encouraging more research, but we shouldn't be limiting it to people in the UAE. We should be opening it up to the rest of the world—doing [a] call for papers so we can get better research coming through about trends, about directions of which, you know, let's say the aircraft industry or the aluminium industry is headed towards.

In addition, Participant 6 outlined that:

> Having competitive grants, having access to research where have celebrating that having, like promotional journals, promotion of seminars, promotion of workshops, is the way forward. I think it's already started, like, approach it like having [a] Russian Academy for a scientist. I think that's a great approach to start [with], because at least researchers are incentivised to do work that would allow them to go in there, and that has [a] sort of prestige that might impact them financially in the job, but also personally and the self-fulfilment there. So, I think a whole mechanism for research, grants, across science, across humanities, across all of the different subjects, would be something that's fantastic; and also having a platform where this can be shared would be great.

Participant 6 suggested that the R&D funding provided needs to become more competitive with the application of research grants. Furthermore, Participant 23 called

for more public investment in R&D because the private sector, in its current state, is not capable of directing extensive R&D because they are risk averse.

Finally, Participant 7 noted that instead of providing more funding, the government should ensure that it knows where the funding is being spent. Participant 7 suggested that we need to:

> Decentralise research capacity, while at the same time centralise funding for research, just so that we have a better understanding of where the money goes and what's the outcome of that.

While several participants solely focused on ensuring that there is enough funding available to carry out the R&D, Participant 10 noted that there need be opportunities generated from the private sector because the government sector cannot do it on its own. Participant 10 explained:

> My understanding is that large companies that set up in the UAE, they don't necessarily have this as their R&D location, right, but they have it as their sales and marketing and distribution. Today, they are happy to sell into the area, and they're happy to market; they might even use it as a gateway to other project region, but they don't necessarily do their R&D. And I think, you know, to get this is, similar to the point about talent, to get this amazing talent, these amazing researchers, they need to, they can go back to choose what they want to do.

Participant 10 elaborated:

> It's very hard for the government to just by themselves, say, hey, we got to create an interesting opportunity to research them. But I think the way to do it … you bring in a couple of companies and institutions. And you might have to subsidise them or give them some incentives to set up here, but then you essentially sort of forced that to happen. And then when those opportunities are here, then the talent will come.

Therefore, using the appeal of subsidies and lower cost as incentives, the Government of the UAE needs to work with large corporations that have an R&D function to ensure they conduct that function in the UAE, rather than limiting themselves to sales and marketing.

The discussion above suggests several steps to enhance the rate of R&D in the UAE and, therefore, lead to a better innovation ecosystem. Given that the allocation of funding

is one of the challenges identified in the preceding sections, the UAE Government can first take steps to centralise funding so that it can track funding allocation. Funds can be made available in the form of research grants awarded to the most novel idea or innovation to strengthen the role of R&D in the innovation ecosystem in the UAE. Finally, the government can develop R&D contracts with large corporations and allow them to set up in the UAE with some incentives so that talent is brought into the country.

5.6.5 Enhancing the regulatory framework

Some participants suggested changes to the regulatory framework to facilitate innovation. That is, the regulatory framework of the country needs to facilitate the setting up of businesses with access to innovative capital structures, as suggested by Participant 13. Furthermore, Participant 19 highlighted that it is essential to create an environment that is frictionless and where:

> It's easy to set up a company; it's easy to do research, easy to collaborate; not bureaucratic, you know; low cost and, and efficient.

Participant 19 outlined that the country can take steps towards reducing the bureaucracy and the prevalent disconnect between different agencies. They said:

> I think 99% of the policies here are amazing. Honestly, I think it's fantastic. It's up to innovators to, you know, maximise these policies … unfortunate[ly], I think the only thing that I would complain about is the disconnect. I know why this is happening. But the disconnect between the licensing and the thinking. Because I've directly paid [for] it. So, it only took us three days to get a license from a DJ. Okay, but it took six weeks to get a bank account from an ATM-recommended bank, which is embedded in VC is the largest bank. You would think that, you know, they will have a process now. It took six weeks to go through KYC. This is KYC of a person … I've worked for the government, so, it should be quick. But obviously, that's happening, because [the] Central Bank is making sure that there's no money laundering and, okay, but I think there has to be something to speed up that process, [its] unacceptable.

From the statement above, it appears that although the policies are appropriate in the country, they do not effectively work together. Due to high levels of bureaucracy, one procedure can be completed with ease, and another can be time-consuming. In a similar perspective, Participant 20 outlined that:

In terms of an innovation ecosystem, it looks like, it seems like, we're putting all a lot of the good pieces of the puzzle together as an infrastructure. We want to enable, you know, accelerators. We want to enable the government from [a] regulations point of view and so forth. But in many ways, that is a government's role … to create an environment ecosystem.

Therefore, it is the role of the government to ensure that the policies and procedures that are required for entrepreneurs to launch businesses in the UAE. Although all the procedures are required to ensure compliance with the established rules and regulations, they need to be integrated to reduce the time taken for their completion. This will not only facilitate and stimulate local talent but will allow foreign talent to come to the country. Finally, Participant 19 also noted that the country needs to ensure that policies are established that facilitate businesses that do not require a physical space to work.

5.6.6 Skill development through education

Better skill development through education was outlined as a necessary step for developing a national innovation ecosystem by some of the participants. For instance, it was noted by Participant 14 that skill development should start at the teenage level to embed skills that enable them to think creatively and do things that may be different from the current status quo. Participant 14 said:

So whatever innovation needed now might not be needed when they're [teenagers] basically graduated from university. What we need to really think of is what kind of skills or what kind of mindset do we need to build in the younger generation. And that should be our longer-term vision. As, unlike students in primary schools and elementary schools, they need to understand and learn how to look at the problem and analyse it and then try and solve it. How do you create, or how do they create, opportunities for themselves from a particular setup? How do they think creatively about different things that might not be available today but might solve the problem tomorrow? And this, these skills, should be embedded in the way they're taught.

Participant 14, in essence, suggested that a reform of the current education system needs to take place to ensure that the younger generation is learning how to use the information and knowledge that they have gained to think creatively, so that they develop innovative behaviour at a young age.

However, while the suggestion provided by Participant 14 needs to be implemented with a long-term outlook, Participant 17 raised an important question:

> The courses on innovation require specific skills that must be learned, and these are not generated by chance. These must be, for example, when you look at design thinking methodology promoted by the course in Stanford [University], you have to learn that to be able to teach it. The question is, do faculty and teachers in the UAE have these skills?

If there is an absence of skills in teachers and the faculty, skill development relating to creative and innovative behaviour cannot be generated. First, what is needed is to educate teachers and the faculties of the UAE to enable them to transfer the relevant skills to the younger generation. It is important to create a channel of facilitated interaction between teachers and leading thinkers who come into the country. This recommendation was provided by Participant 22, who noted that skill development takes place from experiences, contracts and relationships, as well as from education. Participant 22 highlighted:

> The government has many, many contracts with leading thinkers. And they do, of course, leverage a lot of the ideas in terms of those that are in the market and those that are looking to come into the market. But there is no matchmaking of those talents and capabilities to local, up-and-coming entrepreneurs in terms of critical mass. So, one thing that you could do is, for those talents that we interact with on a once-off for a particular contract, we should create a channel as part of that agreement; that they need to come in and actually meet others or lecture others or get involved in particular programmes at universities and, like, to develop those capabilities and skills in somebody else.

What Participant 22 is suggesting is relevant to skill development for the teachers and faculty of the UAE, but it also for the entrepreneurs.

From the discussion above, the overarching objective of the country should be to instil creative and innovative behaviour in young minds. However, to impart such skills in the younger generation, the older generation needs to learn them first. The development of a mentorship programme, designed to facilitate skill development for teachers and faculty members of the UAE, could then help to develop an innovative workforce starting at the school level. This change can be facilitated with efforts from the government, who can expand upon the contracts that it currently has with leading thinkers from across the world.

5.6.7 Talent management and retention

With a huge inflow of talent into the country, there need to be effective management and retention policies to allow the country to leverage that talent towards its innovation ecosystem. Some of the ways in which the UAE can attract, manage, and retain talent were outlined by the participants of this study.

Participant 1 noted:

> If you see the inflow of talent to the UAE [it's] like, very impressive. The fast rate is [because] these people are coming to [the] UAE to build their dream or even to … be part of the UAE dream, if I could say it. The other is the talent. So, this is like something that [is] dynamic coming from outside towards the UAE. So, we need to make sure that we are appealing to that pool of talent globally. [At] the same time, we need to grow talent from the UAE so the national[s] within the universities and the academic institutions to make sure that these standards are ready for the jobs of the future that we are creating within the economy.

In essence, Participant 1 noted that the country needs to build better infrastructure to encourage global talent to come into the UAE and stay here for the long term, rather than use the country as a stepping stone. They elaborated:

> We need to make sure that the talent coming to the UAE is similar to the American dream. We need to make sure that our value proposition for this is done and they are not here for a transaction or temporary basis. We want to make sure that this is a country where they can build their dream and they can stay here for a longer period of time.

Therefore, according to Participant 1, talent management and retention in the UAE will be facilitated with a change in the visa and residency structures of the country.

Highlighting the problem of temporary talent in the UAE, Participant 6 pointed out that for the talent that is attracted to the country, there is a limited sense of community because employers in the country do not focus on building their talent, but rather engaging on a give and take basis. Participant 6 noted:

> So, based on my experience, and on another track of my career, I saw that, like, a lot of UAE companies don't necessarily invest in developing their employees; it's usually a transactional nature. In terms of accessing top talent from abroad, I think here; it's more of a wider problem. I also had a similar situation. So, based

mentioned an anecdote here, Cleveland Clinic in Abu Dhabi, and managed to attract some very top talent here. But usually, those talents left two or three years into their careers. And I would say, the reason why many of those left, and also the professors that went to MIT, is that there wasn't really a sense of community here, professional community. So, if you're the top doctor, you're the top neurosurgeon, if you're not around top neurosurgeons attending those workshops and things you feel you might need, maybe behind your left out, you're not performing costs and surgery all the time.

Furthermore, the participant also noted that to attract top talent, the UAE needs to offer more features like those offered in Silicon Valley.

Adding to the perspective above, Participant 14 outlined the role of the government in developing a system of R&D that does not simply hire people, but also leverages their talent to develop internal capabilities within the country. Participant 14 said:

So, if I would like to focus on one thing that the government should do, is that to establish that structure to establish that R&D system with clear responsibilities, and also focus on the talent management part of it. When I say talent management, it's very important to understand that attracting talent does not only mean hiring people. It's like, how do you leverage and how you utilise talent, be it international, national, be it in [the] UAE or offshore, like, in international locations, but then using that talent to establish something that's meaningful for the UAE.

Participant 12 outlined that when employers are hiring, they need to first and foremost consider the creativity and innovation of the individuals. The same is applicable at the country level when visas are issued, as these will generate a sense of loyalty to the country. Participant 12 said:

I think innovation and creativity should be given more weight and everything when it comes to visa processing, when it comes to hiring, which should have some points in the interviews that should have some points and an appraisal that appraises in the promotions and increments. So, I think if we give weight to, across the board, to innovation and creativity, people, whether UAE nationals or coming from abroad where the global talents will be very well retained, and will also be given a lot of, let's say, trust and loyalty, they will give a lot of loyalty to our country as well.

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Focusing on the political aspect of the country, Participant 22 stressed the need for some form of permanent residency as the most fundamental aspect of retaining talent in the country. They noted:

> Retaining entrepreneurship talent from the residency is really a priority that needs to be looked at. And the extension of the programmes that exist need to really not have any sort of distinction between Emiratis, non-Emiratis. And like, it would have a bigger impact if you create [an] entrepreneurship environment. And those that have the idea when in terms of support and benefit and encouragement. Of course, you can have a little bit extra for the Emirati talent, but not neglect the 90% of what could be a possible talent pool in that space. The third is around the people that you want to attract to the UAE in terms of entrepreneurship talent. Now, what you find is that talent seeks market, they seek lifestyle and they seek funding.

From this, in addition to ensuring that the talent is retained in the country, the UAE needs to develop policies that create support and benefit the entrepreneurs in the country.

Participant 19 stated that the UAE should appear as an attractive alternative for the most talented engineers, developers, innovators and architects; a destination that could fulfil their dreams. Changing the country's mindset is the first step in ensuring that talent is retained in the country.

Participants 2, 7 and 21 noted that because talent follows talent, the country needs to build systems that attract talent using talent, not money. For instance, Participant 2 said:

> I think talent follows talent. So that, you know; that's the other one. Does talent necessarily follow money? No, but it makes it a lot easier to attract talent if there's an economic system that is appealing. But also talent is attracted by … ease of doing business, particularly in the entrepreneurial environment.

In addition, Participant 21 highlighted:

> You can't have a talented people without an ecosystem with any kind of ecosystem with other talents. But someone has to, if you're really serious about innovation, you have to spend money, and create the ecosystem first, and then the talented people will come. And I think that's what needs to happen to the ecosystem is things like making it easier for people to be based out of here.

Finally, Participant 7 provided a brief insight into how this can be achieved:

I think you incentivise your economy in a way that actually drives or allows for these tech companies … to establish themselves here. And then you create a demand for talent above a certain category. And when you create the demand for a certain kind of, I think, talent, you know, can easily come over talent is. So talented tracks down to people who are smart want to work with people who are smarter. And I think the best thing you could give a smart person is a very interesting challenge the software and so if you create the right environment for these companies to flourish, then they become your talent magnet.

There is a shift in policy that must take place to attract, retain and manage talent. The first steps towards this goal would be to establish a pathway for incoming talent to remain in the country for a longer-term and provide them with the economic and innovation ecosystem that will leverage their talent. Thus, the country must have an activated ecosystem that works towards talent attraction, management and retention.

5.6.8 Additional inputs

In addition to the comprehensive inputs above, the participants provided further insights that could ensure that the innovation ecosystem in the UAE is activated and robust. Additional suggestions ranged from adopting systems like the Finnish or Scandinavian systems; establishing innovation drive from the lowest working classes; focusing on space as a sector; appointing a Chief Scientific Officer who would be responsible for decisions relating to R&D, funding, and other aspects of the innovation ecosystem; establishing a think tank; innovating sectors that are already a core part of the country's economy; and bringing in strategic technologies.

Participant 12 outlined the need for the Government of the UAE to consider the Scandinavian or Finnish national innovation ecosystems and adopt their best practices that fit within the context of the UAE:

I would suggest that the government go and check how other innovative systems throughout the world, such as the Scandinavian or the Finnish system, are doing. And through seeing the process they went through [and] the steps they have taken, maybe they can start some steps that fit our system in the UAE, because maybe not the full system of theirs was better or worse, but at least we can take some steps in this direction.

Participant 12 also noted that for the people of UAE to think that the country is focused on innovation, those who work at a minimum wage need to be rewarded for innovation. Participant 12 said:

> We need to see how innovation is taken in all different sectors in the UAE. So, education: How is it taken at [an] employment level? How is it taken? Even in the houses? How is it? How are we taking innovation when it comes to ministries, private sector is, I mean, local government, federal government. And how is it taken from the so we cannot just speak about innovation when it comes at the highest level, like in business, we have to trickle it down until it reaches to the even labour level. So how can we, for example, when we go to a construction site and see labour's working, how can we reward them for innovation? When we reach to this level of rewarding people for innovation, even as the labour level and the genetic level and the sweeper level? Here, we will really drive innovation to the highest level, because people will appreciate that we are very serious about innovation, to the extent that we reward even the lower the lowest class and the community.

Participant 7 stated that focusing on bringing innovation to the already strong sectors of the UAE, such as oil, gas and desalination, will be more beneficial in the long term, but Participant 15 suggested that the country needs to invest in the space sector. Participant 7 stated that 'the primary sectors that we would need to set our science priorities in [are] oil and gas'. The participant suggested, 'it's a significant part of our economy, and it's not going away anytime soon. So, research and in the oil and gas field is recommended.' According to Participant 7, research needs to uncover other uses for oil and gas as this is an aspect of the industry that has not been considered. Furthermore, Participant 7 suggested that research carried out in the UAE needs to focus on solving its current problems. They said:

> Also, research that addresses our national challenges, which is food, water and energy security. So, agritech [agricultural technology] in order to address the ways of food security. How much of the food do we import, how much can we produce here? So incentivising companies to they are agritech companies, to be established in the UAE and to design and develop their technologies based on the UAE environment and climate is, is critical. In addition to water desalination technologies, in terms of renewable energy, or I think a big thing would be to invest in storage capacity. So, battery technologies. That would be very—I mean,

we're blessed with solar energy, but if we can somehow develop our own technology for storage, it would really, it would make it a more feasible.

While the above insights are valuable, Participant 15 said that the focus should also be on the space sector due to its inherent innovativeness and creativity. They said:

Personally, I think it would be nice to, to space as a sector. Because when you put space, doesn't mean I want everyone to go to space, but it would be very, like North Star, for example, if you could start. When you think of space, you'd have to think of science; you'd have to think of creativity; you'd have to think of technology. I mean … even the medical field falls into it. Because when you would send people to space, you'd have to think of ways on how to, for example, treat them as they become sick. So, I think space is cross-sectorial, and would push people's boundaries in terms of thinking, because when you don't have the luxury of having the existing materials that are on earth to take it with you to space, for example, it will be an opportunity for people to start thinking out of the out of the box, and to think of different ways they can tackle the same issue.

Participant 15 elaborated the need to invest in space as a sector since the UAE has not previously done so:

I think space makes science fun, as a country, we steered away in the past from science. I mean, most of our graduates, at least, the past were more from the business side. So, when you start pushing the agenda of space, for example, you start encouraging people to think of other fields other than business. I think it'd be nice to have that combination of arts and technology and science.

Participant 5 suggested the establishment of a Chief Science Officer who would be responsible for leading the strategic direction of the research conducted in the country. They would also allocate funds based on the most relevant area of research. Participant 5 said that innovation:

Needs to be driven by a chief research officer, as Chief Science Officer … the whole idea is that the chief scientist can figure out, okay, where should we allocate our funding? What are our strategic needs over the next 50 years? And how should we allocate that funding? And then how do we get funding both from the government and lobby the government to the minister, and then also lobby the private sector, to follow that agenda slowly, as by giving incentives from the government.

In addition, Participant 6 outlined that the UAE needs to establish a think tank or a research institution. Participant 6 provided a comprehensive explanation of how this would work:

> One thing that I always think that the UAE needs is a research think tank or research equivalent, right? So, for example, you have the Minister of AI and the Office of AI wanting the UAE to be the AI capital by 2031. I think we need to encourage these type of research-driven institutions; we need to look at research as something that we have to do, no matter how much money we're spending in, and just have that leap of faith that this will have a positive outcome in the future. So, you look at the Institute [for] Advanced Stud[y], which accepts 200 postdocs a year. And they stay there for two years. It's a place where Einstein was also like, incubated right. And basically, these are people that come in and they're affiliated, they're Princeton [University]. But a postdoc will come and spend two years there working on any subject matter they like within a specific three or four categories with the natural sciences, physical science, etc., and humanities.

Participant 6 elaborated:

> So at least you have a community of people that are working on those subject matter areas, regardless of the fact that they're not really doing anything other than just having fun. If I could mention one example that I think is doing this world is the King Abdullah University of Science and Technology in Saudi Arabia, right. They are specifically focused on areas such as, like, Red Sea marine biology, where the Red Sea is one of the best environments for marine biology. They've managed to attract the top researchers in the world there, and to come and work there, but also others to come and collaborate with them. Because they have that amazing physical ecosystem at their doorstep. Right? And they're investing in that; they have an endowment of, I think, 20 billion riyals. So, I think maybe the UAE needs to take that approach.

Finally, a recommendation that arose from Participant 9 was that the UAE needs to bring in strategic technologies that are not necessarily unique, but innovative, nonetheless. Participant 9 suggested:

> We need strategic technologies in the UAE. They don't necessarily need to be technologies that are not available anywhere around the world, but there are strategic technologies we need to have. What the government can easily do is identify that if it's okay to talk about defence, as an example, identify a sector that

is needed, or maritime, doesn't matter. That is needed for us. We know as a government very quickly how much we're spending on these sectors, right.

The responses in this section suggest that the UAE can feasibly shift its focus to enhancing its innovativeness in current sectors, and focus on the space sector. Furthermore, establishing think tanks and appointing a Chief Science Officer are also steps that can enable the UAE to build and activate a national innovation ecosystem.

5.7   The education system in innovation ecosystems

5.7.1   Facilitating creativity and innovation

Almost all the participants noted that the role of education should be to ensure that the student has become a creative thinker and an innovator. However, almost all the participants recognised that the current education system of the UAE does not facilitate that. Several key insights provided in this respect are presented in this section.

Participant 10 stated that they did not believe in having a system that encouraged a strict rule on obtaining college degrees. They noted that students could make use of the wide range of material available online and learn competencies that are relevant, and that universities are not providing to their students. Participant 10 stated:

> I don't think that the only way to learn them is through college. I think that you can [learn] by experimenting, by trying. There's so much content available online where you can learn a lot of these things. But I do think that, you know, critical thinking, problem-solving, communication; many of these competencies are even more important than ever before. But it's actually not clear that our school systems are teaching our kids that for us.

Participant 10 elaborated that there is a need for students to become lifelong learners because what is relevant now will not be relevant in a few years, which makes it important for the students to learn.

Similarly, Participant 17 outlined that the education system of the UAE needs to facilitate creativity. They stated:

> [The] education system needs to support and facilitate the creativity in the students. Whether we're talking about high school students or university, there are no education that there is a system approach, followed by higher education institution in the UAE, to promote the creativity.

However, Participant 17 noted that education is slowly changing and provided the example that their institution of employment provides a Master of Science degree in innovation, entrepreneurship, management and product innovation. Participant 17 noted that the course was developed by the Ministry of Education in conjunction with Stanford University. They stressed the importance of education that promotes creativity:

> But the issue of creativity is important. The course that is now being forced to undergraduate students follow[s] a methodology driven from Stanford, which is design thinking, and that promotes the creativity.

Participants 12 and 5 depicted the limitations of the current teaching methodology and curriculum adopted in the UAE. One of the reasons for the shortcomings is that, as outlined by Participant 12, students are not required to innovate in the education system and are 'required to deliver something that is acceptable from a structure perspective to the university'. To mitigate this issue, Participant 12 said that:

> My advice to tackle this is that universities should give way to innovation, to originality, to disruption, when it comes to thesis, when it comes to even the research papers that they write for every subject will probably some credit hours because we don't give weight for that the students will not appreciate.

Further highlighting the issues in the current education system, Participant 5 said that:

> Our education system largely still promotes what you call exam-based and non-applied and non-curiosity-based thinking. And therefore, number one; it's not customised, it's not personalised, it's not encouraging the individual to live to their best strengths. But it's giving them standardised tests that do not bring out the best in each individual. This is the longer-term solution. In the shorter term, from the perspective of, you know, having a surgical impact and a quick surgical impact in the shorter term yet, that needs to be from the perspective of universities. So, in the shorter term, what we can do is, and this is why we did alchemy project, was to focus on interventions that encourage people at the time at which they're thinking about their career choices, because that's where you can have the greatest amount of logical defections into entrepreneurship and entrepreneurial thinking and innovation.

In the same vein, Participant 2 suggested thinking about how the education system:

> Can support, more self-learning, more independent learning, more risk-taking, you know, in a controlled environment.

In addition, Participant 2 added that there needs to be a safe environment in which young people can innovate and fail.

Finally, Participant 22 noted that it is important to ensure that the students have an exploratory mindset that allows for idea generation. The participant noted that collaboration with peers is also important. Participant 22 said:

> From the young kids all the way up to the university age, it really needs to be driven by that exploratory mindset, the ideas generation, the ideas, resourcing. So, how to take your idea, and actually get support for it, collaborate with others, get people to invest in it, develop a relationship beyond your class, beyond your school, and really build that within the curriculum that they can actually have the time to do that, rather than you know, GCSE is and they gotta tick the box and do the exams and everything else, which is always squeezed and things like sports, things like entrepreneurship, all that kind of stuff gets squeezed, in terms of time allocat[ion].

Therefore, based on the above discussion, it can be concluded that the current education system does not facilitate creativity and innovation, which needs to change to drive innovation in the country.

5.7.2 The role of universities

In addition to cultivating innovative thinking and creativity, the role of universities needs to be examined. Several participants stated that the role of universities needs to be revamped to encourage innovative behaviour and establish a culture of innovation in the country.

Examining the current role of the universities, Participant 12 noted that the current system, in general:

> It's not prepared to graduate innovative individuals, because it's based on a memorised test model, which is not a very broad innovative model. It's merely just asking people to learn some set of information and just recite them in the exam, which is not an innovation-based model. There are some private schools, there are some models of innovation, which have allowed people to excel when it comes to being innovative in their approach. I can tell you that the government, as a government, not in the education system, are doing a lot of things, when it comes to incubation, when it comes to giving a space to kids to do a lot of things, maybe in summer camps, maybe outside [the] normal education system. But the

current education system, as I heard, is going through a robust change. And the case by itself has this disrupted the industry through its own entity; has done a lot of things that show that they have an innovative approach. And I believe that their system may or may not penetrate to the private schools, at least in Dubai, and will help with this innovation ecosystem to be nurtured. But [what] I'm seeing for government school[s], is a bit of a long way for them to flourish to this level.

Furthermore, Participant 4 outlined that:

If you look at the education system from a perspective of saying, they need to equip you with what you need to get to the point of, you know, becoming a successful person in the future. I think it's more about the skills aspect of things, rather than academic parts of things, right? How you learn is, what I need the school to teach me, not what to learn. And what to learn is obviously part of it, but the how part is what they need to start focusing more on, right? Because then eventually in life, you're not going to have academics, you're going to have real-life situations, which you need to be able to determine how to deal with. This is something that the US does very well [in] case studies. So, the learning methodology is I think something that could be reconsidered or improved.

In essence, the universities need to develop their curriculum so that graduates can use the subject matter and enhance its applicability. Participant 6 suggested a radical reform and a shift in the role of universities in the UAE. Participant 6 stated:

I think our traditional approach to education as a box-ticking mechanism to getting a job is what needs to be attended. Right? So, I think, for a lot of times, we're simply asking for university education without it having a relevance to the job role required, right? And without actually sometimes looking at the grades at university; without looking at the subject matter studied. We're just looking at it as a filter, as a pre-selection filter to what this person would look like. So, we're not sometimes our job approach our job, I think, particularly in government is not our interviews for candidates are not looked at in a way that we're looking for a candidate that has the right skill set, right? We're mainly just looking at someone that fits the mould. Our interviews are not skills and aptitude based; our interviews are more of just like a formality. Right. So, I actually think that getting rid of the requirement to go to university is something that might have a positive impact on the UAE because it will allow people to really only go to university when they feel they need to develop that skill set, right?

In other words, Participant 6 suggested that a university degree should not be a minimum requirement for a job. This would shift the focus to learning as the goal, rather than obtaining the degree.

Similarly, Participant 12 outlined that the culture should shift from a focus on degrees to a focus on learning how to innovate. Participant 12 noted:

> Because what do colleges teach us? Colleges teach us the key to a technical part of any, let's say disciplines, such as like, finance, accounting, etc. When it comes to innovation, you don't need to have a lot of technical knowledge, you need to have an open mind. You need to have the correct approach and behaviour when it comes to trial, when it comes to, I mean, discovery, when it comes to exploring things. So, I think innovation comes from mindsets and behaviours. And you don't need a specific type of knowledge in order to---yes, you will need some knowledge one, you will innovate. Let's see, and I'm in tech. So, you will learn what type of tech you need to innovate and just [the] very basics. So, I believe that we should not drown people who would like to innovate with degrees.

While it is understood that universities play a fundamental role in the innovation ecosystem, its role needs to transform into that of a nurturer, as implied by Participant 14. The participant noted that:

> Universities can play a significant role into basically nurture the talent, receive them, nurture them, guide them through cultural aspects, in domain aspects, and also, you know, legislations and regulations and these kind of things, and then give them the right channels to go through and access different channels of data and resources and whatnot, and then come up with something that's really impactful. And talent at that time would be able to realise that whatever I'm working on, whatever, whatever I'm contributing to, actually gets realised. In in reality, which is very important? One more thing that I would like to add is the universities today, in my view, can play the biggest role in this because internationally, the biggest inventions … start in universities. And it's not something that we see here in the UAE. So, rather than having universit[ies] as commercial institutions for to attain academic degrees, we can guide them through or channel them very easily, very easily, to focus more on research and research development.

Participant 22 noted that universities need to start focusing on creating networks for students before they graduate so that they may exploit the network to lead innovative practices. Participant 22 said:

> University should encourage students to graduate with a company [that] is driving a change in curriculum for them, because for them to be able to do that properly, not just sort of create a room that they call the incubation hub or whatever else, that they have to go back and see what it is that they're teaching. How are they teaching? And how are they actually facilitating the network for the students before they leave? So, what kind of corporates are coming in with challenges that the students need to solve for them? How are they developing that sort of capital in terms of relationships and knowledge from the real world? So, I think if you take it like that, it's more the mindset, the capabilities, the experimentation, and the way that the role of the advisors or the teachers or the faculty.

Participant 6 also said that the role of the universities needs to shift and mimic what is happening in Germany:

> I encourage [the] adoption of a German approach to university where basically getting into university is easy, but staying in university is difficult. ETH Zurich, [that] is sort of the MIT of Europe, takes a large number of students at the beginning, right? But the people who are graduates are very little compared to the people that came in. So, it's not that we discourage you from going into university, you have that opportunity. But if it's not right for you, if you don't have the right incentives, then why would I keep spending on you? I'm giving you the opportunity and the chance to try it out. But I also think that options for UAE nationals exists elsewhere. So, you have a lot of the young, especially young male generation that has sort of like a laissez-faire attitude to education, because they know they have a safety net to fall back on.

Taking a more moderate approach, Participant 21 suggested strengthening the current education system where students are being intrigued to create and innovate.

> You need to have a very strong education framework … from school students that are helping and are intrigued to think about innovating in different fields of and walks of life, to university students, graduates, PhD students and professors or pushing the boundaries of innovation across different applications. So, education, to me, is the first most important thing. Start [with] the K–12 education,

which is primary and secondary, because those are the people that will feed universities with the quality of the students that are coming out of K–12.

Participant 14 stated that the role of universities is crucial because most of the innovation takes place through research-directed in universities. Participant 14 said:

I really think that universities should play is the most significant role and innovation. Technically, because they have the capacity to leverage on the talent to leverage on to provide R&D facilities to speak with the industry openly and the industries are gone. So, the private sector, or the corporate, or the government sector will be more comfortable talking to universities than talking to any other part of the ecosystem. Then the private sector will not be able to talk to entrepreneurs, for example, directly. But [if] they come via university then they would assume that the university did some due diligence to ensure that this is someone who I can basically talk to freely.

Participant 14 also noted that the role of universities needs to be reformed to ensure that they are not just providing education degrees.

Participant 17 stated that there is a need to introduce vocational education to ensure that students are being exposed to some specific course on innovation. They noted:

I don't see a high school student being exposed to a specific course on innovation, they take some economics courses, they take some business courses, but they are not prepared for what needs to be done. Actually, creativity needs to be injected at that level. And therefore, one needs to go back and see how we can instil in the high school mind through a structured education, their creativity. Okay, in higher education, the current education system actually does address some aspects, though as I said, the course that is actually cut across all universities, and all undergraduate must take it, and therefore, you have to take innovation, you have to look at the creativity. Creativity should actually be driven well before that time, but then you don't want to leave it [out] at the undergraduate level.

Participant 17 outlined an attempt in Abu Dhabi to bring in vocational education. They explained:

There has been some attempt in Abu Dhabi in particular, to bring in vocational educational education off the ground. And there are some positive outcome[s], and the infrastructure provided for that was actually impressive. However, the

vocational education system in the UAE does not talk when to the higher education system in the UAE, both in terms of recognition of vocational education by higher education. In the UAE, it's still difficult for a vocational educational certificate to be recognised in a master's degree or a bachelor degree. And that's a serious shortcoming.

Finally, Participant 4 summarised:

I wouldn't even change the education; I will supplement it. So early years, what we realised is that in, in our part of the world, and others in the UAE, and the other part of the world, education is usually instructed, not developed. I think I wouldn't encourage people not to go through the education system. Obviously, [that] people … go through the education system is important. I think, like I said, that [a] revamp is what you should consider and when you think about why Apple or Google will do something like that, it's because they believe that people are— they perceive that it doesn't matter whether or not you have a degree. What matters to me is that you're, you know, you're a team player, you're smart enough to find solutions to problems, you know how to connect [the] unconnected. I think what you should consider for the education system is that it shouldn't be academic-driven. That's my point. And it should be complemented with skills because skills matter. Just as much as you know, you still need a doctor recently, the philosopher he still needs a nuclear physicist, whatever it is. But the majority of the people in the market, the majority of businesses are driven by people that get things done. That's what you need.

Based on the comprehensive presentation of data above, a radical change of the education system and the role that universities play may be required; although, the change should be incremental. This could mean developing a stronger educational framework that does not completely replace the current system but allows students to explore innovation and creativity. This can be achieved with the implementation of vocational education programmes, with the long-term aim of completely transforming the education system in the UAE.

5.8 Validation of the insights gained

The next step in the research process was to synthesise the core inputs and suggestions provided by the 24 participants of the qualitative research. A triangulation approach was adopted (Creswell and Miller, 2000), where a quantitative survey was used to validate the core insights that were generated. This enabled the researcher to evaluate, on a larger scale, if the themes identified were present within a larger sample size.

Based on the Krejcie and Morgan (1973) ideal sample size indicators, a total of 384 people from across various sectors in the UAE's national innovation ecosystem were sent a survey weblink. Out of these, a total of 230 people responded to the survey, bringing the effective response rate to 59.89%. The following statements were developed based on the insights gained through the thematic analysis of the interviews. Agreement with the statements was measured on a Likert scale ranging from 1 to 5, with 1 meaning 'Strongly Disagree' to 5 meaning 'Strongly Agree':

1. Long-term research is limited due to the current visa structures in the UAE.
2. One of the challenges for entrepreneurs flowing into the country is the lack of permanent residency options in the UAE.
3. The contribution of the private sector in R&D is limited in the UAE.
4. Bridging the existing cultural separation between the students can lead to exposure to differing mindsets, which will further their innovativeness and creativity.
5. Setting up a business and obtaining funding for new ventures in relation to R&D is difficult in the country.
6. There is a disconnect between the current legal and regulatory framework and the innovation dialogue in the UAE.
7. Leveraging AI technologies is one of the ways to better the innovation ecosystem of the UAE.
8. With respect to the improvement of the funding structure in the UAE, select all that apply:
   a. Reducing the cost of doing business
   b. Strengthening of the venture capital funding
   c. Provision of government funding
   d. Providing subsidies for entrepreneurs in helping them manage their costs
   e. R&D funding that is provided needs to become more competitive with the application of research grants.

9. Promoting a culture of entrepreneurship is a core pillar of ensuring the entrepreneurship sector is strengthened.

10. Risks associated with entrepreneurship should be taught at school and university level to generate more awareness of the same.

11. It is better to establish research centres with clear mandates, which will then attract funding rather than making funding available and calling for more R&D.

12. Collaboration between large corporations that have an R&D function and the government has the potential to increase.

13. Better skill development through the process of education is essential to ensure an increasing rate of innovation.

14. International mentorship programmes for teachers and educators can enable them to develop an innovative workforce at the school level.

15. Incoming talent must be retained in the country for longer with the use of longer-term visas.

16. Appointing a Chief Science Officer would be useful to ensure research is taking place effectively.

17. Innovation can be facilitated in the country with the implementation of think tanks.

18. Transforming the education system to one that promotes creativity and innovation rather than rote memorisation can enable increased research and development in the country.

19. Allowing students to explore avenues in innovation and creativity has the potential to increase the rate of innovation in the UAE.

20. Implementation of vocational education programmes would be useful for the country's innovation capacity.

In addition to the above statements, the respondents were asked to provide open-ended suggestions as to what other steps the UAE's government ought to take to ensure appropriate activation of the national innovation ecosystem. Reiterating the points above, the purpose of this data collection was to descriptively validate the findings of the qualitative research. The selected sample was diverse to ensure that the responses generated were varied and encompassed a wide range of different perspectives. To this effect, Table 6.2 depicts the characteristics of the sample in terms of which innovation ecosystem stakeholders the respondents represent. Overall categories include Education and Academia, Entrepreneur/Innovator, Private Sector, Public and Government Sector, Risk Capital and Venture Capital Firms, and others. Within these categories, several overlapping subcategories were represented. Table 6.2 provides a detailed account of the respective stakeholders who participated in the survey (N = 230).

Table 5.2 Survey sample characteristics

Innovation Ecosystem Stakeholders	f	f%
Total Education and Academia	**39**	**16.96%**
Education & Academia	17	
Education & Academia, Entrepreneur/Innovator	5	
Education & Academia, Entrepreneurial Support Network (Accelerators, Incubators, etc.)	2	
Education & Academia, Private Sector	4	
Education & Academia, Private Sector, Entrepreneur/Innovator	1	
Education & Academia, Private Sector, Entrepreneurial Support Network (Accelerators, Incubators, etc.)	2	
Education & Academia, Private Sector, Public & Government Sector	2	
Education & Academia, Public & Government Sector	4	
Education & Academia, Risk Capital & Venture Capital Firms	2	
Total Entrepreneur/Innovator	**41**	**17.83%**
Entrepreneur/Innovator	21	
Entrepreneur/Innovator, Entrepreneurial Support Network (Accelerators, Incubators, etc.)	1	
Entrepreneur/Innovator, Public & Government Sector	10	
Entrepreneurial Support Network (Accelerators, Incubators, etc.)	5	
Entrepreneur/Innovator, Entrepreneurial Support Network (Accelerators, Incubators, etc.)	1	
Entrepreneurial Support Network (Accelerators, Incubators, etc.)	3	
Total Private Sector	**62**	**26.96%**
Private Sector	49	
Private Sector, Entrepreneur/Innovator	11	
Private Sector, Entrepreneur/Innovator, Entrepreneurial Support Network (Accelerators, Incubators, etc.)	1	

Private Sector, Entrepreneurial Support Network (Accelerators, Incubators, etc.)	1	
Total Public & Government Sector	**76**	**33.04%**
Public & Government Sector	74	
Public & Government Sector, Entrepreneurial Support Network (Accelerators, Incubators, etc.)	2	
Total Risk Capital and Venture Capital Firms	**9**	**3.91%**
Risk Capital & Venture Capital Firms	3	
Risk Capital & Venture Capital Firms, Entrepreneurial Support Network (Accelerators, Incubators, etc.)	3	
Risk Capital & Venture Capital Firms, Public & Government Sector	1	
Risk Capital & Venture Capital Firms, Private Sector	2	
Total Others	**3**	**1.30%**
Innovation & Manufactures	2	
International Financial Regulator	1	
Total	**230**	**100%**

Table 6.2 shows that the sample size is highly diverse, which ensures that the responses received are from diverse perspectives. This will instil confidence in the validation results. One of the core findings was that the visa structures and the lack of permanent residency options are not favourable if the country wants to enhance the rate of R&D. The results indicated that 32.2% (f = 74, N = 230) and 21.7% (f = 50, N = 230) of the respondents either agreed or strongly agreed with the fact that the current visa structures in the UAE do not facilitate long-term research. This shows that the majority of the participants agree with the statement that the current visa structures in the UAE do not facilitate long-term research within the country. Around 32.2% (f = 74, N = 230) felt neutral, and the remaining did not agree with this statement. However, as most of the respondents agreed with the statement, it is considered validated.

The majority of the participants either strongly agreed (f% = 24.3%, f = 56, N = 230) or agreed (f% = 33.9%, f = 78, N = 230) with the finding that the private sector in the UAE is not involved in the national innovation ecosystem and does not generate R&D relative

to the public sector. Around 20.9% (f = 48, N = 230) remained neutral while the remaining either disagreed (f% = 13%, f = 30, N = 230) or strongly disagreed (f% = 7.8%, f = 18, N = 230). Therefore, because most of the respondents agreed with the notion that the private sector in the UAE is not engaged in innovation and R&D as much as the public sector is, this finding is considered validated.

An important finding from the qualitative research was that there is a segregation between students in different schools, which limits the interaction that they have with diverse individuals. It was suggested that this segregation limits the innovation and creativity of the students. The majority of the respondents either strongly agreed (f% = 21.3%, f = 49, N = 230) or agreed (f% = 31.3%, f = 72, N = 230) with the statement, with 21.3% maintaining neutrality. The remaining respondents either disagreed (f% = 18.3%, f = 42, N = 230) or strongly disagreed (f% = 7.8%, f = 18, N = 230) with the statement. Therefore, because more than half of the respondents agree with this statement, it can be considered validated. Similarly, it was suggested that the current education system in the universities and schools is oriented towards learning and not research, which hampers the innovation and creativity of students. The respondents were asked to state if they perceived that the current education system sufficiently promoted a culture of innovation and creativity. The majority of the participants either disagreed (f% = 24.3%, f = 56, N = 230) or strongly disagreed (f% = 24.3%, f = 56, N = 230) with the statement. Around 29.6% (f = 68, N = 230) were neutral, and the remaining either agreed (f% = 19.1%, f = 44, N = 230) or strongly agreed (f% = 9.1%, f = 21, N = 230). Therefore, it can be concluded that there needs to be a shift in the current education system to reliably encourage students to tap into their creativity and innovative capabilities.

One of the core findings of the interviews was that obtaining funding and support for new R&D ventures in the UAE is difficult. This statement was also supported by the majority of the survey respondents, who either strongly agreed (f% = 37.8%, f = 87, N = 230) or agreed (f% = 36.1%, f = 83, N = 230). A small number of respondents were neutral (f% = 16.1%, f = 37, N = 230) while the others either disagreed (f% = 7%, f = 16, N = 230) or strongly disagreed (f% = 3%, f = 7, N = 230). Similarly, it was identified that the current regulatory framework is not on par with the innovation dialogue that is being encouraged in the UAE. Again, respondents provided support for this statement, with 27.4% (f = 63, N = 230) strongly agreeing with the idea and 33.9% (f = 78, N = 230) agreeing with the idea. Around 25.2% (f = 58, N = 230) felt neutral, while the remaining 11.3% (f = 26, N = 230) disagreed and 2.2% (f = 5, N = 230) strongly disagreed. Therefore, to some degree, obtaining funding for new R&D ventures is not easy and the

regulatory framework needs to support the innovation dialogue that is being encouraged in the country.

The government has allocated some funding for R&D, so it was important to understand the perception of the strategic use of these funds. The results were inconclusive, with a large portion of the respondents being neutral (f% = 39.6%, f = 91, N = 230), and the remaining being split almost equally between agreement and disagreement.

Having validated most of the findings of the current nature of the UAE's innovation ecosystem, the next set of questions tried to gain insight from the respondents about what the UAE must do to activate its national innovation ecosystem. First, it was asked whether one way to enhance the innovation ecosystem would be to leverage advanced technologies, such as AI. There was strong support from the participants, with the vast majority either agreeing (f% = 39.6%, f = 91, N = 230) or strongly agreeing (f% = 39.6%, f = 91, N = 230) with the statement. A small minority felt neutral (f% = 10.4%, f = 24, N = 230) while some either disagreed (f% = 4.3%, f = 10, N = 230) or strongly disagreed (f% = 1.7%, f = 4, N = 230).

The survey respondents were asked whether there is a need to promote a culture of entrepreneurship as a core pillar for strengthening the UAE's innovation ecosystem. Around 54.3% (f = 125, N = 230) of the participants strongly agreed, and 36.1% (f = 83, N = 230) agreed with the statement. A small number of the respondents remained neutral (f% = 9.1%, f = 21, N = 230) while just one respondent disagreed (f% = 0.4%, f = 1, N = 230) with the statement. The respondents were asked to state if it is critical to shift and transform the education system to ensure that the students and new talents are aware of the risks and opportunities associated with entrepreneurship. A large majority of the respondents strongly agreed (f% = 58.7%, f = 135, N = 230) and another 30.4% (f = 70, N = 230) of the respondents agreed. However, the remaining 7.4% (f = 17, N = 230) maintained neutrality and the others either disagreed (f% = 3%, f = 7, N = 230) or strongly disagreed (f% = 0.4%, f = 1, N = 230).

In terms of R&D funding, the qualitative interviews depicted a need for the UAE to establish a clear research mandate, which would then lead to attracting more funding, rather than making funding available and then calling for more R&D. A vast majority of the respondents either strongly agreed (f% = 49.1%, f = 113, N = 230) or agreed (f% = 28.7%, f = 66, N = 230) with the statement. Around 17% (f = 39, N = 230) felt neutral while the remaining participants disagreed (f% = 3.9%, f = 9, N = 230) or strongly disagreed with the statement. Therefore, considering the overall support for the statement, it can be considered validated. Then, it was suggested that the UAE needs

to work with larger international corporations that have an R&D function. A majority of the participants either strongly agreed (f% = 51.3%, f = 118, N = 230) or agreed (f% = 31.3%, f = 72, N = 230) with the notion, indicating that the suggestion is validated. A small percentage of the respondents were neutral (f% = 10%, f = 23, N = 230) while the others either disagreed (f% = 6.5%, f = 15, N = 230) or strongly disagreed (f% = 0.9%, f = 2, N = 230).

It was suggested that there needs to be a Chief Scientific Officer appointed in the UAE to ensure that there is a wide range of R&D taking place. A majority of the participants strongly agreed (f% = 34.8%, f = 80, N = 230) and agreed (f% = 31.3%, f = 72, N = 230). In terms of research, a vast majority of the participants strongly agreed (f% = 31.3%, f = 72, N = 230) and agreed (f% = 31.3%, f = 72, N = 230) with the suggestion that research think tanks are necessary and crucial for fostering and growing the innovation ecosystem in the UAE. Around 11.3% (f = 72, N = 230) of the respondents felt neutral, and four respondents disagreed (f% = 1.7, N = 230). Therefore, there is support for establishing a think tank, appointing a Chief Scientific Officer, collaborations with large organisations who have an R&D function and establishing a clear research mandate to attract funding into the country.

The respondents were asked if they agree that incoming talent needs to be retained in the country using visas that are valid for a longer period than the current visa period. Around 56.1% (f = 129, N = 230) of the respondents strongly agreed, and 27.8% (f = 64, N = 230) of the respondents agreed with the statement. This suggests that there is overwhelming support for long-term visa acquisition for retaining talent in the country. However, the remaining participants were either neutral (f% = 11.7%, f = 27, N = 230) or in disagreement (f% = 3%, f = 7, N = 230) and in strong disagreement (f% = 1.3%, f = 3, N = 230).

In terms of education, the participants were asked if entrepreneurial skills need to be instilled in education systems. This received wide support from the respondents, where 61.3% (f = 141, N = 230) strongly agreed with the statement and around 31.7% (f = 72, N = 230) agreed. Furthermore, when asked if the teachers and other educators need to enrol in international mentorship programmes to develop their capabilities in fostering an innovative environment at the school level, the majority of the respondents either strongly agreed (f% = 51.7%, f = 119, N = 230) or agreed (f% = 36.1%, f = 83, N = 230) with the statement.

When asked if the universities in the UAE need to allow students to explore different innovation and creativity opportunities, again, the majority of the respondents either

strongly agreed (f% = 57%, f = 131, N = 230) or agreed (f% = 35.7%, f = 82, N = 230) with the statement. Finally, the idea of implementing vocational education programmes to promote innovation and creativity in the UAE was received with either strong agreement (f% = 40%, f = 92, N = 230) or agreement (f% = 45.2%, f = 104, N = 230), indicating general support for the suggestion.

Data obtained from the survey

The participants were asked to select items that would be beneficial for enhancing the rate of innovation in the country: reducing the cost of doing business, strengthening of the venture capital funding, provision of government funding, providing subsidies for entrepreneurs in helping them manage their costs, R&D funding that is provided needs to become more competitive with the application of research grants. All the respondents wanted to see the cost of doing business reduced, a strengthening of venture capital funding and subsidies provided for entrepreneurs to help them manage their costs.

The survey participants provided some open-ended responses regarding additional inputs required for enhancing the UAE's national innovation ecosystem. These responses have been segregated and categorised into similar themes and are presented in Table 6.3.

Table 5.3: Survey suggestions for the national innovation ecosystem in the UAE

Category	Participant recommendation
R&D	A huge element of innovation is tolerance (creativity/entrepreneurship/tolerance) and I believe the UAE needs to do more around this element. We need to walk the talk of tolerance through openness to ideas from both citizen[s] and residents of all ages and backgrounds. Allow[ing] and enabling this element will promote [an] appetite to experiment and identify [the] most suitable innovations for various sectors. Introduce a special mandatory innovation competition in different fields in UAE, which MUST be done annually with a fixed number each in their sector [with the] aim to support the improvement process and solve the regular challenges. Establishment of thematic R&D centres in the UAE based on national priorities (e.g., food security, cybersecurity etc.) independently of universities and teaching institutions (similar to Max Planck Institutes in Germany and RTOs [research and technology organisations] in Belgium). Establishment of fundamental research institute[s] where PhDs/scientists pitch their research and basically are given funding and home to pursue whatever research they want for a set period (2 years) similar to the IAS [Institute for Advanced Study] at Princeton University. Leveraging the science parks that exist around the country to offer free rent to businesses and SMEs to create communities and clusters. Further streamlining and simplification of the business setup process. Systematic engagement of universities with private sector entities. Establishing [an] independent R&D funding agency that targets innovation ventures. A dedicated Policy centre, tech transfer & IP One stop shop in the UAE. Creating more programmes available for individuals to leverage their innovation potential (e.g., MBR [Mohammed Bin Rashid] innovation programme open only for gov[ernment] employees). Creating platforms/research centres for individual innovators and their field of research. Creating [a] database for all

research material of academics that have been completed abroad and locally (Where does all that research go? Where will your research go? Will I be able to access it later on and benefit?)

Innovation needs to be measured with definite indicators. Innovation has to have an impact on the economy some way or another for it to gain trust and weight.

Culture to innovate	As a multifaceted topic, I personally think that rewarding creativity and democratising innovation for everyone (from small to large ideas and initiatives) can help create a good medium for generating ideas and developing solutions.

To have [a] structured approach in implementing new technologies and testing its efficiency before jumping into multiple projects at the same time, innovation need system thinking and gradual expansion to optimise its efficiency

Ensuring that national innovation ecosystem news is part of mainstream media—a section in each newspaper like they have for sports, economy, lifestyle, etc.

In terms of nurturing creativity and talents in schools, I have noticed that there are schools with multinational students who haven't shown any creative and innovative projects, while other schools with one major nationalit[y] who have developed interesting innovative projects and participated in exhibitions even at an international level... so it all depends on the educational opportunities students receive and the right mentoring and guidance they get from their teachers and family support.

Entrepreneurship is not the same as R&D. R&D is a very long-term game that bring[s] a real economy of knowledge. Entrepreneurship, nowadays, is mostly related to apps and ICT businesses, which, in general, has a 95–97% chance of failure. It is better to concentrate in R&D, biotechnology, biomedicine, robotics, AI, etc. all of them are ultra-long-term projects. They need good universities to foster them.

Build education and culture around small businesses and start-up[s] specifically in an era where we move towards e-commerce. Develop favourable options were UAE nationals have favourable options to get into the public sector and work with start-ups.

A big part of an innovation ecosystem is the culture that it belongs to. In the UAE, we discourage failed entrepreneurs from ever starting again and need to allow for a more trial-and-error approach towards start-ups. Additionally, as the UAE aims to become a test bed for the world, making it easy for entrepreneurs to test their ideas in a fast and effect[ive] manner on the ground is crucial and supporting legislative frameworks need to be put in place and practiced to be effective and successful.

Innovation in the UAE needs to be more results-focused and less gimmicky/flashy. Frontline innovation and customer experience is one example but core issues such as climate change need to be addressed before robotics and Mars missions.

Education system

UAE Government, in collaboration with universities and colleges, and come up with educational events that will nurture innovation.

Perhaps direct the educational scholarships abroad towards innovation-related studies and further advertise the impact to make it appealing for graduates. (Local universities could also introduce such majors).

Develop national cadre for academic roles and to take the research agenda forward and ensure sustainability. UAE higher education institutions should develop future academics to ensure sustainable research in universities. To ensure to attract the best minds in the country, the compensation and special incentives packages should be developed.

People from the science field and those who are achievers in their own field of study find it stagnating to be based in a place like UAE. They prefer to go and migrate to the US or UK as they have very old established institutions and these people also get the opportunity to become citizens there. Hence, they opt for those options. For acquiring such talent in the UAE, the UAE must offer such people lifelong residency in the UAE. And set up research centres in collaboration with the best institutes in the US and UK and jointly set up

research centres in the UAE. That way the UAE will be able to pull, retain and develop the best talent from everywhere when it comes to research & development.

Regulatory framework

Having an easily accessible database of existing business, which aids into helping new entrepreneurs gauge the market saturation or gaps in particular fields.

Having separate tracks, one for growth ventures and one for revenue ventures is crucial to improving investor's portfolio performance in UAE. [The] current rate of scaling success is 1.1%. In US, its 10%. The dilution effected created as a result of regular SMEs competing with growth ventures over the same pool of capital weakens the case for investors to invest capital and value locally.

My opinion is that government should not lead the innovation practice in the country, its role is to enable it by the following:

- cut cost of establishing R&D facilities
- support procurement of patents and inventions from the R&D
- no need to allocate government budget for innovation and R&D, it will always be abused
- have faith in Emiratis.

Creating an innovation council appointing experts as members from the public and private sector, the chairperson should remain for one year and create a rotation to enable new implementation of innovation.

Continuity of initiatives—unfortunately as new organisations replace older ones (even at ministry level), the initiatives lose steam and research often takes 10–15 years to bear fruit.

Government should never invest directly, rather provide it to strong fund managers in a simple and straight forward process. Then work with them on matching and supporting. Make sure people stay in the UAE through offering of perks such as long-term residency, healthcare, pension, etc.

In terms of retaining talents, the visa hasn't been a core issue, because we have a lot of great examples of entrepreneurs who have been living in the country for decades. They have remained because they created an opportunity out of their presence with the given situation, the same has to be for talents, as long as they have a positive impact on the economy their visas will still continue, but a lot of the private sector players avoid R&D because they are short-term profit-oriented. The R&D mentality within private sector has to grow, as this will highly contribute to the innovation and to attract talents and to fund R&D.

In [the] UAE, many human capital and talent is retained in government; however, their scopes and horizon is limited to the government's scope, which means we are not utilising their full potential, which is entrepreneurial in many cases. The government should explore creating different entrepreneurship opportunities for its large human capital base in the pursuit of encouraging more experiments in this field and potentially more start-ups and innovation outcomes. The human capital that resides in government is very resourceful and has established great networks that could be utilised in their entrepreneurial pursuit if there was a system established for it.

The UAE should become a testing lab for all entrepreneurships, which means regulations should be eased to allow and attract talents across the world.

1. Create a databank of talented people worldwide to attract them to UAE.

2. Create a group of futuristic studies/scientists to contribute and be part of these studies.

3. Create a system of taking care of gifted students from the early education ages until they reach the [senior] level in government or private sector posts.

4. Link the FDI attraction to innovation strategies.

5. Create the best attraction environment to attract R&D centre.

6. Create proper legislation for intellectual property.

7. Focus on supporting entrepreneurship innovation strategy.

8. Develop attractive packages for attraction of innovative organisations and talents to be based in [the] UAE.

9. Emiratisation strategy in private sector is a must with set of KPIs and development in certain sensitive sectors.

10. We need to focus on preserving and protecting our values, which will have [a] long-term positive impact on [a] personal, social and economic level.

I believe government departments can play a key role on R&D in different domains where they are dealing with a large scale of customers and following are some ideas to enhance this:

1. By directing from TEC or equivalent to add R&D, innovation as a key KPI or OKR, which need to be track[ed] and monitor[ed] [on a] quarterly basis with a real and actual results along with internal employee survey result[s] about the same.

2. Funding & employee dedication is [a] key government R&D function where I believe we need to think [of] different sources of funding with partnership with government and [the] public, which may help.

3. Improve bankruptcy laws.

4. Build a mentorship programme with successful innovators around the world.

5. Open up funding for start-ups as I believe innovation does out of large corporations because they are tied down with systems and procedures. Whereas start-up[s] have those mental barriers removed.

6. Change the mindset to focus on skill and the passion of the entrepreneur. We put a lot of focus on university degrees. This does not ensure innovation.

Collaboration between public and private sector is crucial on topics that concern the country as a whole. The talent pool is wide, especially in universities, where students are keen on spending their time learning and researching new ideas. With a proper R&D Centre, specific research questions and hypotheses can be stated, and, thus, designing and implementing the research will be better constructed. There is a need to empower UAE nationals as well. Fresh graduates are either sitting at home waiting for a job, or currently being consumed in their current first job. The skill of research and innovation is either minimised or used for the job purpose only, limiting the contribution to what they can give back to the country as a whole.

The role of [government] should be limited to that of a facilitator, while the private sector should lead the innovation process. By lead, I mean, the thought process, research and funding.

Note: The responses in this table have been edited for spelling consistency and sentence punctuation.

6 Discussion of findings and framework development

6.1 Introduction

With the aim of developing a framework that the UAE can use to activate its national innovation ecosystem, the present study was guided by the following research questions: What is the current nature of the national innovation ecosystem that exists in the UAE? What are the main drivers that influence or hinder a sustainable (educational) innovation-based national ecosystem? How can the UAE Government best promote and activate a successful national innovation ecosystem? The study was embedded in a qualitative methodology to answer these questions, with quantitative data used to validate the results. A total of 24 semi-structured interviews were carried out and analysed thematically. Surveys were then analysed descriptively to validate the results of the interviews. A total of 207 surveys were carried out. Following this, an initial draft of the framework was developed, which was then validated using semi-structured interviews with six key policymakers who are a part of the national innovation ecosystem of the UAE. This feedback was considered and applied to the framework, which resulted in a final version of the framework presented here. Finally, some key theoretical and practical implications of the study are discussed.

6.2 The UAE's national innovation ecosystem

The results indicated the lack of a functional national innovation ecosystem in the UAE, but that the UAE is striving towards the same. The results suggest that the UAE aspires to embed innovation into its practices, with a strong commitment towards achieving its National Agenda. The interview results indicated that the Government of the UAE had undertaken several steps to generate greater innovation, such as: vetting and funding innovative ideas; directing 1% of all public funding towards R&D; launching a drive towards increasing innovation in robotics; providing subsidised start-up costs for innovative start-ups; creating an internal mandate for research centres across the country; creating positive push platforms that encourage public sector employees to innovate within their entity; establishing the MBRIC, which promotes the culture to innovate in the country and creates awareness about the importance of innovation; and the provision of the entrepreneurship visa. What is clearly missing from the above initiatives, according to the insights provided by the interviews, is the function of education. The importance of the education sector, particularly, university–industry collaboration and its subsequent operationalisation has not been evident in the UAE.

Furthermore, the initiatives are fragmented and disjointed. In addition, the focus of R&D spending is primarily on the public sector with little to no attention being placed on the private sector. The current initiatives are directed towards increasing the rate of innovation at the individual level rather than the country level.

With the extent the UAE Government is focused on innovation, regardless of the success of the measures, it appears that the UAE is moving towards developing a triple helix model of the national innovation ecosystem, where the government is acting as the primary facilitator of innovation in the country (Etzkowitz, 2003). The triple helix model will allow the government to create a government–university–industry triad relationship to facilitate innovation in the country (Etzkowitz, 2003). However, while the government has adopted the role of the facilitator, there is no technology transfer taking place in the UAE through market or non-market collaborations (Carlsson et al., 2002), nor are universities becoming key innovation stakeholders, which is one of the distinguishing characteristics of a triple helix model (Ranga and Etzkowitz, 2013). In addition, while the Government of the UAE is developing policies for enhancing innovation and innovativeness in the country, it needs to develop policies that strengthen the transfer of technology between universities and industry.

One of the primary challenges associated with university–industry collaboration in the UAE was that both university and industry deny the contribution that the other party can make. The university assumes that industry is not theoretically advanced, whereas industry perceives the university less commercialised. When this issue is tackled, it can lead to the development of a robust national innovation ecosystem. For instance, in Singapore, the collaboration and knowledge-sharing between universities and industry has increased substantially since the early 2000s owing to the universities focusing on the commercialisation of research and the development of marketable innovations (OECD, 2013). Therefore, universities in the UAE, rather than disregarding the commercial aspects associated with industry, need to align themselves with industry to generate a greater innovation output. Furthermore, as was carried out in South Korea, the UAE Government needs to adopt policies that foster greater collaboration between universities and industry. This is suggested because there is a strong positive influence of governmental policies on promoting university–industry collaboration, especially in newcomer economies (Eom and Lee, 2010). This suggestion is important because, as indicated in the interviews, there is a lack of government initiatives to transform the educational system to increase R&D activities.

The interview findings illustrated that the universities in the UAE are primarily teaching universities, not research universities. Universities in the UAE work to generate academic excellence and focus on content delivery, which is what Mercan and Götkas (2011) defined as being a traditional function of universities. The role that universities in the UAE are currently playing is not leading to innovative knowledge that industries can leverage, which is an essential precondition of a national innovation ecosystem (Mercan and Götkas, 2011). The knowledge generated by universities is an important resource for industry (Maietta, 2015). Creation of innovative knowledge is critical because codified knowledge does not lead to product innovation (Maietta, 2015). Therefore, an aspect that needs to be addressed to ensure greater university–industry collaboration is the transformation of universities' focus from teaching to research. In doing so, the UAE needs to adopt a similar approach to Singapore. Singapore changed its educational philosophy, which meant that the output from the education system also changed and an emphasis was placed on skill development and knowledge creation (OECD, 2016). Furthermore, establishing entrepreneurial universities, which undertake an innovative approach to acquiring knowledge (Galvao, Mascarenhas, Marques, Ferreira and Ratten, 2019) can be considered possible alternative models to traditional teaching universities.

6.3 Drivers influencing national ecosystem development in the UAE

The interview results have indicated several challenges that the UAE faces in developing its national innovation ecosystem. One of the core aspects that emerged from the analysis was the fact that the current visa and citizenship structure in the UAE is not well-equipped to bring external talent into the country. Due to the lack of a long-term option for obtaining citizenship, talent and researchers will not flow into the country. This means that talented individuals might use the UAE as a springboard for migrating to other countries that provide permanent citizenship and permanent residency. Several participants stated that the UAE needs to take steps akin to Singapore and its permanent residency programme to encourage talented individuals to invest their time and research orientation in the UAE. Past research has indicated that it is STEM workers who contribute substantially to increasing technological innovation (Peri, Shih, and Sparber, 2015). While scientific and technical knowledge has a wide research base, the STEM workers who possess this knowledge are less mobile (Peri, Shih, and Sparber, 2015). That is, STEM workers need close interaction with one another and tacit knowledge to drive innovation. Research by Moretti (2004) and Iranzo and Peri (2009) has outlined that STEM workers, when present in a concentration, significantly increase the strength of innovative productivity. Supporting this idea, Moretti (2012) found that industries

heavily reliant on innovation and idea generation have a tendency to agglomerate. This leads to the conclusion that the UAE needs to provide long-term residency options to STEM workers. This will help to retain their tacit knowledge in the country and increase the production capacity of innovation in general.

Another driver of national ecosystem development in the UAE identified was the limited funding available for research purposes and the high cost of living. Funding can be generated using R&D grants and performance-based funding to counteract this. The development of grant policies in collaboration with a university or firm can provide greater funding access to researchers (Guimón, 2013). In the Netherlands and the UK, there is an innovation voucher that provides access to funding and facilitates collaboration between universities and industry (OECD, 2010a). Guimón (2013) stated that there is a stigma attached to university professors collaborating with firms. Therefore, there need to be initiatives to increase motivation for collaboration and provide returns for the professors that go beyond the publications. Similar approaches can be applied in the UAE to ensure that there is sufficient interest from academicians towards enhancing R&D in the country. Enhancing the rate of R&D funding was a method adopted by South Korea (OECD, 2000). Enhancing the provision of R&D grants and other methods of funding for research will allow innovative entrepreneurs in the UAE to overcome challenges associated with obtaining an SME loan and capital. Additionally, the findings indicated that although the UAE has made some efforts towards the implementation of innovation deployment programmes, the short-term nature of these programmes usually led to low rates of innovation and low return on investment. Finally, there is no accountability associated with the allocation of funding in the country, which leads to limited innovative output.

A critical factor outlined in the interviews was the mismatch that exists between the public and private sector in the UAE. Several participants noted the limited role that the private sector plays in the UAE in terms of R&D, with more accountability resting with the public sector. While a triple helix model outlines that the government plays a central role in enhancing innovation in the country, limited participation by the private sector can lead to statist configuration of the national innovation ecosystem. A study by Yoon (2015) found that while the national innovation system of Korea has already evolved into a triple helix model, marked by the development of complex university–industry–government channels of communication (Yoon, 2015), there is an almost exclusive contribution of large firms and government strategies to this rapid evolution. In this respect, Yoon (2015) stated that there is a lack of participation of SMEs in the innovation system and that the country will need to develop policies to enhance voluntary collaboration and promote a

more sustainable model of innovation involving SMEs. Therefore, for a sustainable national innovation ecosystem, the Government of the UAE needs to ensure that the private sector R&D is enhanced.

The cultural dialogue in the UAE was also noted to be a hindrance for enhancing innovation. Several participants noted that the aspirations of youth are traditional, in that graduates are expected to obtain jobs in their respective fields. The opposite is true in a country like Germany, which is known for its innovative capacity. For instance, the transition of labour from university to industry is more standardised and effective in Germany (Jacob and Weiss, 2010). The perception of education in Germany is also something to highlight. For example, graduates from top universities usually choose entrepreneurial and innovative fields as their career choice (Bergmann, Geissler, Hundt and Grave, 2018). In addition, the more innovative the climate at the university, the more it is likely that students will move into innovative and entrepreneurial careers. A similar approach needs to be encouraged in the UAE so that the culture shifts from the traditional education–job perspective to an education–innovation–entrepreneurship perspective.

6.4   Development of a national innovation ecosystem in the UAE

Skill development through education was identified as a core input that will be required by the UAE to ensure that it develops a national innovation ecosystem. Participants suggested a reform of the current education system in the UAE to ensure that the younger generation is learning how to use the information and knowledge that they gain to think creatively and develop innovative behaviour at a young age. Some other participants suggested the development and enhancement of teaching capabilities in the country to ensure that the teachers are trained to impart specific skills that are required. The way that Singapore instils core problem-solving skills and innovative capacities can be seen in the way it teaches mathematics to the students. According to the OECD (2010), the primary responsibility of the teacher is to develop maths sense. The focus is on developing skills that lead to the right answer, rather than focusing on one right answer (OECD, 2010). In addition, Singapore has established a model learning method where abstract mathematical ideas are transformed into tangible models of various shapes and sizes. This enhances the learning of the subject on a deeper level and encourages creative thought.

Adopting the South Korean example will also prove beneficial for the UAE. In terms of education policy, South Korea is consistently improving its education system, which can be seen through the implementation of several policies (OECD, 2015). To improve the

equity of learning and education, South Korea has implemented and plans to implement initiatives that will increase the rate of entrepreneurship and research. However, the UAE's education system still largely promotes an exam-based, non-applied and non-curiosity-based thinking and assesses the knowledge in each individual using standardised tests. The education system needs to support self-learning, encourage independent learning, and initiate risk-taking in a controlled environment to empower students to create and innovate.

Contributing to the development of educational infrastructure will ensure that there is sufficient knowledge being produced in the economy, which will ultimately lead to its growth and development. By enhancing education and training quality, Guimón (2013) suggests that the transfer of knowledge to the firm can be facilitated. This can be done by allowing industry leaders to be part of the curriculum development process so that universities are creating a better response to industry requirements (Guimón, 2013).

The UAE can also adopt the practices of Switzerland, which is said to have one of the best education systems in the world (OECD, 2017). The educational system in Switzerland promotes lifelong learning (OECD, 2017). The system is also divided into two sections: general, which is the academic; and vocational, which provides industry skills. In this way, the Swiss education system provides individuals with sufficient skills to perform in industry. Looking at the Singaporean education system, it encourages and motivates learning, creativity and innovation. It has done so by maintaining a close collaboration with policymakers, researchers and educators (OECD, 2010). Such a collaboration in the UAE to transform the education sector will ensure that there is a greater alignment between the UAE's education sector and its industry.

The current education system in the UAE is not geared to generate innovative individuals. More focus is placed on rote learning, which is not an innovation model. The focus needs to shift from what to learn to how knowledge can be gained and how learning can be facilitated outside the classroom. Moreover, universities should instruct their students to achieve greater applicability of the concepts rather than rote memorisation.

The focus on using education only to obtain a job needs to shift so that learning becomes the goal, rather than obtaining an educational degree. In the same vein, the educational degree should serve as a tool for learning how to innovate and commercialise. Universities need to ensure that they nurture talent, provide students with guidance for cultural aspects and provide them with the knowledge that will allow them to become innovators and entrepreneurs who use the appropriate channels, access a variety of data and establish their innovations in the country. Furthermore, universities need to enable

students to create networks before they graduate so that they may exploit the network to lead innovative practices. Universities also need to have the capacity to leverage talent and provide R&D facilities that speak openly with industry. The introduction of vocational education that could ensure that students are being exposed to specific innovation courses to help enhance innovation in the long term. However, the country needs to enhance the vocational education system because it is difficult for a vocational education certificate to be recognised in lieu of a master's degree or a bachelor's degree.

Creativity should be driven in students from a young age in a similar approach to the Netherlands. In terms of the education system, the Netherlands is one of the top-performing OECD countries (OECD, 2014). The report noted that the country is performing much better than the OECD average, based on the 2012 PISA cycles. In addition to the standard subjects such as mathematics and science, the performance of the Dutch students in areas of creative problem-solving was higher than the OECD average.

The need to enhance the education system of the UAE comes from the fact that when an economy develops a sound and structured education and research system, it invariably increases its absorption of innovation and knowledge developed in other economies (Gackstatter, Kotzemir and Meissner, 2014). There is a direct link between the R&D expenditure and the innovation rate of the countries. It can be posited that by increasing the R&D expenditure and increasing its private and public sector contribution to R&D, the UAE can move closer to realising its goal to transition into an innovation-based economy.

There remain a few areas where improvements can be made; namely, the creation of complex system linkages and pathways of communication, and the promotion of a sustainable innovation system by integrating SMEs and increasing the rate of voluntary R&D collaboration between universities and industries.

An issue in the UAE is the high turnover of teachers and professors. The high rate of teachers' turnover impedes the development of strategic alliances and, thus, hinders the growth of R&D in the country. One of the ways to combat this issue in the UAE is to enhance financial compensation for teachers. Following the example of the Netherlands, the UAE needs to provide sufficiently higher salaries for educators to ensure that they remain motivated to teach. The government should also work towards changing the perception of teaching to be more highly-regarded, such as the dialogue created in Finland. This contrasts to the US, where teaching is not regarded as highly and is often used as a stepping stone to a better socioeconomic status.

Table 6.1 outlines the key results and responses to the study.

Table 6.1: Summary of key results and responses

Key result	Key responses
Limited long-term research might be due to visa structures	'It's hard for people to justify putting investing their life and time into something that feels impermanent. And it's that lack of permanence that discourages a lot of people to keep investing and keeping their assets and the assets cannot isn't necessarily just cash or were hard things it could be intellectual property. If people don't feel that this is their home, why should they do it here?' (Participant 11) 'Let me take researchers worldwide. If I look at talented researchers, you stay in a university because you have tenure, which means I can retire in the university. I've got a pension I can contribute with. Because we don't have the visa, you don't have tenure here. Right? So, you have rolling contracts. But that does not mean you can stay here as long as you want. So, this becomes a challenge also with research'. (Participant 16)
There are a lack of permanent residency options	'If you want to become a true innovation economy that brings the brightest minds from the rest of the world, those brightest minds will not just come for two or three years; they want to see that they're appreciated and valued. And also, that those countries as host countries also value them right now, across the board. Having met with a lot of CEOs and leadership, and entrepreneurs, they all expressed their concern that UAE is a great place to land to grow. But it's certainly not [a] place they called home to their always consider places like Canada, Australia or the US as the ultimate destination'. (Participant 5) 'Research and development require time and, therefore, that doesn't get aligned, doesn't talk well to the visa issue here. Because most of [the] researchers, if they are experts, they are on two to three years contracts'. (Participant 17)

There is a limited contribution from the private sector to R&D	'I can notice that there is a very limited intervention from the private sector and the innovation ecosystem. I mean, we hear a lot about government initiatives and what the government was trying to promote, both in the government sector and the private sector. But what we see on the day-to-day practical approached off the cover of the private sector towards innovation, it's very limited. So, I would, just to sum up, I would say that the private sector should play a bigger role in whatever the UAE Government is trying to achieve. But currently, they're very limited'. (Participant 14)
There is a prevalent cultural separation between Emiratis and expatriates at the school and university levels	'Even if I look at schools, it's generally expats [that] are separate from us; I mean, locals. And I think this is a disadvantage, in some cases, because the greatest creativity will [come from] mixing people together'. (Participant 16)
Setting up and funding R&D-related businesses in the UAE is difficult	'When I look at the funds that are doing this, the majority of them are former founders, who succeeded and sold their businesses and made a lot of money for they're using their own money. And because they're putting their own money, the other investors who invest with them say, oh, man who he's putting his returns from his sale of his company into this thing; he really believes in it. And because he's earned before, he'll know how to select what to invest in and what not to invest in. Right. So, I think we have a funding gap in the early stage, but I don't feel that we have enough investors who think this way'. (Participant 11)
There is a disconnect between the innovation dialogue and current legal and regulatory frameworks in the UAE	'I think 99% of the policies here are amazing. Honestly, I think it's fantastic. It's up to innovators to, you know, maximise these policies … unfortunate[ly], I think the only thing that I would complain about is the disconnect. I know why this is happening. But the disconnect between the licensing and the thinking. Because I've directly paid it. So, it only took us three days to get a license from a DJ. Okay, but it took six weeks to get a bank account from an ATM-recommended bank, which is embedded in VC is the largest bank. You would think that, you know, they will have a process now. It took six weeks to go through KYC. This is KYC of a person … I've worked for the government, so, it should be quick. But obviously, that's happening, because [the] Central Bank is making sure that there's no money laundering and, okay, but I

	think there has to be something to speed up that process, [its] unacceptable'. (Participant 13)
AI could enhance the innovation ecosystem in the UAE	'One way to do this is to introduce artificial intelligence or to introduce a new platform, a predictive analytics platform, to be able to predict when a part may fail based on all the unstructured information out there related to things that are happening in the world, or structured information related to wind, temperature'. (Participant 4)
The cost of doing business is high	'The cost of setting up a business is so high, and I think really, when you're looking at entrepreneurs, people want to test whether the idea works before they start. That makes common sense, right? Why would I spend 10, 000 dirhams for a license and everything else will need to find out? It feels I would rather like to invest it slowly; see if it works perfect[ly], and then put in the money to build the business. We don't have that progressive chart here for various systematic reasons, and I think this discourages innovation'. (Participant 16)
Venture capitalism needs to be strengthened	'So many people, so many, so many investors worldwide, they're more than happy to invest in the UAE but they don't know the channels. So, they end up doing the obvious stuff: real estate, starting some small businesses here and there. But once they see, you know, a channel that is supported by credible bodies, very well known VCs, very well non-government buddies supporting those VCs, they'll be able to put their money like willingly and raise funds. And raising funds will be way easier'. (Participant 14)
Government funding needs to be provided	'We would like to pretend we are research-based, and that's according to the innovation index. But there are some challenges. So, let's look at again, things like government funding. Okay, so the amount of funding we spend is very low: 0.2% of GDP. I know that we had outlines like for the UAE, that we're going to spend more money, and we are doing it through the TFF and things like that. But that's not again, going to; yeah, it's going into outside start-ups and places like that. So, this is a big thing. And like I said, the last National Research Foundation was in 2014. And then, very little money was put out. We have another systematic challenge, which is we don't have enough critical mass of researchers'. (Participant 16)

'Decentralise research capacity, while at the same time centralise funding for research, just so that we have a better understanding of where the money goes and what's the outcome of that'. (Participant 7)

Cost subsidies need to be provided	'[Another thing] that the government can facilitate and provide, whether it's supporting or licensing cheap office space, a place for someone to work from … helping people connect globally with other entrepreneurs, innovators around the world, is reducing the cost of doing business'. (Participant 21) 'It's very hard for the government to just by themselves, say, hey, we got to create an interesting opportunity to research them. But I think the way to do it … you bring in a couple of companies and institutions. And you might have to subsidise them or give them some incentives to set up here, but then you essentially sort of forced that to happen. And then when those opportunities are here, then the talent will come'. (Participant 10)
Using research grants, R&D funding needs to become more competitive	'Having competitive grants, having access to research where have celebrating that having, like promotional journals, promotion of seminars, promotion of workshops, is the way forward. I think it's already started, like, approach it like having [a] Russian Academy for a scientist. I think that's a great approach to start, because at least researchers are incentivised to do work that would allow them to go in there, and that has [a] sort of prestige that might impact them financially in the job, but also personally and the self-fulfilment there. So, I think a whole mechanism for research, grants, across science, across humanities, across all of the different subjects would be something that's fantastic; and also having a platform where this can be shared would be great'. (Participant 6)
A culture of entrepreneurship needs to be promoted	'Really, to make sure that through the childhood to a university level, the UAE national, the UAE talent, they can embrace … risk, and there is no problem to fail in an endeavour as an entrepreneurial endeavour … because so many people, they are having this taboo … like, 'if I'm going in business, I felt people they will portray me as a loser''. (Participant 1)

The risks of entrepreneurship need to be taught at the school and university levels	'I find that a lot of the youth are being drawn to general employment and aren't going down the entrepreneurship path. I think what would help a lot is early on in the development and education of the youth is to introduce entrepreneurial concepts, expose them to innovators, to leaders that have succeeded and also fail[ed], because we learn a lot from our failures. To show them, you know, when you put your mind to it and you try to solve problems, that you can do great things. And maybe it can be great in terms of financial success, but maybe it's great for humanity and society. So, I think that's [what] we said first about having an entrepreneur-friendly regulatory framework environment. And then, number two, having entrepreneurship exposed at an early age to our youth'. (Participant 11)
Research centres should be established with a clear mandate to attract funding rather than making funding available first	'I think things like the MBR Space Centre are great initiatives. And what these sorts of government entities do, is that it number one forces the government entity to go into the country and find talent and fund research. Because there's a purpose, you know, that centre has a purpose that they need to fulfil. So, long-term centres, like [the] Space Centre, for example, now we have a Ministry of Food Security; another great institution that has their own internal mandate to meet, and to meet an internal mandate, they have to fund research'. (Participant 19)
Collaboration between MNEs and government for research needs to increase	'You don't see much of the research and development done within companies in the UAE. Most of the even international companies, big companies operating in the UAE, unfortunately, the research and development is done in their home country'. (Participant 17)
Skill development through education is crucial for enhancing innovation	'The courses on innovation require specific skills that must be learned, and these are not generated by chance. These must be, for example, when you look at design thinking methodology promoted by the course in Stanford [University], you have to learn that to be able to teach it. The question is, do faculty and teachers in the UAE have these skills?' (Participant 17)
An international mentorship programme should be provided for teachers and educators	'The government has many, many contracts with leading thinkers. And they do, of course, leverage a lot of the ideas in terms of those that are in the market and those that are looking to come into the market. But there is no matchmaking of those talents and capabilities to local, up-and-coming entrepreneurs in terms of critical mass.

So, one thing that you could do is, for those talents that we interact with on a once-off for a particular contract, we should create a channel as part of that agreement; that they need to come in and actually meet others or lecture others or get involved in particular programmes at universities and, like, to develop those capabilities and skills in somebody else'. (Participant 22)

Longer-term visas should be made available	'I think we started to see a lot of great government initiatives around entrepreneurship visas and the kind of long-term visas and so forth to address that gap, and I'm sure those sort of an initiative will support on attracting the kind of a lot of good investor'. (Participant 13)
	'We need to make sure that the talent coming to the UAE is similar to the American dream. We need to make sure that our value proposition for this is done and they are not here for a transaction or temporary basis. We want to make sure that this is a country where they can build their dream and they can stay here for a longer period of time'. (Participant 1)
Appointing a Chief Science Officer to be considered	'Needs to be driven by a chief research officer, as Chief Science Officer … the whole idea is that the chief scientist can figure out, okay, where should we allocate our funding? What are our strategic needs over the next 50 years? And how should we allocate that funding? And then how do we get funding both from the government and lobby the government to the minister, and then also lobby the private sector, to follow that agenda slowly, as by giving incentives from the government'. (Participant 5)
Implement and establish think tanks	'One thing that I always think that the UAE needs is a research think tank or research equivalent, right? So, for example, you have the Minister of AI and the Office of AI wanting the UAE to be the AI capital by 2031. I think we need to encourage these type of research-driven institutions; we need to look at research as something that we have to do, no matter how much money we're spending in, and just have that leap of faith that this will have a positive outcome in the future. So, you look at the Institute [for] Advanced Stud[y], which accepts 200 postdocs a year. And they stay there for two years. It's a place where Einstein was also like, incubated right. And basically, these are people that come in and they're affiliated, they're Princeton [University]. But a postdoc will come and spend two years there working on any subject matter they like within a specific three or four categories

	with the natural sciences, physical science, etc., and humanities'. (Participant 6)
Promote creativity and innovation through education rather than rote memorisation	'[the] current system in general … it's not prepared to graduate innovative individuals, because it's based on a memorised test model, which is not a very broad innovative model. It's merely just asking people to learn some set of information and just recite them in the exam, which is not an innovation-based model'. (Participant 12) 'If you look at the education system from a perspective of saying, they need to equip you with what you need to get to the point of, you know, becoming a successful person in the future. I think it's more about the skills aspect of things, rather than academic parts of things, right? How you learn is, what I need the school to teach me, not what to learn. And what to learn is obviously part of it, but the how part is what they need to start focusing more on, right? Because then eventually in life, you're not going to have academics, you're going to have real-life situations, which you need to be able to determine how to deal with. This is something that the US does very well [in] case studies. So, the learning methodology is I think something that could be reconsidered or improved'. (Participant 4)
Encourage students to explore innovative and creative solutions through education	'So whatever innovation needed now might not be needed when they're [teenagers] basically graduated from university. What we need to really think of is what kind of skills or what kind of mindset do we need to build in the younger generation. And that should be our longer-term vision. As, unlike students in primary schools and elementary schools, they need to understand and learn how to look at the problem and analyse it and then try and solve it. How do you create, or how do they create, opportunities for themselves from a particular setup? How do they think creatively about different things that might not be available today but might solve the problem tomorrow? And this, these skills, should be embedded in the way they're taught'. (Participant 14)

'Universities here are really teaching universities, they're not research universities. So, I think when you are focusing on teaching, you're focusing long content delivery. Whereas, if you're focusing on research, you're really thinking exploratory. So, there is a little bit of conflict'. (Participant 16)

Implement vocational education programmes	'There has been some attempt in Abu Dhabi in particular, to bring in vocational educational education off the ground. And there are some positive outcome[s], and the infrastructure provided for that was actually impressive. However, the vocational education system in the UAE does not talk when to the higher education system in the UAE, both in terms of recognition of vocational education by higher education. In the UAE, it's still difficult for a vocational educational certificate to be recognised in a master's degree or a bachelor degree. And that's a serious shortcoming'. (Participant 17)

6.5 Development of the framework prototype

Based on the insights that were gained from the interviews and the survey, a framework was developed with five subsections that correspond to the five core areas needed to ensure that the UAE activates its national innovation ecosystem. The five areas are immigration and visa rules, laws and regulations and the role of the government, university–industry collaboration and innovation in education, promoting culture to innovate and role of funding. These five areas have been developed from the insights gained after analysing the qualitative and quantitative data in this study. Before outlining the framework, a brief case for the various countries used for benchmarking purposes will be presented.

In 1996, South Korea joined the OECD as an important part of its liberalisation strategy. The OECD identified several new policy agendas for South Korea to undertake to build a strong national innovation system. South Korea is creating an environment that fuels innovation by reducing the stress of being judged by tests at the middle and elementary school level. In addition, Germany was the first country to develop a research-oriented university. The early German government played a major role in the catching up of German technology and innovation through government-funded learning and development programmes. The industrial development of Germany started with the beet sugar industry and rapidly expanded to include pharmaceuticals (including one of today's largest pharmaceutical firms, Merck & Co.). Moreover, since the economic crisis in 2009, the economy of Switzerland has stabilised and is in a state of steady growth. The country's innovation and R&D systems are top ranked among the other OECD member states. However, there is no widespread knowledge transfer or sharing.

Singapore's education system focuses on building skills that can match the changing global market and innovative environment. The education system of the country is driven by efficiency and creates a culture of innovation. The use of streaming has been beneficial as it allows students to study at their own pace and encourages learning and development. Singapore has come a long way in its ambition to build an education system that encourages learning, creativity and innovation. It has displayed strong growth and development, especially in the technology sector, by creating an open economy and establishing a unique but highly effective education system. The Government of Singapore is increasingly playing a major role in its development as an innovation hub by creating and implementing specific policies. The US, in comparison, tends to lag behind the other advanced education programmes, until it can find a means to guarantee that the assessments it uses determine what students should learn. No

explanation was found to explain how a country with a comparatively weaker education system can have such a high rate of innovation. In the Netherlands, R&D cooperation between universities and industry needs to be improved, and complicated pathways for knowledge and information sharing need to be established. The trend should move from focusing on developing products that anchor the business as a leader, to finding new avenues that produce creative solutions. Finally, considering Sweden, the education system has been promoted as one of the best in the world. The country's dedication to improving its creative competitiveness is seen in how much of its GDP is invested in R&D efforts. Since agriculture plays an important role in the Swedish economy, it promotes links between universities and industry to drive innovation.

Before presenting the framework, the primary influential stakeholders will be described. The stakeholders are grouped into the following categories: government bodies, entrepreneurs, universities and the private sector. Of the government bodies, the following stakeholders have been identified:

- The Ministry of Finance, which manages and oversees all monetary aspects and regulates the Central Bank of the UAE. The Ministry of Finance also implements bankruptcy laws.
- The Ministry of Economy, which oversees and directs the economic development of the country and proposes plans that can enhance the financial and economic condition of the state.
- The Ministry of Entrepreneurship and Small and Medium Enterprises, which is the government body that oversees work relating to the SMEs and start-ups in the UAE. (Established Q4 2020).
- The Ministry of Cabinet, which is responsible for evaluating and approving strategies to be implemented within the country. This government body is also tasked with incubating any new potential strategies.
- The Ministry of Industry and Advanced Technology, which oversees the innovation ecosystem in the UAE and promotes public interest and dialogue on initiative such as innovation and knowledge-based capabilities. (Established Q4 2020).
- The Ministry of Education, which is the primary stakeholder and deals with policies and regulation of the education sector of the UAE.
- The Ministry of culture and youth, which oversees youth empowerment and the start-ups and innovation within the creative economy and industry.

- The Ministry of Human Resources and Emiratisation, which is responsible for directing and managing all the labour, workforce, migration and visa-related policies and regulations.

- The Dubai SME Fund, which is a national fund for the SMEs and start-ups of Dubai.

- The Emirates Development Bank, through its Fund – Mohammed Bin Rashid Innovation Fund- which is also a fund tasked with funding the SME and innovation ecosystem development in the UAE.

- Hub 71, which is situated in Abu Dhabi and is a technology ecosystem that plays a primary role in the ecosystem of the UAE.

- The Khalifa Fund, which is similar to the Dubai SME Fund, but limited to the emirate of Abu Dhabi.

- The Dubai Future Foundation, which plays a huge role in providing support to SMEs and start-ups in the UAE and Dubai.

- Regulation Lab, which is an important platform under the UAE Cabinet that allows for the regulations to be changed at a smaller level before applying them to the higher, federal level.

For the national innovation ecosystem to be successful and sustainable, there needs to be a strong link between the various stakeholders in the ecosystem. With this in mind, the framework was developed as an initial prototype. The five various categories and areas of focus for the framework are outlined separately first to allow for an appropriate discussion.

6.5.1 Immigration and visa rules

One of the issues identified by participants was that in the university system, and even in schools, the turnover of teachers is very high and teachers and professors do not have the tenure time to continuously develop relationships with industry that they that would have in a different country. A possible long-term association with the school or the academic institution provides opportunities to explore relationships with other academic institutions and, thus, builds networks to drive R&D initiatives. However, the high rate of teacher turnover impedes the development of such alliances and, thus, hinders R&D growth. In addition, when employers are hiring, they need to consider the creativity and innovation of the individuals. The same is applicable at the country level when visas are issued, as this will then generate a sense of loyalty to the country.

Based on the insights above, one of the primary objectives is to implement a long-term visa plan for key individuals such as entrepreneurs, investors and researchers to enable them to stay within the country and contribute to its innovation ecosystem. In addition, the path to permanent residency could be similar to what Singapore has implemented. The framework outlines the role of the various stakeholders and the core steps that need to be taken. First, the Ministry of Interior Affairs will need to submit a proposal to the Ministry of Cabinet, which will then initiate action and allow the Ministry of Human Resources and Emiratisation to issue long-term visas for entrepreneurs, investors and researchers. While the UAE has recently launched the five-year investor visa for entrepreneurs and investors, the duration of the visa should be based on merit. This is especially true for researchers, whose visa length should be based on the duration that their research process will take. Furthermore, for the start-ups and investments that are carried out in an innovative manner and for an innovative outcome, the MBRIF needs to provide funding. This funding needs to be provided only to those individuals or entrepreneurs whose ideas are truly innovative and research-based, which will make the funding space highly competitive. The researchers also need to submit their research proposals to the Ministry of Education, who can then evaluate them based on their research merit. They can then decide the duration of the visa required and provide an appropriate amount of funding. Furthermore, the research proposed needs to lead to R&D commercialisation. The researchers will also fuel university–industry collaboration, which can then lead to the Ministry of Education issuing a more favourable visa recommendation. With respect to permanent residency, the scientists, researchers and talented graduates who are on the research career track need to be engaged with the Ministry of Industry and Advanced Technology, who can enable these individuals to create R&D spin-offs, which can lead to further R&D commercialisation and generate highly innovative start-ups. This can bring the UAE closer to its 2071 goal. Therefore, there are two primary aspects that need to be considered: long-term visa provisions and a pathway to permanent residency.

With long-term visas, as several participants from the interviews have noted, there is a need to ensure that researchers have a longer time guaranteed within the country to encourage the research. By providing long-term visas for researchers based on the merit of their research, they will have the time required to accomplish their research objectives. Furthermore, with the permanent residency pathway, individuals who are on a research career track are provided with this unique and attractive opportunity to contribute to the UAE and be a part of its future. The participants of the study have noted that unless researchers feel connected to the country, they will not contribute to it. This framework

will address that issue and ensure that more talent is brought into and retained in the country. Figure 6.1 details the proposed immigration and visa framework.
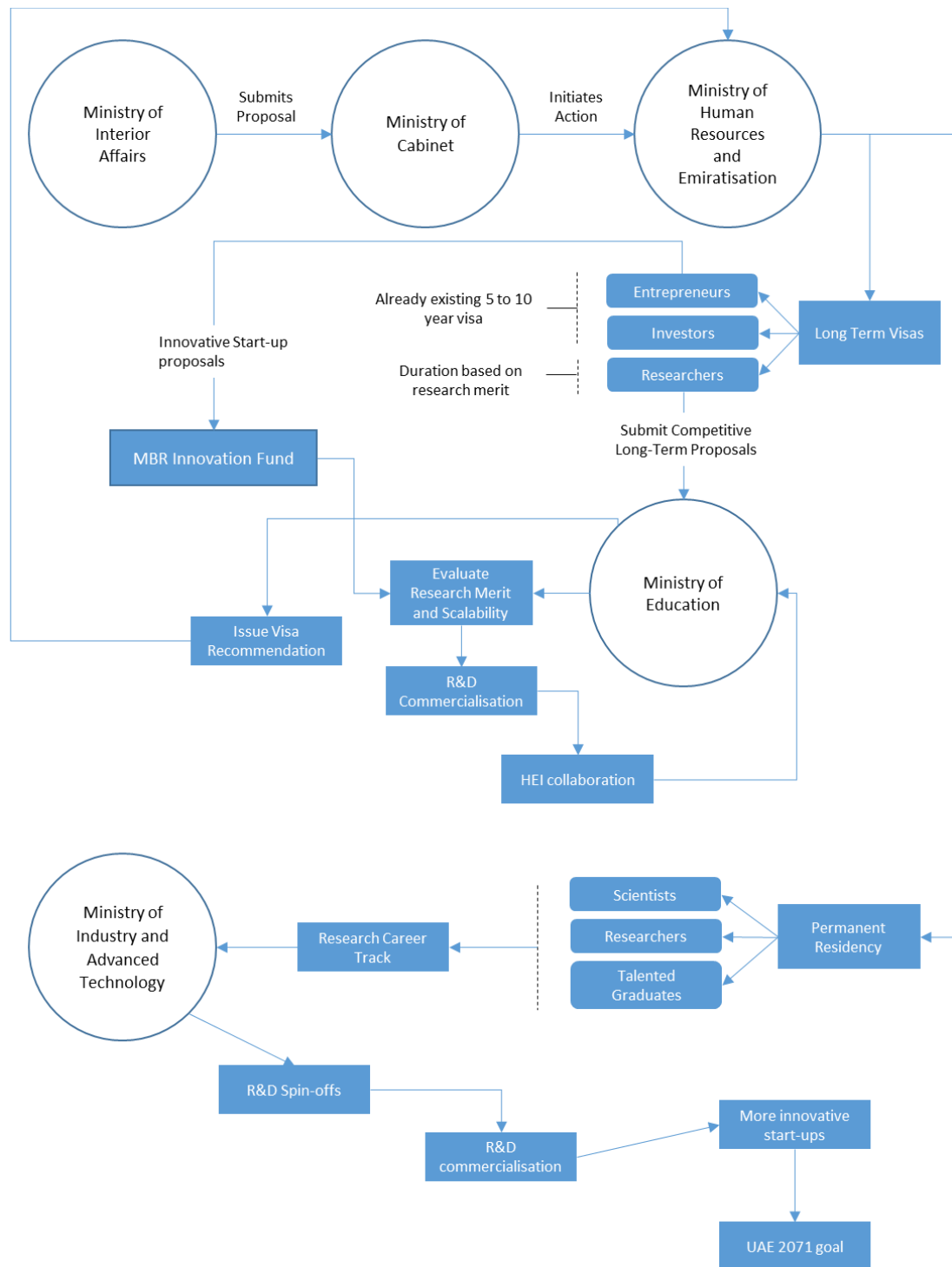
Figure 6.1: Immigration and visa framework

6.5.2 University–industry collaboration and innovative education

The challenge for university–industry collaboration is not inadequate funding; there are a number of investors and leaders who are willing to provide funding for new ideas. Rather, the problem is to connect investors and researchers so that collaborations can form and R&D activities can take place. However, in the absence of initiatives from industries and academic institutions, as well as lack of push factors, such alliances between universities and industry are rare. Some initiatives have been implemented but have not generated the kind of success needed. For instance, institutions such as the MBRIC and Alchemy project have made significant moves to drive innovation across sectors in the UAE, but such initiatives are few.

The two major players in building the innovation ecosystem are industry and academia, who are disjointed and have made little collaborative efforts to foster research, innovation and development of new solutions. Moreover, there has been no serious attempt to promote R&D between industry and universities, and there are no knowledge transfer channels between them. Incentives in the form of financing, reward or recognition are required to encourage R&D collaborations and innovation activities. The government must actively incentivise universities and companies to collaborate on R&D projects and offer rewards for ground-breaking innovations. Current initiatives are rather fragmented and confined to smaller pockets. Scaling up is required, where different stakeholders can come together, brainstorm, generate new ideas, explore them and create innovative output. Therefore, a lack of incentives is also one of the challenges hindering university–industry collaborations. Alliances must be formed internally, and collaborations need to take place among different institutions, industries and sectors within the country.

For the university–industry collaboration aspect of the framework, the Ministry of Education needs to appoint a Chief Science Officer, who is rotated every year or two and who focuses on increasing university–industry collaboration. This can be done using internships, placements and joint research programmes that are integrated with higher education institutes and the private sector. The Ministry of Education can also launch and implement think tanks, which can be used to bring together corporations and researchers. This can also help facilitate the research career track, which will be used to feed into Area 2071 and Hub 71 and link to internships, placements and other joint research programmes. Furthermore, the Chief Science Officer can provide essential insights to the Ministry of Economy, who can initiate cost subsidies to the private sector entities that are collaborating with higher education institutes. The higher education institutes can then have greater R&D outputs such as spin-offs and commercialisation.

Furthermore, awareness of IP can be generated, which will lead to the generation of private equity, thereby launching joint companies and further feeding into research commercialisation. The higher education institutes can also ensure that there is greater research continuity.

Although none of the countries studied in Chapter 3 has appointed a Chief Science Officer, it is proposed here as a valuable initiative. There needs to be Chief Science Officer responsible for setting the mandate and ensuring that cost subsidies are provided to the private sector based on their research merit. Furthermore, the higher education institutes need to own private sector equity to ensure that they are not only contributing to research but are also leading to greater commercialisation of R&D initiatives. In addition, the Chief Science Officer will also oversee the think tanks suggested in section 6.6.1, including the research and operations, as well as manage Area 2017 and Hub 71. Participants also indicated that the Chief Science Officer needs to be rotated every two years to ensure that new ideas are being generated regularly.
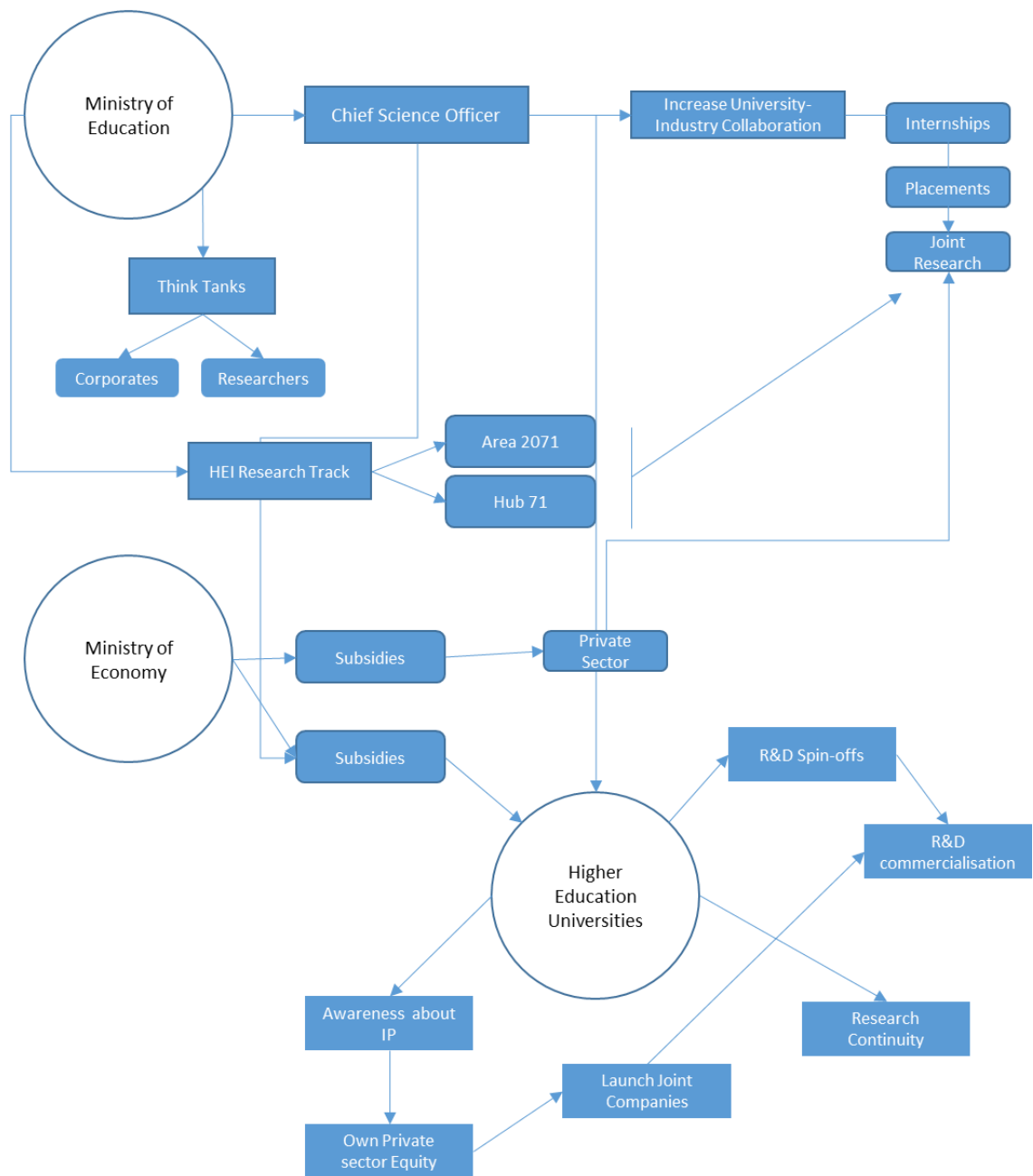
Figure 6.2: University–industry collaboration and innovative education framework

6.5.3   Promoting a culture to innovate

Universities in the UAE are not designed to solve real-life problems and, thus, companies are not approaching universities to the extent observed in Europe and in North America. The universities are not focused on R&D activities, and teaching philosophy is tied to traditional curriculum-oriented learning because the UAE was not focused on innovation historically. The cultural dimension failed to inculcate innovative zeal among the individuals, motivating them to look for alternatives, moving away from the traditional pathways to achieve something exceptional and contribute towards the development of the country. This was because, historically, there was a very clear mandate from the UAE leaders to the graduates to serve the government to build the country. Thus, the focus was on creating an educated workforce, which led to the development of teaching universities rather than research universities. This led to a lack of formal policy at the university and school level to encourage R&D activities.

From a cultural standpoint, individualism and innovation need to be more favoured in the UAE and considered drivers of its growth. Taylor and Wilson (2012) found that, in a society where collectivism is encouraged, the rates of innovation tend to be lower. In effect, in individualistic societies, there is a higher value placed on innovation and advancements. However, Taylor and Wilson's study did not identify any causal links between the phenomena and only reported on the correlation. The authors cautioned against 'stereotyping all collectivist cultures as anti-innovation' (Taylor and Wilson, 2012:245) because they found evidence of collectivism being used to solve problems of a societal nature by influencing innovation. This was also true for cultures of institutional collectivism, which is a display of national patriotism. Another study echoed the results above and found that there is a positive correlation between the levels of individualism and innovation output (Efrat, 2014). Efrat identified that masculinity affects innovation, as does uncertainty avoidance. The author also noted that one factor might affect the rate of innovation negatively when it is acting alone, but influence innovation positively when it is acting together with other factors. In addition, Shane (1992) found a correlation between a culture that displays a higher power distance and lower rates of innovation. This could be because a large power distance creates a greater, more complex channel of communication between two parties located at either end of the power spectrum, thereby implying that there is a lower information processing capacity. This can be observed in multinational organisations that have a highly developed and enforced hierarchical structure. In contrast, Shane noted that smaller firms might have an

advantage because information processing takes place at a faster rate due to the informal structure of the organisation.

Evidence suggests that an organisational culture that values and rewards innovative approaches positively influences the rates of innovation (Chandler et al., 2000; Hofstede, 2001). Chandler et al., (2000) also identified that gender, or gender constructs, influence the rate of innovation. More specifically, there is a higher rate of innovation displayed in 'masculine' societies; a result that was also stated by Efrat (2014). Hofstede (2001) has also stated that there is a link between the culture of an organisation and that of a nation, which means that the national culture will influence the culture of the organisation. Thus, Hofstede stated that there is a positive correlation between societies that favour openness, reward innovation and flexibility and the rate of innovation or innovative capabilities of that organisation.

While it was identified that the UAE has a good R&D investment, the collaboration between universities and industries to develop and create new and innovative products, no indication was found regarding its cluster development. Moreover, schools are focused more on curriculum-oriented teaching, which provides no room for innovation, exploration and creative ventures. In the absence of proper policy requirements, the academic institutions lag behind in innovative efforts and fail to inculcate inquisitiveness and risk-taking among the students to contribute to the greater good of the nation. This is an issue, because teaching only the academic curriculum will not be adequate for meeting the constantly changing needs of industries. Theoretical knowledge must be supported with practical skills, experience and expertise so that the students can engage in R&D activities and create collaborations with the companies. This will be needed to foster the development and activation of the innovation ecosystem. Exposure to core aspects and principles of entrepreneurship through education is crucial during the early stages of the youth.

The government needs to establish innovation centres that have a clear mandate and, hence, carry out extensive R&D to meet its goals, which will then need to be funded. Better skill development was outlined by some of the participants as a necessary step in developing a national innovation ecosystem. Furthermore, a reform of the current education system needs to take place to ensure that the younger generation is learning how to use the information and knowledge that they have gained to think creatively and develop innovative behaviour at a young age.
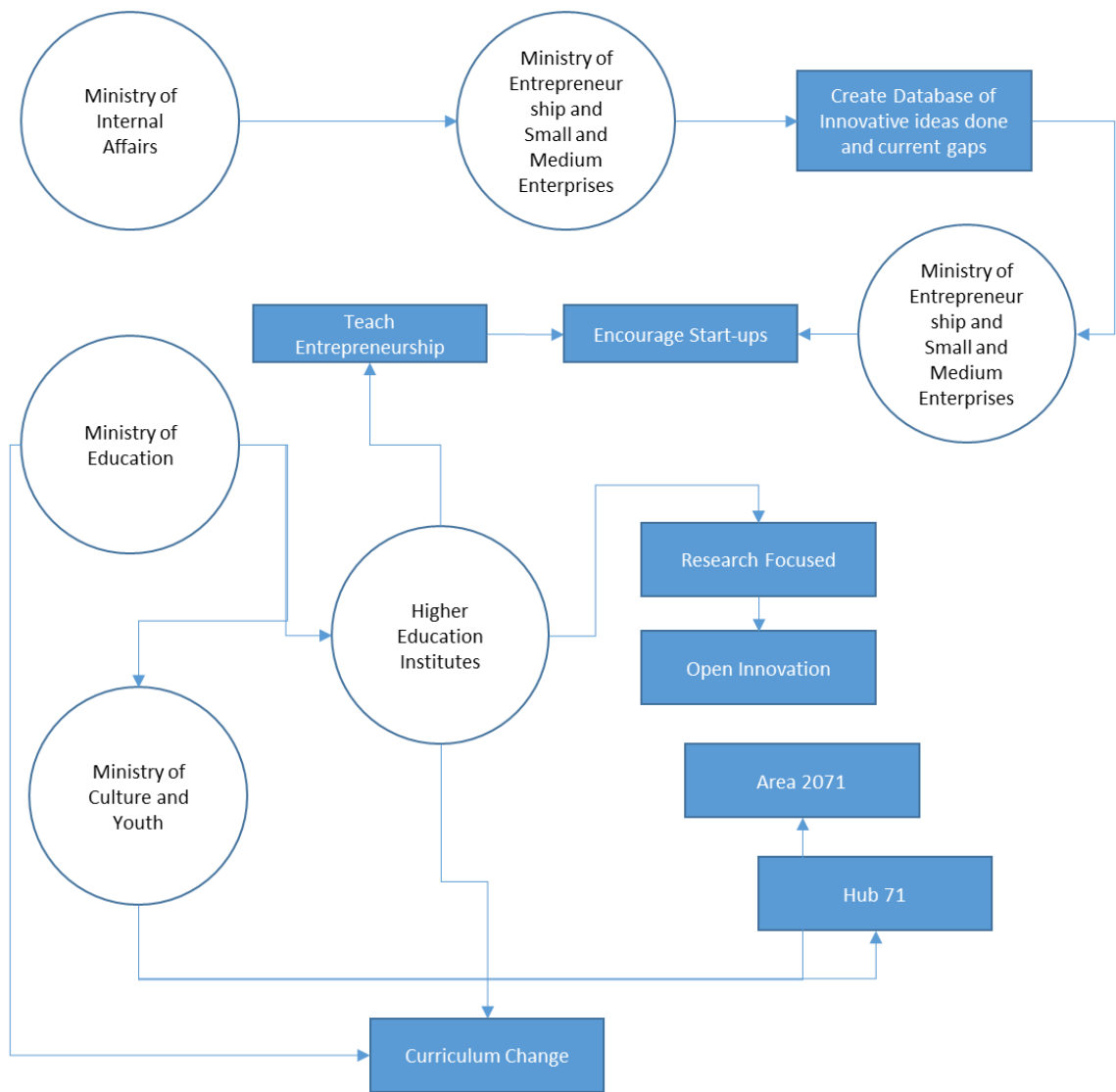
Figure 6.3: Framework for promoting a culture of innovation

6.5.4 Laws, regulation and the role of the government

The legal and regulatory framework is highly complex and not on par with the innovation dialogue that is being encouraged in the UAE. The legal requirements for innovative business ventures such as Uber and others need to go through a long process of documentation and approvals, which has the potential to discourage innovators who have ideas that challenge the status quo. Therefore, the legal and regulatory environment of the nation is a hindrance for the effective implementation of an innovation ecosystem.

One of the primary limitations identified in this study was a disconnect between the current laws and regulations and the innovation dialogue that is promoted in the country. That is, IP and bankruptcy laws do not facilitate greater innovation and development. One of the participants had noticed that the ban on VoIP (Voice over Internet Program) was counterproductive to the innovation dialogue that was present in the country. This ban prevented individuals from communicating with members in other countries. Also, participants identified that the process for opening a business bank account was not streamlined and was very time-consuming.

It was also noted that there is a limitation because research is primarily conducted by the government, and there is no control over the funding. To address these limitations, the framework here suggests that the Chief Science Officer, under the mandate of the Ministry of Cabinet and the Ministry of Industry and Advanced Technology, ensures that they are establishing research centres in several research areas, establishing a clear research mandate and calling for more research in conjunction with Area 2071 and Hub 71. Furthermore, the Ministry of Economy & the Ministry of Finance, under the mandate of the Ministry of Cabinet and in coordination with the Central Bank, needs to ensure that bankruptcy laws are enhanced. The Ministry of Economy also needs to ensure that IP laws are strengthened to facilitate a greater degree of innovation and commercialisation. In addition, the Central Bank of the UAE also needs to reduce the complexity of bank account opening processes for companies.
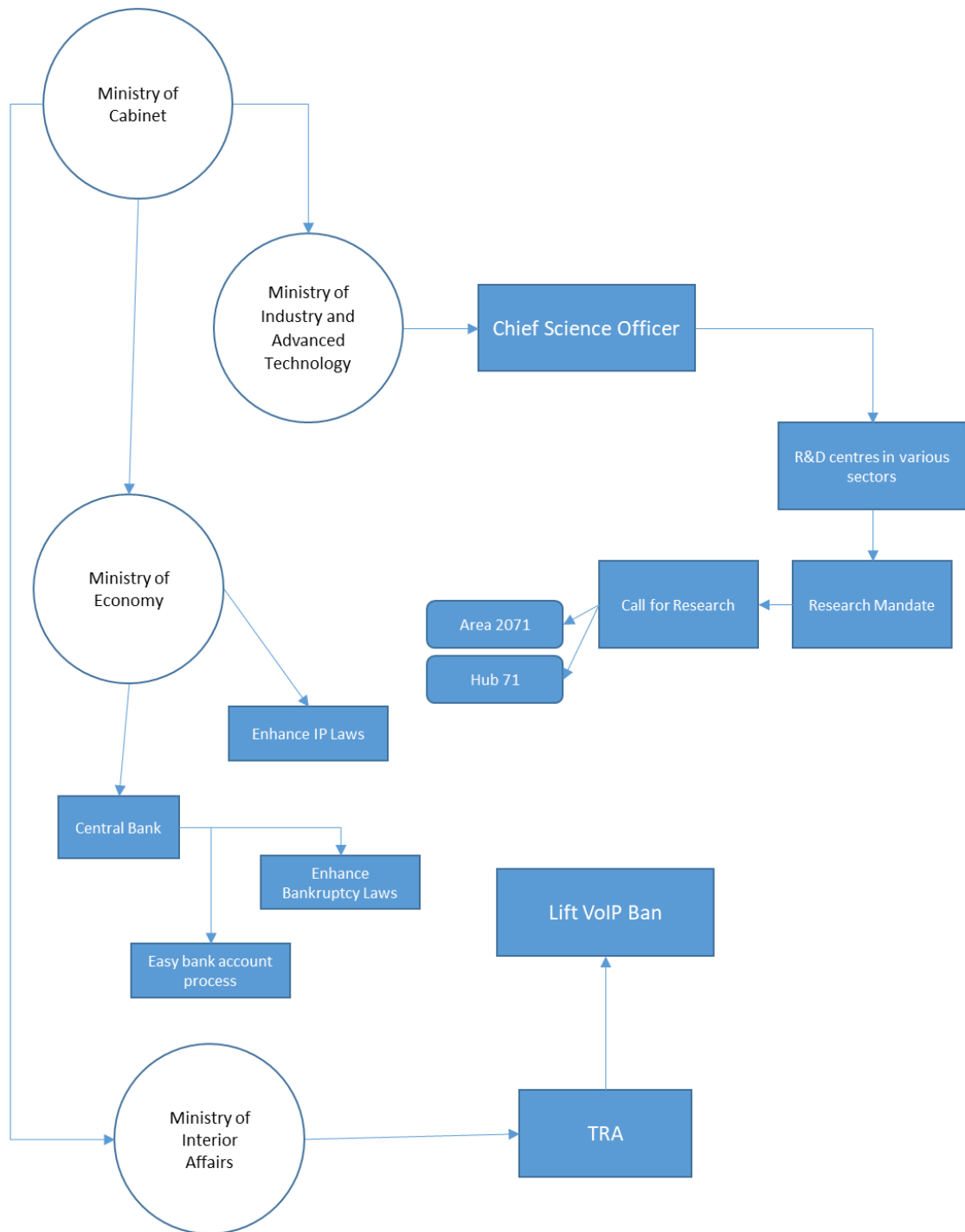
Figure 6.4: Law and regulation framework

6.5.5 The role of funding

Due to the high cost of doing business and living in the UAE, entrepreneurs cannot afford to try something new due to extremely high education costs. This issue becomes prominent when the entrepreneur or innovator has a family to support financially. The cost of setting up a business is high, which prevents entrepreneurs from investing in a risky idea. Obtaining funding is a hurdle for the development of an innovation ecosystem,

and the funds provided to nascent or emerging entrepreneurs by the government are not being distributed appropriately. Therefore, the funding needs to be strengthened, and channels must be created for international funds to be brought into the country to enhance the current entrepreneurship development.

It is proposed that the Ministry of Entrepreneurship and Small and Medium Enterprises sends a proposal to the Ministry of Finance to increase the innovation budget as a proportion of GDP. This proposal can then be then sent to the Ministry of Cabinet. When the funding budget created, it is fed to the Emirates Development Bank, Dubai SME, Khalifa Fund and the MBRIF. This then leads to the creation of venture capital channels. The Ministry of Industry and Advanced Technology can set up a clear research mandate, which can be used to source competitive research proposals and innovative business plans. Completed research will feed into future research aligned with the research mandates. The funding for venture capital channels will be provided in the form of research grants. Furthermore, there will be a quarterly or half-yearly evaluation of research initiatives and their scale-up potential. Based on this framework, the Department of Economic Development can provide cost subsidies based on innovativeness and scale-up potential. Finally, the Department of Economic Development can reduce the cost of doing business and provide subsidies to MNEs to establish R&D centres in the UAE.

Figure 6.5: Funding framework

6.6 Validation of the framework prototype

The framework was presented to six policymakers who are part of the national innovation ecosystem and are involved in innovation dialogue in some capacity. Feedback was solicited from these individuals with discussions regarding feasibility issues and other challenges in the framework. The feedback and suggestions are presented verbatim below:

- The framework is clear; however, it needs one macro framework, which is high level, that demonstrates the pillars of the ecosystem and how they interact with each other. Then you can go deeper into each pillar in more detail like what you did in your model. The links/relationships between components are mentioned in some places like; teach initiate actions, submit proposals and are not mentioned some other times. There needs to be consistency. There are several repetitive components. Like the incubators, for example. In your high-level framework, you can show the whole picture with no repetition first.
- First, it shouldn't go back to MOE, the HEIs should have their own autonomy to collaborate and supposed to have necessary enabling policies for collaboration and commercialisation, without the involvement of MOE. Second, the collaboration could be with government entities and/or private sector companies based on the nature of the problem, the owner of the problem, the clients, etc.
- I think the role of MoIAT and probably other ministry to facilitate and regulate but not get involved in R&D commercialisation or spin-off; their mandate will not help. In fact, it might add another step, which might not be necessary.
- Can be merged with R&D commercialisation.
- I would suggest tailoring a process map like a journey where you identify the starting point of attracting researchers/entrepreneurs, and then highlight the associated partners, processes, stakeholders, steps, regulators, customers.
- You may draw the journey/map; one at macro level and another one for each key component.
- The main goals here for the new structure is to simplify the process for outstanding entrepreneurs to incentivise them to come to the UAE and who is in the UAE to stay in it and expand from it.
- Also, we need to remove investors from this chart as they are not within the same category as entrepreneurs and researchers.
- So, here I prefer also in the structure for research it doesn't go back to the Ministry of Education to keep the higher education institutes to have their own

autonomy to collaborate with start-ups but Ministry of Education comes in to have the necessary enabling policies for collaboration and commercialisation.

- We should have more private sector engagement to be part in our committees based on the nature of the problem to be solved or the start-ups field.
- The role of ministries, such as a Ministry of Artificial Intelligence, [and] others, is to facilitate and regulate but not get involved in research and development commercialisation and spin-off[s], where their mandate may not help and may add another unnecessary layer.
- We need to add a commercialisation committee at the end to push it and consist of previous start-ups, VCs, public sector and private firms.
- Encouraging start-ups and have a clear one voice in the media to promote innovation in the UAE.
- Create a database of all creative ideas and current gaps to get creative ideas from [the] public via a portal.
- Work with academic institutions to promote tech entrepreneurship for the younger generation.
- Work in embedding innovation into the curriculum so that we can push the culture of innovation to the kids and grow it.
- Work closely with the Ministry of Youth to promote innovation and shifting the culture from being government employees to a start-up.
- The map is very good but there is no clear beginning and ending to the process. Also, it is better to have a council or committee at the beginning rather than having four Ministries.
- I feel it is very good but need[s] to be clear and easier with a very clear ending of the process.
- Here, maybe forming a committee including Dubai Media Incorporated, Brand Dubai, Abu Dhabi Media Corporation and other Emirates' national media, and other international media channels.
- To form a committee headed by the Ministry of Entrepreneurship and SME, having the main stakeholders such as the Ministry of Education, the Ministry of Industry and Advanced Tech, Ministry of Interior Affairs, Area 2071, think tanks, higher education institutes and private firms.

A primary theme from the feedback was that there is no clear ending or beginning to the framework and that the process journey is not clear. Another common aspect raised was the fact that there are too many ministries involved, which might make the overall process slow and highly bureaucratic to implement. To tackle this, the participants have

suggested the formation of a committee that will involve the key stakeholders. This will lead to the development of a streamlined process. In line with the feedback received, the initial draft of the framework was edited, and the process of the framework from start to finish is outlined in the next section.

6.7   A framework for the UAE to activate the national innovation ecosystem

Based on the insights that have been gained from the data, as well as past research and country analysis as discussed in the preceding chapters, one of the suggestions that emerged from this study was the appointing of a Chief Science Officer who will oversee the entire R&D mandate and innovation progress in the UAE. The Chief Science Officer will be responsible for directing R&D across various sectors by establishing a research mandate and calling for more research, which will further facilitate the research done in Area 2071 and Hub 71. Furthermore, within the framework, universities will need to have autonomy to collaborate. They will need to have policies to facilitate collaboration and commercialisation without the involvement of the MOE. This will generate a greater degree of collaboration with government entities and the private sector. Several government entities will also play a core role in the framework, but their role will be restricted to enablers. They will enable the private sector and the universities by relaxing several legislations that have been shown to reduce the rate of innovation and development in the country. These include, but are not limited to, lifting the ban on VoIP, creating a database of innovative ideas and current gaps in various fields of research, facilitating greater R&D commercialisation by relaxing bankruptcy laws and providing access to funding, enabling universities to provide a research career track by providing long-term visas and permanent residency options, enhancing IP laws for greater R&D collaboration, providing cost subsidies to the private sector based on their innovative capabilities and creating the pathway for research grants. Universities and the private sector need to display greater collaboration in the form of internships, placements and joint research. In addition, the universities will need to undergo a curriculum change. Hence, the framework, which is provided as a high-level view in Figure 6.6, followed by a more complex and nuanced view in Figure 6.7, will address the educational and research aspect of the current challenges as well as the legislative challenges (relating to visas as well as private sector) which hinders greater R&D in the country.
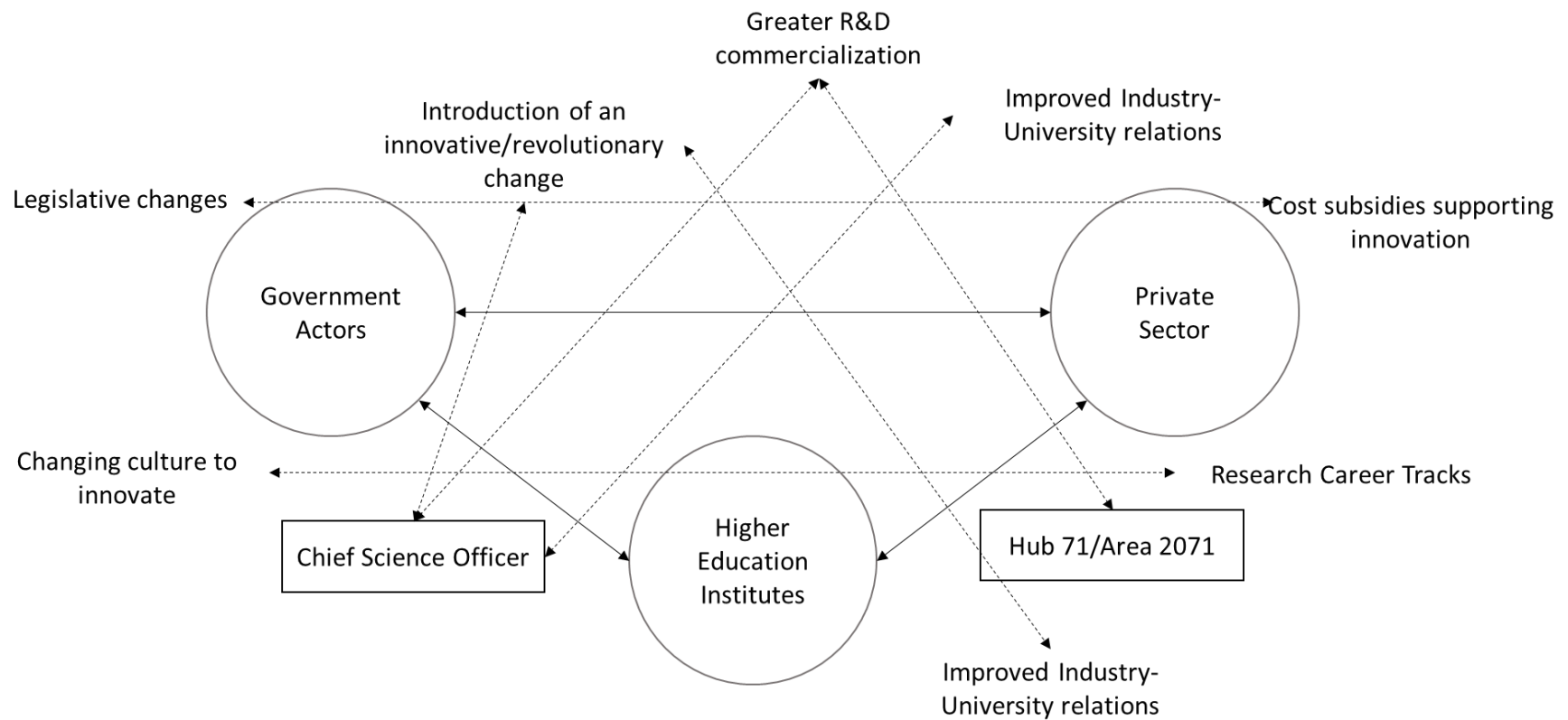
Figure 6.6: A high-level summary of the proposed national innovation ecosystem framework
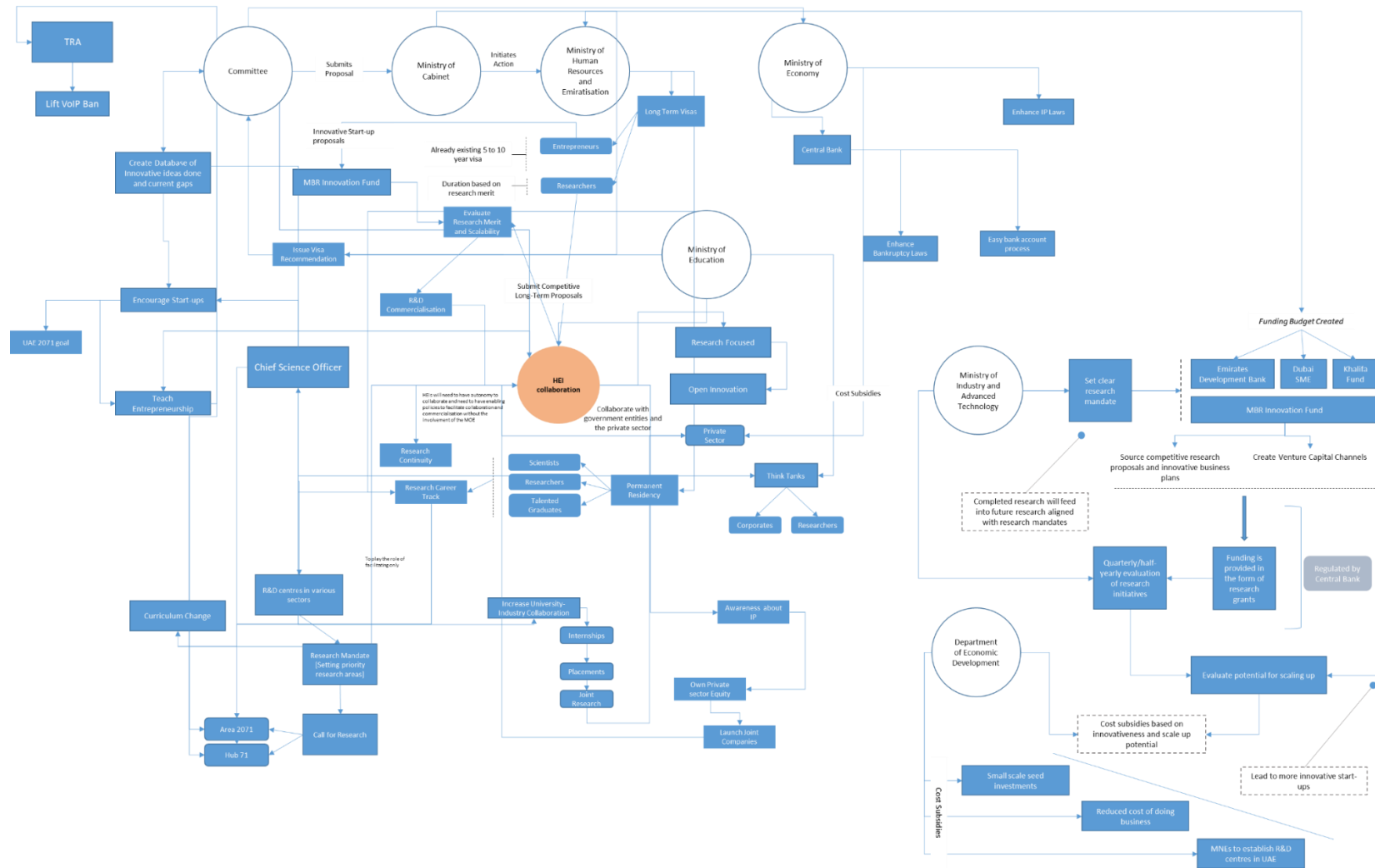
Figure 6.7: A national innovation ecosystem framework for the UAE

6.8 Contributions of the study

By developing a definition of the national innovation ecosystem, this study has provided a step towards the unification of the conceptualisation: *A national innovation ecosystem is an ecosystem that does not transcend a nation's boundaries and creates complex pathways of sharing knowledge, technology and information across various actors, organisations and institutions. This network allows continual reuse and recycling of potentially scarce resources. It promotes effective cluster development, sustainability and enhanced integration of educational and learning programmes. University–industry collaboration plays a fundamental role in the functioning of the ecosystem, and it is driven by cultural norms and practices that influence the actors, organisations and institutions in a geographical area. The national ecosystem will reach full potential when information flows across all its pathways, and when available resources are utilised efficiently.*

In a region where no such research occurs, this study has created new knowledge and furthered research in the national innovation policy research domain. The UAE is an understudied area, and this analysis will have important consequences for future academic studies on national ecosystems of innovation. However, the primary achievement of the present study is its potential for enhancing practice and influence policy making. What makes this research novel and particularly useful is that it is the first study that has developed an actionable framework, developed leveraging the expertise of key stakeholders, a critical analysis of the findings, and a rigorous validation mechanism. This research, therefore, has the potential to push the country towards faster economic growth and facilitate the transformation towards a knowledge-based economy by providing a framework for a national innovation ecosystem in the UAE. With the implementation of this framework at the policy-level, the UAE will fast-track its way to becoming a developed economy driven by a comprehensive educational system that encourages cooperation between the university and industry, creates people with skills that can push innovation and lead the way to scientific and technical innovation.

This study will encourage and support policymakers to make decisions that support and improve the UAE's economy, which is changing from oil-based to knowledge-based. An innovation ecosystem is a manmade, artificial system that does not undergo an automatic evolutionary process like a natural ecosystem does. So, a roadmap or structure needs to be drawn up detailing the crucial moving parts of a national innovation ecosystem, enabling policymakers to adopt strategic measures to make the ecosystem sustainable, as has been done in the present study. The establishment of a committee is suggested, consisting of various stakeholders such as the Ministry of Education, the

Ministry of Industry and Advanced Technology, the Ministry of Entrepreneurship and Small and Medium Enterprises, the Ministry of the Interior, the Ministry of Economy, the Ministry of Human Resources and Emiratisation, Area 2071 and Hub 71. This committee will provide a centralised body to oversee the national innovation ecosystem so that it can change rapidly and dynamically as the market and country conditions change.

7 Conclusion

7.1 Summary of the research

This research began with the primary aim of developing an education-based framework for the activation of a national innovation ecosystem in the UAE. The following objectives were established to achieve the primary aim: to understand why the UAE should create a sustainable (educational) innovation-based ecosystem, to evaluate how the UAE Government can best promote a successful national innovation ecosystem, to identify the main drivers (e.g., cultural, political, governmental, regional) that influence/hinder a sustainable (educational) innovation-based ecosystem and to propose a framework that the UAE can implement to activate its national innovation ecosystem. To achieve this aim, and meet the objectives, a complex mixed methodology was adopted. Specifically, the primary research questions were answered using a qualitative interview method, the results of which were validated using a quantitative survey. Insights received from the two datasets were then used to develop the prototype of the framework, which was further validated by conducting more qualitative interviews.

The concept of this research was embedded in the fact that the UAE is making an effort to transform into a knowledge-based economy from an oil-based economy. The launch of the National Vision 2021 outlined the goal to reduce reliance on oil-based sources of revenue and enhance the rate of R&D occurring in the country. As stated in the National Agenda, the Government of the UAE has outlined key aspects for its transformation into a highly competitive knowledge-based economy, like driving R&D, increasing the rate and standard of education and driving innovation. In terms of R&D spending, it was identified that the UAE spent about 0.955% of its GDP on R&D activities at the end of 2016. There is a lack of disclosure about the actual amount spent and the output of the R&D activities in the country. Furthermore, there is very limited research carried out in the context of innovation in the UAE. Research suggests that a higher percentage of GDP spent on R&D efforts corresponds to a higher R&D output. The country has implemented Emiratisation, which outlines the mandatory inclusion of the local workforce into the private sector. This has been done to enhance the productivity and inclusion of the local workforce into the country. While the country is moving towards the development of an innovation economy, the efforts being carried out by the country at present need more cohesion. There needs to be a systematic plan if the country intends to develop into a true knowledge-based economy. Therefore, this research is providing the country just that. At the country level, this research outlines the broad steps that need to be undertaken to ensure that the national innovation ecosystem is activated and is

instilled into the very fabric of the country. This is important because research has identified that only through the development of integrative policies that include various stakeholders can there be an appropriate extent of knowledge absorption in the country. This will then lead to further strengthening of linkages and networking at the policy level such that the national innovation system of the country can be activated and transformed into an evolving ecosystem. Moreover, the extent of the networking and linkages will facilitate the flow of knowledge by engaging the internal and external knowledge flows, which are non-linear in nature, and lead to greater investment in R&D across the country.

One of the core aspects that need to be considered here is that research should increase the commercialisation of the research initiatives, which should fuel additional research. When this cycle is generated, with linkages between internal and external stakeholders at the policy level, the national innovation ecosystem will be activated. Additionally, there needs to be a process of continuous recovery and recycling to prevent losses for both the research and commercial economy. Moreover, to promote a higher innovation capacity and greater sustainability in the face of a non-linear and dissipative ecosystem, the quality and quantity of collaborative partnerships must be augmented, which will in turn increase innovation capacity. Therefore, the innovation ecosystem is presented as complex pathways, which are interdependent business models that continually engage in the recycling of resources.

The role of learning and education, which are an indisputable part of any national innovation system, are a focus of this study. This is because the role of the educational infrastructure is such that its strengthening will ensure that there is sufficient knowledge being produced in the economy, which will ultimately lead to its growth and development. Schools and other learning centres, such as higher education institutes, form an intense network of connections that enable information sharing, technological development and support the commercialisation of unique R&D efforts. The influence of market forces, value transactions and complex interactions, which are considered hallmarks of innovation ecosystems, have not been investigated in the UAE. Thus, this study considers the interactions of internal stakeholders, market forces and other complex interactions to form a core part of the national innovation ecosystem plan. While this discussion has outlined some of the core reasons for this research, further exploration of the same is deemed necessary. The discussion below includes the conceptualisation of the national innovation ecosystem, followed by a brief summary of the results that outline the specific context of the UAE, something that has not been done in this research field before. The proposed framework is discussed, as well as its validation and revision.

7.1.1 Overview of the methodology

This research focused on understanding the current UAE ecosystem and what changes could be implemented to develop a robust national innovation ecosystem. This research is novel, so the literature available was scarce. The UAE's innovative ecosystem, whether it exists or needs to be established, was yet to be explored. The central question that guided the research was an understanding of the measures that could best promote a successful national innovation ecosystem in the UAE. This study investigated the current condition of the (educational) innovation-based ecosystem in UAE, the need for the creation of a sustainable innovation-based ecosystem and identified the various factors that impact the development of the ecosystem. It is important to note here that the quantitative data was completely descriptive in nature. The study also considered the qualitative analysis and drew upon a more subjective approach based on interpretive philosophy.

A national innovation ecosystem will serve the ambition of the country and make it a self-sufficient and growing economy. Such an ecosystem will enhance knowledge-sharing activities, promote alliances between the clusters and the academic institutions. This sort of collaboration will also enhance the optimal use of scarce resources.

7.1.2 Origins and conceptualisation of the national innovation ecosystem

The concept of a national innovation system was first proposed by Freeman in 1982 but was based, in part, on the ideas from List (1841). This conceptualisation of the national innovation system was carried out as a response to the neoclassical theory of economic growth. This theory was thought to be inaccurate in predicting economic growth because it did not consider technological change and innovation, even in economies that are substantially driven by science and development. Thus, for Freeman, and later Lundvall, the role of technology and innovation was of crucial importance because of the establishment of the industrial revolution and because these scholars were inspired by the Schumpeterian view of innovation. The early work on the idea of national innovation systems focused on companies (big and small), as a central agency for the production and commercialisation of innovations. Other major institutional actors have a central but supporting role to play in this regard. Policymakers enable creative businesses using incentives and regulatory assistance, while universities grow fresh innovations and expertise to repopulate the high-speed high-tech industries' entrepreneurial ecosystems and R&D divisions. However, associations among primary institutions, specifically

across universities and industry remain important, and the national identity of the innovation system remains predominant in these concepts.

There was a lack of literature investigating the main national innovation framework at the time to define and explain, beyond its alleged and somewhat ambiguous 'educational' position, the activities of the organisations identified as other public and private organisations. Drawing on the network of possibilities provided by collaborative learning, an evolving strand of literature on innovation systems—technology innovation systems—began analysing individual actors and organisations from an intermediary perspective: companies and organisations that would promote the exchange of knowledge by connecting (i.e., bringing) common and complementary actors. The existence of intermediary companies that serve as 'bridging institutions' has been proposed; in particular, industries whose purpose is to draw on collective expertise to address individual companies' problems. The private sector's contribution to the national innovation framework is, therefore, undeniable. These intermediary organisations' information flows between policymakers and innovators are facilitating. These intermediaries are institutional players that are likely to help form the overall system of innovation. Network-related information is scanned by intermediaries, gathered and bundled and then exchanged with network participants. Such details could include existing and emerging technology, new products and procedures, new legislation and future competitors and partners. Intermediaries may contribute directly to the creation or growth of this network by exchanging information with network members. The intermediary acts to bring together similar and/or complementary players, and decides which acting players can join and maintain a role in the network and, thus, make it easier to spread technology. Promoting network principles may also contribute to the collaborative culture and structural characteristics of the network. When a collaborative partnership has been formed between network members, intermediaries may support and promote the collaboration process. This can be achieved by understanding the parties' evolving collaborative needs and encouraging the recognition and fulfilment of their respective needs by promoting the growth of the partnership. However, the role played by private sector organisations in national innovation systems research is limited in research. It could well be due to the negative connotations of the business groups that are not part of this early literature of innovation structures. The latter are known as controversial players in growth and innovation.

Early frameworks were largely drawn from countries with successful national innovation systems. For example, previous research examined the national innovation structure of Japan, which had less support for fundamental research, and much less emphasis on

university-led research. Government and industry collaborations have concentrated on providing regulatory security and funding to applied research in particular industries (e.g., automobile companies and consumer electronics). The US economy's alleged deteriorating resilience has been attributed to a national innovation framework providing strong governmental support for critical science; a high level of defence spending, which has contributed to the creation of research; and a system for the academic research, which has effectively linked fundamental research activities to emerging technologies. At the same time, it proved especially powerful and productive in promoting R&D funding from the private sector, with an industrial base dominated by larger corporations engaged in chemical and advanced machinery, such as Germany, Sweden and Switzerland (manufacturing and defence). In comparison to other Western European countries, the OECD countries such as Italy and Portugal have relatively poor national innovation structures. After considering the Japanese, US and Western European economies in many fields of technology, work on a national innovation system concept quickly focused on the fast-growing East Asian economies; in particular, South Korea, Taiwan and Singapore. Although these countries had significant differences, some parallels were visible in their national innovation frameworks. This included government involvement and funding for the main manufacturing sectors, carefully designed policies to support international technology reverse engineering and eventual technological breakout by latecomer companies, support for patent defence, public education and the creation of a technical workforce. These East Asian national innovation programmes have enabled and driven national innovation strategies that effectively balance the protectionism of key, system-open indigenous industries by enabling these industries to introduce, leverage and develop advanced technology and organisational practices. The so-called Asian Tigers have been divided into the underperforming industrialised economies similar to those of Latin America, which have also been studied in national innovation structures, into an effective government strategy towards developing national innovation capabilities. Although many developing countries are experts in technology, they often work alone in different sectors, as defined by the national innovation system concept, in an integrated system of institutions.

The implementation of the national innovation system to develop nations is complicated due to so-called over-regulatory trend of the national innovation system concept. It is, in other words, viewed as an inefficient road to business growth and maturation as a whole, which often quickly corrects them. Implementing a national innovation system might be difficult in countries that are focused on slowly evolving and less technologically advanced industries, and that there is no existing strategy to address this in existing

national innovation system structures. Acquiring the heterogeneity of national innovation structures across newly developed countries and highlighting the engagement between institutional actors to promote collaborative learning to innovate is necessary to create innovative systems for both the recovery and sustainable growth of the economy.

As the idea of the national innovation framework was embraced as the political precondition for catch-up, early conceptualisations of the national innovation system were increasingly criticised for being too unclear and vulnerable to misinterpretation to the point where they were impractical. This led to the emergence of many frameworks that considered innovation as being present at levels other than nation-states. This was based on innovation system theories and ideas of collective learning and pathological dependence.

Approaches to innovation systems not only looked at how they promote the appearance and spread of innovation but at the degree to which they are successful in doing this, outside the largely systemic context provided by the national definition of the innovation system. It proposes a functional approach for innovative systems, which first defines the fundamental functions of the efficient innovation system. It then assesses the relative importance of different functions and interactions related to the innovation process, as well as the growing potential of a specific innovation system. Based on a number of previous studies using a functional approach to systems innovation, a list of seven primary roles outlined to support successful innovation systems was identified: (1) entrepreneurial activities, (2) collective learning, (3) network dissemination of information, (4) technology selection/promotion, (5) market formation, (6) resource mobilisation and (7) technology legitimacy/overcoming resistance. In this context, it is the national government that initially stimulates business activity and then answers the needs of emerging technology manufacturers and the requirements of a vulnerable yet emerging market. In addition, business groups are identified as lobbying governments for greater rewards and market conditions on behalf of entrepreneurs and industry. Although they are not identified as such, industry associations play the role of institutional intermediaries.

Researchers have turned away from newly formed East Asian economies to concentrate on China's, India's, and to a smaller degree Brazil's, large and rapidly developing economies. China's 'open door' policy in the late 1970s and market reforms in the 1980s and 1990s, and India's liberalisation policy in early 1991, helped establish the two countries global economic powers. Although the policies of the two countries varied somewhat due to their historical and national backgrounds, the methods used for catch-

up purposes were quite similar. These included: greater openness to international trade, denationalisation of some industries (China), opening up of indigenous industries to global competition and greater support for private enterprise and business activity. These strategies were implemented alongside policies to improve technology, maturity and the global orientation of indigenous industry. Those policies are strongly reminiscent of Japan and the recently developed countries of East Asia's earlier ratcheting strategies. The policies included programmes and incentives for the aggressive adoption of international production technology, the gradual decentralisation of national R&D activities from government institutes and universities into business enterprises, the promotion of partnerships among indigenous and foreign companies and the development of numerous business and science parks.

Different national innovation systems can exhibit different capabilities and competitiveness. They engage with an increasingly global economic environment, which dates back to the earliest iterations of the idea of a national innovation system. However, while international links become increasingly relevant, the institutions that govern these connections are largely national. This is the overall feeling in national innovation systems literature. Faced with institutional shortcomings, intermediaries, such as industry organisations, must be essential players that collaborate with policymakers to establish healthy business environments for the growth and innovation of industry.

The OECD has outlined the significance of understanding the national innovation system as it can enable policymakers to enhance the innovative competence and general competitiveness index of a nation. The OECD identified reasons for poor innovative performance in some countries: no interaction taking place between the various actors of a system, a lack of balance between research in the public and private sectors, faulty processes of technology diffusion and a lack of knowledge and technology absorption at the firm level. For developing countries, using global knowledge flows is essential for them to catch up with technology and be on par with the rest of the world. The innovation output is positively influenced by internal knowledge flows and external knowledge flows (the latter being non-linear).

More recently, the concept of a national innovation ecosystem has emerged, which is a system that can reach a state of equilibrium when the two economies (research and commercial) contribute to the growth of each other. There needs to be a process of continuous recovery and recycling to prevent losses for both the research and commercial economies. There should be an innovation cocktail in the ecosystem,

consisting of knowledge, IP, marketplace knowledge, human capital and innovative ideas to regulate and maintain the equilibrium.

Using the term innovation ecosystem as opposed to innovation system is increasing due to the similarity between an innovation event and innovation structure. There are three primary components that make up the innovation ecosystem: cluster development, university–industry collaboration and a culture to innovate. An innovation ecosystem is a dynamic system. It is ever-changing and cannot be directly governed by policies and needs a balance between the public and private sectors. In keeping with this emerging conceptualisation of a national innovation ecosystem, and the issues identified in the past conceptualisations, the present research has attempted developed a theoretical conceptualisation of a national innovation ecosystem, which also addresses the gap in consideration of institutional intermediaries: *A national innovation ecosystem is an ecosystem that does not transcend a nation's boundaries and creates complex pathways of sharing knowledge, technology and information across various actors, organisations and institutions. This network allows continual reuse and recycling of potentially scarce resources. It promotes effective cluster development, sustainability and enhanced integration of educational and learning programmes. University–industry collaboration plays a fundamental role in the functioning of the ecosystem, and it is driven by cultural norms and practices that influence the actors, organisations and institutions in a geographical area. The national ecosystem will reach full potential when information flows across all its pathways, and when available resources are utilised efficiently.*

7.1.3 Benchmarking of developed countries

Insights from the evaluation of various highly innovative and developed countries also supported the development of the framework. For instance, in the initial stages of South Korea's economic development, it relied almost exclusively on foreign technology exports. The South Korean Government noticed the lack of R&D investment and therefore, established the KIST. The government increased the creation of large firms and implemented a reward scheme for good economic performance and penalised bad economic performance. In 1996, South Korea joined the OECD as an important part of its liberalisation strategy. The OECD identified several new policy agendas for South Korea to undertake in an attempt to build a strong national innovation system. According to the OECD, by 2000, Korea was playing catch-up with the other countries in terms of economic growth. In 2005, it was identified that the national innovation system of South Korea was stronger, in terms of producing patents, than the Netherlands. South Korea still appears to be transitioning to a knowledge-based economy. South Korea has

implemented, and plans to implement, initiatives that will increase the rate of entrepreneurship and research. South Korea is also creating an environment that fuels innovation by reducing the stress of testing in schools at the middle and elementary levels.

Germany was the first countries to develop the research-oriented university. One of the pioneers of the national innovation system, Friedrich List, was a German national. There was a conflict between the promoters of innovation and production and the promoters of the old autocratic order. The early German government played a major role in the catching up of German technology and innovation through government-funded learning and development programmes. By the turn of the 20th century, Germany had developed one of the most advanced education systems in the world. The industrial development of Germany started with the beet sugar industry and rapidly expanded to include pharmaceuticals by the end of the next century. The research levels in Germany rose tremendously, especially in fields such as medicine and physics. The rapid industrialisation that took place in Germany began to show economic results by the beginning of the twentieth century. In the following years, there was significant growth in Germany's economy. However, better university–industry collaboration and better quality higher education was needed; this has shaped the German innovation systems that we see today.

In terms of Switzerland, since the economic crisis in 2009, the Swiss economy has stabilised and is in a state of steady growth. While the country's innovation and R&D systems are top ranked among the other OECD member states, there is no widespread knowledge transfer or sharing. The government could focus on creating a culture of innovation in the country through integrated educational advancements. The trend in R&D investment in Switzerland has been positive. The country has become one of the highest spending countries in terms of R&D spending since 2010. However, there is a wider gender gap in Switzerland than in any other EU country. The education system of Switzerland is touted as one of the best in the world. There remains a gap in the high-skilled sector.

Singapore has developed its innovativeness and competitiveness due to two reasons: its focus on building educational capability and its global openness. The country set up two clusters to replicate the success of Silicon Valley in the US. Singapore's education system focuses on building skills that can match the changing global market and innovative environment. The innovation infrastructure of Singapore is one of the most advanced among the Asian countries, and the government consistently works towards

building innovation capabilities. The goal of this development was to establish complex but informal pathways to share knowledge and fast-track scientific and technological progress. It's the most ambitious R&D infrastructure support project attempted by the government to date. The country has also established a site where innovations can be tested before they are released into the market. The linkages and sharing of information across various stakeholders are very strong in the country. The Government of Singapore is increasingly playing a major role in its development as an innovation hub by creating and implementing specific policies.

The Singaporean education system is driven by efficiency and creates a culture of innovation. The use of streaming has been beneficial as it allows students to study at their own pace and encourages learning and development. The education system has moved towards an individualised approach. The country launched a vision that encouraged thinking and learning as essential capacities for the people of Singapore. The slogan of this movement is 'Thinking Schools, Learning Nation'. This movement was designed to provide greater flexibility in term of time and areas of study. Hence, the focus shifted towards capacity building and ensuring that there is sufficient creativity, innovation and research in the education system. The top-down system of management was removed, and leaders were established to manage each school cluster. Singapore has come a long way in its goal to build an education system that encourages learning, creativity and innovation. It has done so by maintaining a close collaboration with policymakers, researchers and educators. The education system is tightly coupled; a change in one sphere results in all spheres. The human resource needs of the country match the manpower requirement. Overall, the country has displayed strong growth and development, especially in the technology sector, by creating an open economy and by establishing a unique and highly effective education system.

The US education system tends to lag behind other advanced education programmes. Until it can guarantee that the assessments it uses determine what students should learn; the available instructional resources match the curriculum that teachers should be taught; the schools of education train teachers to teach what the state wants students to learn; there is a pool. The US has several programmes underway to resolve many of these issues in areas such as quality evaluation, training materials and support, recruitment of high-quality teaching applicants, alignment of teacher readiness with classroom needs and alignment of student learning requirements with the preferences of employers and colleges. The US needs to pay careful attention to the coherence of these initiatives as they grow, to promote successful implementation at national and local

levels. No reason has been found to explain how a country with a comparatively weaker education system can have such a high rate of innovation.

The amount of knowledge available on the national innovation environment in the Netherlands is scarce. However, the evidence available points to a secure structure with a solid backbone for education. The R&D collaboration between universities and industry needs to be improved and complicated pathways for knowledge sharing and information sharing need to be developed. The emphasis should change from development that promotes business as a pioneer in the industry to seeking new avenues for creating innovative solutions.

Finally, Sweden is a nation that has become synonymous with gender equality in all aspects of life. The country seems to be a leader among the other OECD member states in terms of innovation as well. The country invests a greater percentage of its GDP in R&D efforts, showing a dedication to improving its creative competitiveness. The Swedish education system has been promoted as one of the best in the world, characterised by higher-quality education that focuses on providing individuals with useful skills. Despite being a decentralised system, student performance is excellent. Since agriculture plays an important role in the economy of the country, Sweden promotes links between universities and industry to drive innovation in the agricultural sector. Life sciences, electronics and pharmaceutics are other industries that encourage innovation. The country also encourages universities to establish partnerships with industry. The country is leading the way in creativity, education and equality with its emphasis on renewable energy.

7.1.4 The context of the UAE: Results from the interviews

A total of 24 participants were interviewed using semi-structured interviews. These individuals are stakeholders of the national innovation ecosystem of the UAE. The interviewees included a Chief Strategy Officer, Entrepreneurs, Researchers, Business Leaders, Financial Advisors, Educators and Investors. By interviewing these individuals, it was identified that the UAE has placed a considerable focus on innovation. That is, innovation is at the core of the UAE's aspiration to become one of the leading countries in the world by 2071. The data indicated that His Highness Sheikh Mohammed bin Rashid Al Maktoum -Vice President and Prime Minister of the United Arab Emirates (UAE), and ruler of the Emirate of Dubai- has launched a directive mandating that 1% of the public sector budget will be directed towards innovation. Several innovation-focused initiatives have taken place, and the government is providing funding to foster innovation

in the country. The country has also offered million-dollar prizes for those undertaking innovative projects involving drones or robotics. These initiatives clearly demonstrate the country's commitment to innovation and have received much attention from the leaders and government. This thesis concludes that there is considerable focus on innovation as a driver to advance the nation towards becoming a knowledge-based economy. The UAE has placed consistent emphasis on innovation and has a national innovation strategy for the Year of Innovation. It has also set a target to become the best country in the world in 2071.

The UAE Government has lowered the initial start-up costs. The country is making great strides in terms of innovation research, as is evident from its investment in R&D. According to interview participants, substantial efforts and significant advances have been made in the UAE within a limited period of time relative to other countries. The UAE Government is ambitious and has made substantial investments in innovation research and start-ups. Participants have addressed funding for R&D projects undertaken by a number of government bodies. In addition to financial support and positive government support, innovation programs have been undertaken, such as Hub 71 & Area 2071. The initiatives implemented by the MBRIC have focused on driving innovation in both the public and private sectors. The MBRIC is encouraging the culture to innovate in the country by encouraging the students to work on innovative projects and experiment with new ideas.

While there are a number of projects, innovation programs and government policies, the current conditions may not be sufficient to trigger the national innovation ecosystem. There are many barriers to the establishment and development of collaborative ecosystems. Significant investment has been made in innovation projects, but with little ROI. The emphasis was on improving tools and technology rather than shifting people's thinking. In terms of university-industry cooperation, secrecy is one of the greatest obstacles. The leakage of sensitive information is a risk that hinders such alliances. There is little contact between industry and universities that hinders teamwork and collaboration. Both the university and industry deny the possible contribution that others may make to collaborative R&D.

Universities in the UAE are not focused on R&D activities and the teaching philosophy is tied to traditional curriculum-oriented learning. The traditional curriculum has little influence on practical learning and students are not encouraged to try new ideas or take risks. The culture of the country undermines the importance of risk-taking. A risk-taking mindset is not infused by the education system, which hinders new innovative ventures

from the individuals. The UAE needs to make a clear distinction between educational universities and research universities. The education institutions are more focused on academic promise; that is, attaining degrees. Moreover, the UAE does not have a legacy of connecting university and industry in comparison to other countries. In other countries, universities often receive financial support from the companies for undertaking R&D. This type of support is not observed in the UAE. According to one participant, there are no incentives for universities to create original knowledge. Universities in UAE are not designed to solve real-life problems and, thus, companies are not approaching universities like they do in regions like Europe and in North America. There is no serious attempt to promote R&D collaboration between industry and the university in the UAE; there are no knowledge transfer channels between the university and industry sectors. The challenge is not in the inadequacy of funding, but rather the lack of initiatives from industry and academic institutions.

Lack of incentives is also one of the obstacles that impede cooperation between universities and industry. Governments must play an active role in encouraging universities and companies to work together on R&D projects and provide incentives for innovative technologies. At present, the initiatives in the UAE are very scattered and limited to smaller pockets. Initiatives should be scaled to a level where various stakeholders can come together, brainstorm, generate new ideas, explore them and produce creative production. In the absence of an appropriate R&D budget and financial support from investors or governments, innovation does not take shape and achieve its desired objective. Very few UAE universities have scope for interaction. In the absence of sound policy requirements, academic institutions are lagging behind in creative efforts. The lack of genuine industry involvement hinders the establishment of collaborative R&D partnerships between universities and industry. There is a lack of genuine effort from both industry and academia to foster initiatives around R&D. Without a two-way effort, innovation cannot reach its full potential and meet the goal of creating an ecosystem for the country.

Other problems for the UAE include the shortage of long-stay visas and the arrangement of citizenship. One of the reasons why innovation is not encouraged in the UAE is the lack of an adequate visa structure to promote long-term study. Citizenship is not a choice for expatriates, which hinders the creation of a greater push for innovation in the region. Singapore offers a route to permanent residence, which is different from full citizenship, but allows talent to feel that they have a place to which they belong, said the participants. It is difficult for talented individuals to justify investing their lives and their time in something that feels impermanent. This lack of permanence discourages a lot of people

from investing and maintaining their assets in the UAE. Temporary residency in the UAE would not help to draw the best minds in the rest of the country. The UAE is not a place they can call home, and they see places like Canada, Australia, or the US as the ultimate destination.

The shortage of resources and the high cost of living in the UAE are a problem for innovators. Occasionally, entrepreneurs cannot afford to withdraw their wages from their company in the first few months or even years. Many companies are financed by former owners, who have flourished and sold their businesses and made a lot of money. The cost of starting up a company and the cost of living are the key factors that impede the emergence of entrepreneurs. It is not possible for individuals to participate in practical innovation without strong financial support. The role of banks is not helpful because they typically function as an equity investor, but at high interest rates. If the business defaults, the banks have first access to the firm's properties, which discourage many innovators from beginning their creative ideas.

Government initiatives are run at government level only and do not trickle down to the private sector. The private sector does not seem capable of directing innovation due to a lack of appetite for risk-taking. The private sector should play a bigger role in what the UAE Government is trying to achieve, but currently, their involvement is limited. Dubai has established a very rigorous, very attractive infrastructure to attract the private sector to work with the government, but there is a mismatch between the private and the public sector.

Several market-level factors were also identified by the participants as being challenges in the UAE's innovation ecosystem, including the cultural orientation that creates different expectations for students. In the schooling system, UAE nationals are not studying in the same schools as expatriates. This is limiting the potential for creativity that can be fostered by interacting with people of different mindsets. The career orientation of the parents is also an influencing factor.

There is not much research taking place locally in the UAE, according to participants. The legal and regulatory environment of the nation is also a hindrance for the effective implementation of an innovation ecosystem. There is a mismatch between the public and private sector in that the public sector is conducting research at the government level only and not integrating the private sector. The cultural aspect and the limitations of the current regulatory and legal system have also been identified as challenges. Without mitigating the above challenges, establishing the innovation ecosystem in the country will not be feasible.

7.1.5 Validation of the survey results

The following results were validated from the survey: long-term research is limited due to the current visa structures in the UAE; one of the challenges for entrepreneurs flowing into the country is the lack of permanent residency options in the UAE; the contribution of the private sector in R&D is limited in the UAE; bridging the existing cultural separation between the students can lead to exposure to differing mindsets, which will further their innovativeness and creativity; setting up a business and obtaining funding for new ventures in relation to R&D is difficult in the country; there is a disconnect between the current legal and regulatory framework and the innovation dialogue in the UAE; the cost of doing business needs to be reduced; venture capital funding needs to be strengthened; government funding for research needs to be provided; subsidies for entrepreneurs in helping them manage their costs need to be provided; R&D funding that is provided needs to become more competitive with the application of research grants; promoting a culture of entrepreneurship is a core pillar of ensuring entrepreneurship sector is strengthened; risks associated with entrepreneurship should be taught at school and university level to generate more awareness of the same; it is better to establish research centres with clear mandates, which will then attract funding rather than making funding available and calling for more R&D; collaboration between large corporations that have an R&D function and the government has the potential to increase; better skill development through the process of education is essential to ensure an increasing rate of innovation; international mentorship programmes for teachers and educators can enable them to develop an innovative workforce at the school level; incoming talent has to be retained in the country for longer with the use of longer-term visas; appointing a Chief Science Officer would be useful to ensure research is taking place effectively; innovation can be facilitated in the country with the implementation of think tanks; transforming the education system to one that promotes creativity and innovation rather than rote memorisation can enable increased R&D in the country; allowing students to explore avenues in innovation and creativity has the potential to increase the rate of innovation in the UAE; the implementation of vocational education programmes would be useful for the country's innovation capacity. There were 230 survey respondents, who all played some role in the innovation ecosystem of the UAE. In addition to the quantitative survey results, these respondents were also asked to provide suggestions to facilitate the activation of the national innovation ecosystem of the UAE. Their suggestions included: government departments can play a key role on R&D in different domains where they are dealing with a large scale of customers; the UAE needs to create a databank of talented people worldwide to attract them to the country; we need to focus

on preserving and protecting our values, which will have a positive long-term influence at the personal, social and economic levels. In addition, it was noted that the talent pool is wide, especially in universities, where students are keen on spending their time learning and researching new ideas. Moreover, there is a need to empower UAE nationals. Research and innovation are either minimised or used for job purposes only, and the private sector should lead the innovation process. Make sure people stay in the UAE by offering perks such as long-term residency, healthcare, pension, etc. In addition, the UAE should become a testing lab for entrepreneurships, which means regulations should be eased. Moreover, the results indicated that the UAE Government, in collaboration with universities and colleges, should come up with educational changes that will nurture innovation in the country. The UAE's higher education institutions should develop future academics to ensure sustainable research in universities. Special incentive packages should be developed to attract the best minds to the country.

Some of the participants had noted that entrepreneurship, nowadays, is mostly related to apps and ICT businesses, which, in general, have a 95–97% chance of failure. It is better to concentrate on R&D, biotechnology, biomedicine, robotics and AI as these are long-term projects. Innovation in the UAE needs to be more results-focused and less gimmicky/flashy. Core issues such as climate change need to be addressed before robotics and Mars missions.

A huge element of innovation is tolerance, and the UAE needs to do more around this. The UAE needs to walk the talk of tolerance through openness to ideas from both citizen and residents of all ages and backgrounds. Enabling this element will promote an appetite to experiment and identify the most suitable innovations for various sectors. Introduce a special mandatory innovation competition in different fields in UAE that must be done annually.

7.1.6 Activating the UAE's national innovation ecosystem

Skill development through education was identified as one of the core inputs that will be required by the UAE to ensure that it develops a national innovation ecosystem. Participants suggested that the schools and universities in the UAE need to reform the current education system. Adopting the South Korean example will also prove to be beneficial for the UAE. However, it was found that the UAE's education system still largely promotes an exam-based, non-applied and non-curiosity-based thinking. The education system needs to support self-learning, encourage independent learning, and initiate risk-taking to empower students to create and innovate.

Furthermore, the transfer of knowledge to the firm can be facilitated by allowing industry leaders to be part of the curriculum development process. The UAE can also adopt the practices of Switzerland, which is said to have one of the best education systems in the world. The Singaporean education system encourages and motivates learning, creativity and innovation by maintaining a close collaboration with policymakers, researchers and educators. Such a collaboration in the UAE will ensure that there is a greater alignment between the education sector and its industry.

The new education system in the UAE is not oriented towards the generation of creative individuals. More emphasis is on rote memorization, which is not an invention model. Universities need to cultivate talent, provide guidance on cultural aspects, and provide students with information that will enable innovators and entrepreneurs to use appropriate platforms, access a variety of data, and develop their innovations. The country needs to strengthen the framework of technical education because it is difficult for a professional education certificate to be recognized instead of a master's degree. Universities are not focused on R&D activities, and the teaching philosophy is tied to traditional curriculum-oriented learning. The culture has failed to encourage innovative zeal among individuals. This is because, traditionally, there has been a very strong mandate from UAE representatives to graduates to represent the government. In the absence of sound policy standards, academic institutions have lagged behind in creative efforts. Early exposure to key aspects and values of entrepreneurship through education is critical. The Government needs to set up innovation centres with a strong mission and comprehensive R&D to achieve those objectives, which would then need to be financed.

In addition, creativity should be driven in students from a young age in a similar approach to the one taken by the Netherlands. The need to strengthen the education system of the UAE stems from the fact that, when the economy establishes a sound and organized education and research system, it inevitably increases the diffusion of creativity and knowledge from other ecosystems. By increasing R&D investment and the the contribution of the private and public sector to R&D, the UAE will move closer to realizing its aim of transformation to an innovation-based economy. Moreover, the high turnover rate of teachers hinders the establishment of strategic alliances and hinders the growth of R&D. The UAE needs to provide teachers with enough higher wages to ensure that they remain motivated to teach. The government should also strive to improve the understanding of the teaching profession.

The UAE needs to implement a long-term visa plan for key individuals such as entrepreneurs, investors and researchers. This should be done in conjunction with a path

to permanent residency, similar to what Singapore has achieved. The UAE has recently launched the five-year investor visa for entrepreneurs and investors. However, for researchers, the duration of the visa should be based on merit, and funding should also be provided. This can help bring the UAE closer to its 2071 goal. The government needs to take steps to ensure that innovative ideas are truly innovative and research-based. This will make the funding space highly competitive. There is a need to ensure that researchers have a longer time guaranteed within the country to encourage commitment to research. Participants of the study have noted that unless researchers feel connected to the country, they will not contribute to it. With the permanent residency pathway, individuals who are on a research career track can be attracted and provided this unique opportunity.

In the UAE, there is no serious attempt to promote R&D collaboration between industry and universities. The lack of incentives is one of the challenges hindering university–industry collaboration. Alliances must be formed internally, and collaborations need to take place among different institutions, industries and sectors within the country. The government must play an active role to incentivise universities and companies to collaborate on R&D projects and should offer rewards for groundbreaking innovations. Current initiatives are rather fragmented and are confined to the smaller pockets. These initiatives should be scaled up to a level where different stakeholders can come together, brainstorm, generate new ideas, explore them and create innovative output. Within this aspect of the framework, the Ministry of Education needs to appoint a Chief Science Officer, who is rotated every year or every two years, who focuses on increasing university and industry collaboration. This can be done using internships, placements and joint research programmes that are integrated with higher education institutes and the private sector. The Chief Science Officer will also oversee the think tanks, which includes the researchers as well as manage Area 2017 and Hub 71.

High education costs and high cost of doing business make it difficult for entrepreneurs to try something new in the UAE. Funding is another hurdle for the development of an innovation ecosystem. Venture capital channels must be created for international funds to be brought into the country to enhance the current entrepreneurship development. The Ministry of Industry and Advanced Technology can set up a clear research mandate that can be used to source competitive research proposals and innovative business plans. The Department of Economic Development can reduce the cost of doing business and provide cost subsidies to MNEs to establish R&D centres in the UAE.

7.2   Limitations of the research

One limitation of this research is that the study focused on qualitative information, which may be subjective. While the research has used quantitative data for validation purposes, the analysis was done mainly inductively. In addition, while the framework has been validated and is considered feasible, such a high-level framework to be applied at the country level will require high resource investment from the country. This has not been considered in the present research. Finally, due to this research being highly subjective and focused on the UAE, the results of the study cannot be generalised to the external contexts.

7.3   Recommendations

A primary recommendation to future researchers is that there needs to be an empirical study design to test the current scenario and provide future solutions for the country. The second recommendation is that the resource requirements need to be considered to evaluate the feasibility of the framework that has been proposed here. Furthermore, future researchers also need to conduct the study using a wider sample size.

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9   Appendices

Appendix A. Survey data from quantitative research

The current visa types in the UAE are not favourable for long-term research

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	9	3.9	3.9	3.9
	Disagree	23	10.0	10.0	13.9
	Neutral	74	32.2	32.2	46.1
	Agree	74	32.2	32.2	78.3
	Strongly Agree	50	21.7	21.7	100.0
	Total	*230*	*100.0*	*100.0*	

Due to the limited grants of citizenship to foreigners in the UAE, researchers and entrepreneurs are deterred from coming into the country

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	26	11.3	11.3	11.3
	Disagree	50	21.7	21.7	33.0
	Neutral	50	21.7	21.7	54.8
	Agree	61	26.5	26.5	81.3
	Strongly Agree	43	18.7	18.7	100.0
	Total	*230*	*100.0*	*100.0*	

The private sector is not involved in the innovation ecosystem nor in the R&D in the UAE in comparison to the public sector

		Frequency	Percent	Valid Percent	Cumulative Percent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	18	7.8	7.8	7.8
	Disagree	30	13.0	13.0	20.9
	Neutral	48	20.9	20.9	41.7
	Agree	78	33.9	33.9	75.7
	Strongly Agree	56	24.3	24.3	100.0
	Total	*230*	*100.0*	*100.0*	

Innovation and creativity are limited among students due to cultural & social segregation and the lack of exposure to different mindsets within the education institutions in the UAE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	18	7.8	7.8	7.8
	Disagree	42	18.3	18.3	26.1
	Neutral	49	21.3	21.3	47.4
	Agree	72	31.3	31.3	78.7
	Strongly Agree	49	21.3	21.3	100.0
	Total	*230*	*100.0*	*100.0*	

Setting up a business and obtaining funding for new ventures that depend on R&D is difficult in the UAE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	7	3.0	3.0	3.0
	Disagree	16	7.0	7.0	10.0
	Neutral	37	16.1	16.1	26.1
	Agree	83	36.1	36.1	62.2

		Frequency	Percent	Valid Percent	Cumulative Percent
	Strongly Agree	87	37.8	37.8	100.0
	Total	*230*	*100.0*	*100.0*	

The current legal and regulatory framework is tedious and not on par with the innovation dialogue that is being encouraged in the UAE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	5	2.2	2.2	2.2
	Disagree	26	11.3	11.3	13.5
	Neutral	58	25.2	25.2	38.7
	Agree	78	33.9	33.9	72.6
	Strongly Agree	63	27.4	27.4	100.0
	Total	*230*	*100.0*	*100.0*	

Government R&D funding is being strategically utilised to enable and encourage entrepreneurship mindset in the UAE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	12	5.2	5.2	5.2
	Disagree	50	21.7	21.7	27.0
	Neutral	91	39.6	39.6	66.5
	Agree	61	26.5	26.5	93.0
	Strongly Agree	16	7.0	7.0	100.0
	Total	*230*	*100.0*	*100.0*	

Leveraging emerging technologies, such as artificial intelligence technologies, is one way to improve the innovation ecosystem in the UAE

		Frequency	Percent	Valid Percent	Cumulative Percent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	4	1.7	1.7	1.7
	Disagree	10	4.3	4.3	6.1
	Neutral	24	10.4	10.4	16.5
	Agree	94	40.9	40.9	57.4
	Strongly Agree	98	42.6	42.6	100.0
	Total	*230*	*100.0*	*100.0*	

Promoting a culture of entrepreneurship is a core pillar of ensuring that the UAE's innovation ecosystem is strengthened

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	0.4	0.4	0.4
	Neutral	21	9.1	9.1	9.6
	Agree	83	36.1	36.1	45.7
	Strongly Agree	125	54.3	54.3	100.0
	Total	*230*	*100.0*	*100.0*	

It is critical to shift and transform the education system to ensure that the students and new talents are aware of the risks & opportunities associated with entrepreneurship

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	0.4	0.4	0.4
	Disagree	7	3.0	3.0	3.5
	Neutral	17	7.4	7.4	10.9
	Agree	70	30.4	30.4	41.3
	Strongly Agree	135	58.7	58.7	100.0

		Frequency	Percent	Valid Percent	Cumulative Percent
	Total	230	100.0	100.0	

Establishing a research centre with a clear mandate followed by attracting funds can be a better approach than making funds available followed by calling for more R&D

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	3	1.3	1.3	1.3
	Disagree	9	3.9	3.9	5.2
	Neutral	39	17.0	17.0	22.2
	Agree	66	28.7	28.7	50.9
	Strongly Agree	113	49.1	49.1	100.0
	Total	230	100.0	100.0	

The Government of the UAE needs to work with large corporations that have an R&D function

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	2	0.9	0.9	0.9
	Disagree	15	6.5	6.5	7.4
	Neutral	23	10.0	10.0	17.4
	Agree	72	31.3	31.3	48.7
	Strongly Agree	118	51.3	51.3	100.0
	Total	230	100.0	100.0	

Enhancing entrepreneurial skills through education systems is essential to increase the development of innovation in the UAE

		Frequency	Percent	Valid Percent	Cumulative Percent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	0.4	0.4	0.4
	Disagree	3	1.3	1.3	1.7
	Neutral	12	5.2	5.2	7.0
	Agree	73	31.7	31.7	38.7
	Strongly Agree	141	61.3	61.3	100.0
	Total	*230*	*100.0*	*100.0*	

Teachers and other educators need to be enrolled in international mentorship programmes to develop their capabilities in fostering an innovative environment at school level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	0.4	0.4	0.4
	Disagree	4	1.7	1.7	2.2
	Neutral	23	10.0	10.0	12.2
	Agree	83	36.1	36.1	48.3
	Strongly Agree	119	51.7	51.7	100.0
	Total	*230*	*100.0*	*100.0*	

Incoming talent must be retained in the country for a longer period via long-term visas

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	3	1.3	1.3	1.3
	Disagree	7	3.0	3.0	4.3
	Neutral	27	11.7	11.7	16.1
	Agree	64	27.8	27.8	43.9

		Frequency	Percent	Valid Percent	Cumulative Percent
	Strongly Agree	129	56.1	56.1	100.0
	Total	*230*	*100.0*	*100.0*	

Appointing a Chief Research Officer in organisations could be an effective way in ensuring that R&D is being conducted

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	5	2.2	2.2	2.2
	Disagree	22	9.6	9.6	11.7
	Neutral	51	22.2	22.2	33.9
	Agree	72	31.3	31.3	65.2
	Strongly Agree	80	34.8	34.8	100.0
	Total	*230*	*100.0*	*100.0*	

Research think tanks are crucial to fostering and growing the innovation ecosystem in the UAE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	4	1.7	1.7	1.7
	Neutral	26	11.3	11.3	13.0
	Agree	101	43.9	43.9	57.0
	Strongly Agree	99	43.0	43.0	100.0
	Total	*230*	*100.0*	*100.0*	

The current education system in the UAE sufficiently promotes a culture of innovation and creativity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	26	11.3	11.3	11.3

		Frequency	Percent	Valid Percent	Cumulative Percent
	Disagree	71	30.9	30.9	42.2
	Neutral	68	29.6	29.6	71.7
	Agree	44	19.1	19.1	90.9
	Strongly Agree	21	9.1	9.1	100.0
	Total	*230*	*100.0*	*100.0*	

Universities in the UAE need to allow students to explore different innovation and creativity opportunity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	4	1.7	1.7	1.7
	Neutral	13	5.7	5.7	7.4
	Agree	82	35.7	35.7	43.0
	Strongly Agree	131	57.0	57.0	100.0
	Total	*230*	*100.0*	*100.0*	

Implementing vocational education programmes are needed specifically to promote innovation and creativity in the UAE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	3	1.3	1.3	1.3
	Neutral	31	13.5	13.5	14.8
	Agree	104	45.2	45.2	60.0
	Strongly Agree	92	40.0	40.0	100.0
	Total	*230*	*100.0*	*100.0*	

DBA Programme

Interview Format

How the UAE government can best promote a successful national innovation Ecosystem?

Name:	Saeed Mubarak Kharbash AlMarri
Study:	Doctoral Researcher, Warwick Business School
Email:	▮▮▮▮▮▮▮▮▮▮▮▮
Mobile:	▮▮▮▮▮▮▮

Dear Interview Participant,

Introduction

Thank you for agreeing to take part in this research study.

My name in Saeed AlMarri I am a Doctor of Business Administration student at Warwick Business School.

My research area is Innovation Ecosystems in the United Arab Emirates with a focus on the status of University-Industry collaborations. The result of my research will provide steps the UAE Government should take to promote its National Innovation Ecosystem.

The Date is XXX the **Date: XX/XX 2019 – XX:XX AMLPM UAE Time - @ XXXXXX**

I am here with XXXX,

Research Thesis

This research seeks to identify **how the UAE government can best promote a successful national innovation Ecosystem?**

AIM of the research is to create a framework of how the UAE can create and activate a National Innovation Ecosystem.

THROUGH a mixed method approach where the quantitative method (Survey) will be used for obtaining a real picture of what is currently taking place in the UAE's national innovation ecosystem and the qualitative method will be used by interviewing 'specialists' from a wide area, a further in-depth analysis will be developed based on what is happening in the UAE.

OUTPUT of the research is to create a framework of how the UAE can create and activate a National Innovation Ecosystem, which has the potential to propel the country towards faster economic growth and transition into a knowledge-based economy. With the application of the recommendations that this research will provide, UAE can fast-track its way to becoming a developed economy driven by a robust educational system that promotes university-industry collaboration, provides individuals with skills that can

further drive innovation and lead the way towards scientific and technological innovation.

All participants will receive a full copy of the findings.

Explanation of the Interview Process

- The interview will consist of open-ended questions and normally range between
- 30-60min.
- Participation is completely voluntary and participants reserve the right to withdraw at any point. All participants are automatically anonymised at the individual and organizational level.
- If participants permit me to I would like to record the interview. The rationale for recording interviews is it enables verbatim transcription, rather than transcription based on notes and recall, facilitating more robust analysis.
- A copy of their transcript is provided to all participants for review.
- I will run through all of the agenda points again at the start of our recorded conversation, however if the participant has any concerns please let me know before we start.

Qualitative Interview Guide - Educators & Policy Makers (Main Actors)

Before we begin, I would like to provide an explanation as to what I mean by innovation and innovative individuals. Innovation is an ongoing process that is defined by consistent learning, searching, and exploring. This results in new products, techniques, and new types of organisations. It does not have to be a revolutionary change; it can be a small change that eliminates the inefficiencies of a current process or makes small enhancements to a product. An individual who facilitates that or leads that can be considered to be an innovative individual.

Education Stakeholders

1. How effective is the current Educational System, in your opinion, effectiveness of the UAE producing innovative individuals? Why is this the Case? Can you provide some examples?

2. What, in your opinion, are factors hindering collaboration between university and industry? OR How can those Obstacles be removed? What are the 3 things hindering collaboration between university and industry?

3. Does the Current system in Schools and Universities have enough variations in its curriculum to drive the UAE innovation Capacity? How can it be improved? Or what should be done less or more?

4. What skills are teachers lacking in the UAE which might be hindering the innovation capacity of the students? How those Skills can help in improving innovation in the UAE?

5. Which level of education, primary, secondary, or higher, needs an immediate reform? What Type of Reforms Needed?

6. Do you think the range of courses and programs available in the universities are promoting innovation capability of the country? Why or Why not?

7. Do you think that the academic researchers need to be incentivized in an effort to enhance the rate of R&D collaboration? Why or Why not?

8. Which of the two - academic researchers or industries - need to be encouraged to focus on R&D? And Why?

9. Do you think that it is difficult to transfer knowledge from universities into the industry in the UAE? Why or Why not? Also how can the difficulties be removed if any?

10. Many OECD countries have vocational education as part of their education system and it has been proven to be successful in providing essential skills to students. What is the current state of vocational education in the UAE and how can it be transformed to maximize its returns? [If needed, provide explanation of vocational education in other countries]

11. Which sectors do you think the country needs to enhance its R&D budget?

12. Is the education currently being provided capable of meeting the demands and needs of the market? Why or Why not? How can it be improved?

Government Stakeholders

1. Who, within the ecosystem, do you think is responsible of the R&D agenda? And why do you think that?

2. What are in your opinion the three main focus points that the UAE Government should tackle to improve its Innovation Ecosystem?

3. What are the 3 biggest things the UAE can do to improve its innovation performance especially when it comes to R&D?

4. What are the major government process Drawbacks that is or may effect IDE's?

5. Please let us know your thoughts on accessing & Retaining Talent in Dubai and what you would recommend on that matter?

6. What are the main points that the UAE government needs to tackle to enhance the start-up capabilities and ability within the UAE nationals to compete globally?

7. What skills are the Education stakeholders lacking in the UAE which might be hindering the innovation capacity of the students? How can those skills be improved?

8. Which level of education, primary, secondary, or higher, needs an immediate reform?

9. Do you think that the academic researchers need to be incentivized in an effort to enhance the rate of R&D collaboration? Why or Why not?

10. Do you think that a culture similar to South Korea – Collective - or Germany – Individualism-, is more conducive to innovation and why?

11. Do you think that it is difficult to transfer knowledge from universities into the industry in the UAE? Why or Why not?

12. Many OECD countries have vocational education as part of their education system and it has been proven to be successful in providing essential skills to students. What is the current state of vocational education in the UAE and how can it be transformed to maximize its returns? [If needed, provide explanation of vocational education in other countries]

13. Which sectors do you think the country needs to enhance its R&D budget? Why those sectors specifically?

14. What, in your opinion, are factors hindering collaboration between university and industry? OR What are the 3 things hindering collaboration between university and industry?

15. What are in your opinion the three main focus points that the UAE Government should tackle to improve its Innovation Ecosystem?

Qualitative Interview Guide - Interested Observers (VCs and Entrepreneurs)

1. What educational reforms would you suggest to increase the market focus of the education system?
2. What are the key financing Challenges and What's the preferred mode of finance to succeed within the IDE startups in the ecosystem?
3. In your opinion, is there a disconnect between the education provided and the skills that are needed in the workplace?
4. Do you think apprenticeship schemes will be a good way to create a channel of transfer of knowledge between university and industry? Why or Why not? Can you give if possible some Examples?
5. Who, within the ecosystem, do you think is responsible of the R&D agenda? And why do you think that?

6. What are the 3 biggest things the UAE can do to improve its innovation performance especially when it comes to R&D?

7. What steps do entrepreneurs need to take to ensure that there is sufficient R&D collaboration?

8. What are the main points that the UAE government needs to tackle to enhance the start-up capabilities and ability within the UAE nationals to compete globally?

9. From an economic standpoint, what steps does the government need to take to ensure maximum skills transfer takes place?
10. How can innovation at the workplace be encouraged from a culture perspective?
11. What are the main points that the government should tackle to enhance UAE's innovation based Start-up's (IDE's) to compete globally?
12. What steps are required to create clusters which have a high rate of R&D collaboration?
13. In terms of policy, do you think some current policies are considered as barriers towards R&D collaboration between businesses and schools? If so, can you name a few and suggest alternatives to overcome this challenge?

14. In terms of funding, do you think the government should incentivize R&D collaboration to enhance the rate of such collaboration?

15. Based on your experience, which sector is the most prominent in the UAE and which one needs to be enhanced to bring innovation to the forefront?

16. What is the culture in the country with regards to innovation and creativity in schools and universities?

17. Recently companies like Google, Apple and 14 others no longer require employees to have a college degree. As an entrepreneur, what are your thoughts on that? What impact will this have on the innovation ecosystem more specifically towards R&D and the relationship between universities and the industry?

General Questions

18. Are there any Areas or questions that needs to be addressed in this research?

19. Are there any additional thoughts that you want to share on the Innovation Ecosystem in the UAE?

20. Who do you recommend to meet and have an Interview with within the Innovation Ecosystem in the UAE?

Observation Protocol

The observation protocol outlined by Saeed Kharbash AL Marri in his DBA was informed by Creswell (1998) (cited by (Savin-Baden & Howell-Major, 2013: 398).

1. Physical Setting Room Layout/ Architecture? Flow of activity?
2. Participants Clothes: • Formal/Casual? Speed of movement? Body language   • Smile/Frown?
3. Activities What activities take place during the meeting?
4. Interactions   (whether & how participants come together)

Isolated? Partner? Form small groups? Who is included in interactions? Who is left out? Is everyone engaged? (texting versus listening or conversing)
5. Delivery of information How is info delivered? How is info received?
6. Subtle factors Non-verbal or symbolic communication Pay attention to participants talk (intonation) and body language

Warwick Business School

Doctoral Programme

Research Ethics Form and Checklist

The School is committed to ensuring that the research conducted by its staff and students maintains the highest possible standards of integrity and respects the dignity, rights, safety and well-being of participants. This is why it has put in place procedures for considering the ethical aspects of all proposals for research.

Research students in their first year of registration must complete this form, in consultation with their supervisors, and submit it via *my.wbs* as part of their Upgrade review documentation. Importantly however, this should be seen as a living document. In particular, should your study change in any substantial way following this initial submission (e.g. change in participants, or methods, or a new experiment/research question, or similar), you **must** submit an updated form before starting your research. If you are not clear whether this is necessary, please contact the DPO or the Nominated Ethics Representative. Doing so is not only an ethical obligation toward your participants, but also requirement by the University. **Completion of this form is mandatory for all WBS doctoral students.**

Student name: Saeed Mubarak Kharbash ALMarri

Supervisor (s): Prof.Stephen Roper & Prof.Mark Skilton

Title of proposed research project: How can the UAE government best promote a successful innovation Based ecosystem?

SECTION 1: HISTORY OF APPROVAL

Is this your first Research Ethics Form submission?   YES   NO

If the answer to the above is NO, please tell us in brief about when previous approval was given, by whom, and how this application differs. If it does not differ, please state…NO CHANGE?

The previous Ethics Form was submitted on Wednesday, September 19, 2018 17:36 to Rhona. The Approval was given via email through Rhona on 25 Sep 2018, 18:38 with the following Reply - I have received feedback from the WBS Ethics Representative regarding your ethics submission, the feedback is:"I have examined the ethics submission and consider that it has shown an acknowledgement of the ethical issues and can approve it".

The only difference between both applications is the addition of a survey that is based on the answers from the interviews a Survey will be shared with the larger number of stakeholders within the UAE. One of primary purposes for conducting this survey is to validate the results obtained during the qualitative interviews. The survey has been developed and is currently online and rolled out to the general public. The sample size considered is 384, based on the Krejcie and Morgan sample size table with a 95% confidence interval. However, if the survey does not hit the required sample size, a minimum threshold of at least 100 responses is being considered.

SECTION 2: DECLARATION

(A)   I confirm that I have read and understand the following documents:

1. The University's Research Code of Practice:
    http://www2.warwick.ac.uk/services/rss/researchgovernance/research_code_of_practice/

2. The Economic and Social Research Council's *Research Ethics Framework:*
    http://www.esrc.ac.uk/funding/guidance-for-applicants/research-ethics/

3. The University's Humanities and Social Sciences Research Committee's (HSSREC) Guidelines for Research Students:
    http://www2.warwick.ac.uk/services/ris/research_integrity/researchethicscommittees/hssrec/student/

(B)   I confirm that I (in consultation with my supervisors) have considered the ethical implications of the proposed research project and that it is consistent with the principles outlined in the above documents.

(C)   I confirm **EITHER** (please tick appropriate statement below):

That the research project does not involve direct interaction with human participants or their data (eg. through interviews, participant observation, survey, or other collection of participant data).

☐

OR

That the research project does involve direct interaction with human participants or their data, and that I have completed Sections 2-4 of this form as accurately as possible as a result.

■

Signatures attesting this:

Student: Saeed AlMarri ███████ Date: 25th February 2020
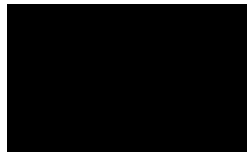
Supervisor 1: Professor. Stephen Roper Date: 25th February 2020

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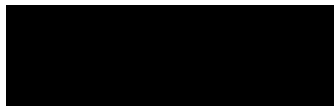
Supervisor 2: Professor: Mark Skilton Date: 25th February 2020

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SECTION 3: RESEARCH ETHICS CHECKLIST

Please answer each question by ticking the appropriate box

	YES	NO
1. Will the research involve NHS patients or their data, NHS staff, premises or facilities?		✓

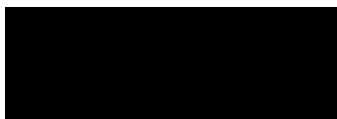|		
2. Will the research involve audit and evaluation of projects involving NHS patients or their data, NHS staff, premises or facilities?		✓
3. Does the research involve participants who are vulnerable or unable to give informed consent (e.g. children or young people, those with learning disabilities or cognitive impairment, or individuals in a dependent or unequal relationship)?		✓
4. Does the research involve discussion of sensitive topics (e.g. participants' sexual, political or illegal behaviour, their gender or ethnicity, their experience of drug use, their experience of violence, abuse or exploitation)?		✓
5. Does the research require the permission or co-operation of a gatekeeper for initial access to the participants (e.g. members of particular ethnic or cultural groups, members of self-help or other interest groups and associations)?		✓
6. Does the research involve deception or covert observation of participants without their full and informed consent?		✓
7. Does the research require access to identifiable individuals?		✓
8. Does the research require access to records of personal or confidential information, including genetic or other biological information?		✓
9. Will blood or tissue samples be required from participants?		✓
10. Will the research involve any intrusive interventions (e.g. administration of drugs, placebos or other substances, vigorous physical exercise, or techniques such as hypnotherapy)?		✓
11. Is the research likely to induce physical pain, psychological stress, anxiety or humiliation or cause more than minimal discomfort?		✓
12. Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?		✓
13. Is the research likely to entail any risk to your personal security and safety as a researcher?		✓
14. Is the research likely to pose any risk to the environment?		✓
15. Have you obtained the appropriate permissions to carry out this research (e.g. to obtain data, access to sites etc.)?	✓	

16. Have you taken measures to ensure confidentiality, privacy and data protection where appropriate?	✓	

If you answered YES to Questions 1 and 2 above, you should refer to the University's guidance on working with the NHS to see whether your research needs approval by the NHS Research Ethics Committee and follow the required approval procedure (http://www2.warwick.ac.uk/services/rss/researchgovernance_ethics/research_code_of_practice/humanparticipants_material_data/working_nhs/). If formal approval by the NHS REC is not required, please complete the rest of this form and return it to the DPO. You will be advised if you need to submit an application for full ethics approval to the Humanities and Social Sciences Research Ethics Committee (HSSREC).

If you answered YES to questions 3-13 and/or NO to questions 14-15, you may need to submit an application for full ethics approval to the HSSREC, following consideration of this form by the Nominated Ethics Representative (NER). The DPO will forward you the application form and guidelines, if needed; further information is available here: http://www2.warwick.ac.uk/services/ris/research_integrity/researchethicscommittees/hssrec/apply/.

SECTION 4: PROJECT DETAILS

Project summary (*please describe the nature and aims of the study in brief*)	The Thesis intendeds to Study the Distinct UAE Innovation Ecosystem with some Stakeholders to Organizing and activating the innovation Driven ecosystem, Linking between some stakeholders in the Innovation ecosystem and Propose strategic Steps for the UAE Government to lead it.
Proposed methods	Qualitative • Structured Interview • Survey

Criteria for selecting participants	Selected Involved Personal – From the major Stakeholders - in the Innovation Ecosystem in the United Arab Emirates.
Method for recruiting participants	Via Face to Face meetings, Phone Calls, Skype or Emails.
Number of participants required	50 Interviews at least (10 per Innovation Stakeholder whom are: Entrepreneurs, Government Officials, Corporate Managers, Academic Institutions Personal and Risk Capital Institutions Managers). Then based on the answers from the interviews a Survey will be shared with the larger number of stakeholders within the UAE. One of primary purposes for conducting this survey is to validate the results obtained during the qualitative interviews. The survey has been developed and is currently online and rolled out to the general public. The sample size considered is 384, based on the Krejcie and Morgan sample size table with a 95% confidence interval. However, if the survey does not hit the required sample size, a minimum threshold of at least 100 responses is being considered.
Project start and end dates	October 2017 – October 2020
Where will data and consent forms be stored?	All Data Will be stored in Password Protected Computer and only accessed by the Researcher. Also All Printed Data will be stored in closed locker room Home available only to the researcher to access.
How will you ensure confidentiality and anonymity? *Please*	ALL Data will be stored in Safe and Secured Places / Folders that will be ONLY accessible to the Researcher and shared ONLY with the Supervisors and Authorized Personal.

provide a detailed statement.	

SECTION 5: RESEARCH ETHICS STATEMENT

Please summarise the ethical issues that arise from your proposed research **and** how you plan to address these. It is in your interest to make this **as detailed as possible** (e.g. adapting the section on research ethics from your proposal/thesis for these purposes is fine). The summary should be sufficiently developed for the NER to make an informed judgment as part of research ethics approval.

Please also append a copy (including updated copy, if applicable) of the Participant Information and Informed Consent Forms you intend to use (a template for each can be downloaded from my.wbs and adapted, if appropriate, for your project).

The Data Collection for the Project will basically will be between using Archival Data and Semi Structured Interviews as well as Surveys (if possible).

The Researcher, with Direct guidance from the Supervisors will ensure that:

- All Interview & survey questions will be chosen to be related (directly or partially) to the research topic and any questions that may violate the ethical or Privacy stance of the Interviewee will be avoided.
- All Interviewees will have the full right not to participate in the interview or/ and some questions in the interview.
- All Surveyed personal will have the full right not to participate in the Survey or/ and some questions in the Survey.
- All collected information will be directly or partially connected to the research topic.
- All Interviewees will be informed beforehand if the interview is recorder (video or Audio) and will be given full opportunity to provide their consent to such data collection methods.

Please return this completed form to the DPO.

CONSENT FORM

Title of Project: How can the UAE government best promote a successful innovation Based ecosystem?

Name of Researcher: Saeed Mubarak Khalfan Kharbash AlMarri

Name of Lead Supervisor: Prof.Stephen Roper

Date: XXth February 2020

Please Initial Box

1. I confirm I have read and understand the information sheet dated [insert date] for the above study. I have had the opportunity to consider the information, ask questions of a member of the research team and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.

3. I understand that that my information will be held and processed for the following purposes: [insert purpose of data gathering and analysis, e.g. 'to be analysed by the researcher for the purposes of completing their PhD research and, where relevant, for the writing of associated academic journal articles or monographs'].

4. I agree to take part in the above named study and I am willing to [insert tasks required of participants, e.g. 'be interviewed' and 'have my interview audio/video recorded'].

_____   _____   _____

Name of participant   Date   Signature

_____   _____   _____

Name of Researcher   Date   Signature

Researcher: [name and contact details of researcher]

Supervisor: [name and email address]

Date: [insert date]

You are invited to act as research participant for the above project. Your participation in this project is entirely voluntary. You may withdraw from participating in this project at any time, with no negative consequence to yourself or the organisation for which you work.

This is a research project investigating….

The project involves….

Your involvement in this project will help……

Participation in this project will involve being interviewed by the above named researcher on the theme of…..

It is not expected that you will experience any risks through participating in this project. Data will be anonymised from the start, with no names or specific positions recorded as part of the interview material. Your consent form will be stored in a locked office at the University of Warwick, and transcripts of interview data will be anonymised before being printed and stored in the same place. The transcripts will also be stored electronically on the lead researcher's password-locked laptop. All material may be destroyed after 10 years from the completion of the research. The material from this research may be published. You can request a copy of the publication from the researcher named above

Should you have any further questions about this research, please contact [insert name and email of PhD researcher and/or supervisor].

You may also contact the University of Warwick Research and Impact Services, University House, University of Warwick, Coventry, CV4 8UW, UK (phone: 02476575732) should you have wish to make a complaint about the conduct of the researcher.

Appendix D. List of Interview Participants (Anonymised)

Interview ID	Anon ID	Name	Company	Innovation Stakeholder	Nationality	Position	Date	Time Started	Time (Mins)	Type of Interview	Audio File	Physical Setting
I-001	I-001	AY	Public	Government	Moroccan	Chief Strategy Officer	7-Aug-19	2:33 PM	29:02:00	Face to Face	Received	Office
I-002	I-002	BO	Public	Semi-Government	Emirati	Chief Executive Officer	5-Sep-19	3:57 PM	32:58:00	Face to Face	Received	Office
I-003	I-003	AD	Public	Accelerator / Incubator	British	Associate	4-Aug-19	3:52 PM	49:16:00	Face to Face	Received	Office
I-004	I-004	ER	Public	Accelerator / Incubator	Egyptian	Advisor	20-Aug-19	2:27 PM	01:18:18	Face to Face	Received	Office
I-005	I-005	SF	Public	Government	Australian	Strategic Advisor	23-Jul-19	4:44 PM	01:03:49	Face to Face	Received	Home
I-006	I-006	DT	Private	Entrepreneur	Emirati	Founder	5-Sep-19	9:16 PM	39:21:00	Face to Face	Received	Café Area
I-007	I-007	IQ	Public	Government	Emirati	Director	28-Jul-19	6:45 PM	49:35:00	Face to Face	Received	Home
I-008	I-008	IA	Private	International Organization	Canadian	Director	10-Jul-19	3:26 PM	51:12:00	Face to Face	Received	Office
I-009	I-009	KQ	Public	Government	Emirati	Head of Future Platforms	22-Aug-19	2:16 PM	45:28:00	Face to Face	Received	Office
I-010	I-010	M	Private	Start-up	Swedish	Founder	31-Jul-19	4:31 PM	51:23:00	Skype	Received	Office
I-011	I-011	JP	Private	Start-up	Lebanese	Director	4-Sep-19	3:14 PM	39:21:00	Face to Face	Received	Office
I-012	I-012	MK	Public	Bank	Emirati	Director	17-Jul-19	6:28 PM	36:49:00	Face to Face	Received	Café Area
I-013	I-013	M	Public	Accelerator / Incubator	Emirati	CEO	2-Sep-19	2:13 PM	20:09:01	Face to Face	Received	Office
I-014	I-014	MA	Private	Bank	Emirati	Chief Strategy Office	18-Jul-19	2:07 PM	54:49:00	Face to Face	Received	Office
I-015	I-015	NK	Public	Government	Emirati	Director	8-Jul-19	2:27 PM	45:04:00	Face to Face	Received	Café Area
I-016	I-016	PM	Public	Academia	German	Professor	6-Aug-19	2:20 PM	58:42:00	Face to Face	Received	Office
I-017	I-017	PNN	Public	Academia	New Zealand	Professor	28-Jul-19	2:07 PM	01:02:33	Face to Face	Received	Office
I-018	I-018	PWM	Public	Academia	Iraqi	Professor	30-Jul-19	1:42 PM	29:58:00	Face to Face	Received	Office
I-019	I-019	MRH	Private	Start-up	British	Founder & CEO	15-Sep-19	6:28 PM	39:21:11	Face to Face	Received	Café Area
I-020	I-020	RU	Private	Private Company	American	Founder & CEO	16-Jul-19	5:30 PM	01:20:49	Face to Face	Received	Office
I-021	I-021	SA	Private	Advisory	Emirati	Head of MENA	1-Aug-19	6:00 PM	49:43:00	Face to Face	Received	Office
I-022	I-022	TAB	Public	Government	Australian	Strategic Advisor	10-Jul-19	5:12 PM	53:47:00	Face to Face	Received	Office
I-023	I-023	ZN	Entrepreneur	Entrepreneur	Lebanese	Founder	17-Jul-19	10:06 PM	01:01:03	Face to Face	Received	Café Area
I-024	I-024	Z	Public	Government	British	Advisor	14-Jul-19	9:06 PM	01:08:01	Face to Face	Received	Office

Appendix E. Interview Transcript

Participant 1

Speaker 1: So the date is the seventh of August. And I'm here with Mr. AY, the CSO in [Organisation Name]. And we're talking about the research that seeks, that seeks to identify how the UAE government can best promote a successful national innovation ecosystem. First, thank you very much Mr. AY for your time.

Speaker 2: You're Welcome Saeed.

Speaker 1: So the first question would be, please Mr. AY, if you could tell us on your connection within the innovation ecosystem, your thoughts in the UAE and your thoughts on the innovation system in the UAE.

Speaker 2: So my connection with the innovation ecosystem started back when I was working with the Prime Minister's office as an advisor at the Prime Minister's office, we worked as a team on the national innovation strategy and some national initiatives within vision 2021, or even at the centennial 2017. So innovation is at the core of that aspiration of the UAE, as a nation, to become one of the leading countries in the world by 2021 and to become the best country in the world in 2071. So If you say the main driver for this vision is innovation, So in the context of the Fourth Industrial Revolution, the talent war between nation, Innovation is key to give the nation a competitive a sustainable competitive advantage. So it has an economic perspective of that. So innovation is not just for the sake of innovation, innovation has an impact economically, it has an impact socially, it has an impact on government at large. So that's how the context where I'm coming from, and what's my connection with the innovation ecosystem. And recently, when I was honored to take the task of Dubai future foundation as a chief strategy officer, The core mandate of Dubai future foundation is to make Dubai a leading city of the future. So it's the mandate is much more at the Dubai level, but it's not in this connection with the overall mandate of the UAE. So in order to make Dubai a leading city of the future, It has to be innovative in different approach

when it comes to mobility. And it comes to sustainability when it comes to so many different forms. So I'm glad to be within this organization. And I think that our roadmap would somehow enable that echo innovative ecosystem to happen.

Speaker 1: Thank you very much. So I'll start with a couple of general questions. So the first question, in your opinion, what are the three main focus points that the UAE government should tackle to improve its innovation ecosystem, If you had to choose three, Yeah, and you could cut it into short term to long term aspect.

Speaker 2: So I think of it, So the first input to that ecosystem, any talent, So whether that talent is homegrown, or attracted from outside, so if you remember, there is a recent study from LinkedIn, based on the data that they have, I'm not sure which year I think it's last year that has been published UAE is one of hub for attracting talent in the region, and also in the world. So if you see the inflow of talent to the UAE was like, very impressive, the fast rate is that these people are coming to UAE to do a to build their dream or even to take, you know, there to be part of the UAE dream, if I could, I could, I could say it, The other in the talent. So this is like something that dynamic coming from outside towards the UAE. So we need to make sure that we are appealing to that pool of talent globally. On the same time, we need to grow talent from the UAE so the national within the universities and the academic institutions to make sure that these standards are ready for the jobs of the future that we are creating within the economy. So that's one, two, is the governance of the innovation, right to make sure that as a government, we are here and enabler for innovation, we cannot force people to innovate, but we need to enable people to innovate and that with that mindset, we need to review our policies, governance structure to make sure that that ecosystem is happening. When it comes to IP registration, or whether it come into starting up a business there is a lot of there's a big components of innovation, governance and policies that are taken into place. And I think the government should take a lead on that to make sure that our policy they are world class to enable that ecosystem. Three is the, Again, innovation, by talent. In the first point that I mentioned, by talent, I mean, the talent and the academia to grow that talent. So it's within that the attraction of the talent and homegrowing talent, the academic institution that played a major role to go that

done. So I think that is point Number one, two is governance, three is, again, to be an innovation hub we need to have funding for for this endeavors. On funding, I'm not talking only about funding the start-ups but only funding, also funding the fundamental research that are key for the UAE. As a country, I know that we have in the Vision 2021 at Target to increase the GDP the percentage of r&d in the GDP. And that, for us is a very key indicator. We are not there yet, we benchmark with other countries like Israel, like, you know, other advanced countries in terms of GDP expenditures and r&d. But we we we, as a government, we we saw that there is a gap there. And we are working to fill that gap within 2021. And So in a nutshell is talent, governance and funding.

Speaker 1: Thank you very much. And my question would be on on these three, three subjects. So that my first question would be on on the maybe it's it's connected to the funding side, which is the r&d that you mentioned, within the on the how we can improve the innovation performance, especially when it comes to R&D. What could the UAE what could the government do to improve the innovation performance?

Speaker 2: Yeah, There are many successful models around the world about how you drive an r&d agenda, the nation, the country level. So let's say maybe in the US they have the Office of Science and Technology Policy, which is kind of a small office connected to the White House that kind of orchestrate if not defined the high level areas of innovation at the national level. But again, it's not, it's only an orchestrator. At the end of the day, the major Much of the innovation done in the in the United States is not from government, it's like in the private sector of the Google of this world the Amazon of this world. So This is the private sector is taking the lead. There are certain models also in Europe, where government and private sectors like through a certain incentive, the match whatever is in tax credit, or they are matching schemes in terms of building those funds for innovation. And therefore they drive that that force through those through the funding. Here in the UAE recently. Along with these lines, we announced the Minister of State for advanced sciences, led by Her Excellency Sarah Al Amiri. So In a nutshell, Sarah will play will be playing the role of the orchestrator of the R&D agenda, the nation, the nation level, bringing both public sector and private sector Around the same table. And I'm highly recommend that if you can have a chance to

meet her, She can give more detail about her strategy and approach to design and implement the on the agenda in the UAE. But this is basically from the governance side that how how we are planning to tackle it.

Speaker 1: And My question was, and the reason of my question, because as you mentioned, the r&d usually happens within the corporate, corporate world and other place in the world Here, the government plays a bigger role. So

Speaker 2: yes, there is no right or wrong approach. So it's, again, you design the framework and the enablers that will that's suitable to us. So we cannot say, yeah, the the the approach of the US the white for us, or the European, so we have to design our own approach.

Speaker 1:

I have a, I would say, it's not a sensitive question. But every government has its drawbacks, or I would say points of the, you know, to improve, what would be the drawbacks of the points have improved for the UAE government in terms of their policies and rules and regulations here, specially on on the ideas on the innovation driven enterprises,

Speaker 2: The bottom line of what we need to minimize the friction for any idea entrepreneur,to to stop, so the barrier to entry should be very minimal, whether it's, It's in the process wise, meaning that the journey that this idea entreprenuer is going through to start up his business, or from the cost wise, which is how much does it cost him in order to operate and start up his business? So it's too front process wise, we need to have a completely engineering of that journey, and to have a very specific value proposition to ideas. So Currently, we just started the discussion about the definition of what is an idea or versus what is an SME. So we know the idea in terms of economic impact that this unique, they are all ideas, right? So we need to make sure that our

approach is kind of customized to the need of the ideas to minimize the friction, which is very relevant to any other start-ups as well. But we need to have a unique approach to the ideas because they are not as any other business this this guy's they are they are different The the operating differently. The ideas of this one, they may be the the entrepreneur, he's working on Starbucks if he doesn't even need an office. So why should I asked him, for example, to have a permanent office in order to get a license, for example. So we need to take all this component into consideration plus the cost component as well to make sure that we are not, it doesn't hinder our competitiveness as we have to attract those ideas into the region.

Speaker 1: So the process and the cost?

Speaker 2: yes...yes

Speaker 1: in terms of the talent, which you put as part number one on the government to work on, I wanted to get your thoughts on the, on assessing and retaining talent here in the UAE. And what the what the government should do on that matter, especially. So we we we have a lot of talent coming out of the UAE and coming from from different countries. But there is a huge issue of most of these talents, having eternal of five to eight years and leaving. What could what could we do and that's only for the talent coming but also for the homegrown talent

Speaker 2

we need, we need to make sure that the talent coming to the to the UAE is similar to the American dream, We need to make sure that our value proposition for this done and they are not here for in a transaction or temporary basis, We want to make sure that this is a country where they can build their dream and they can stay here for a longer period of time. And If you remember I just recently the government announced many schemes coming into the long term visa The talent visa and entrepreneur visa. So all these policy actions they are in line to make sure that that talent, They are coming to the UAE and they have selected UAE as a hub for… to Incorporate and to stay doing.

Speaker 1

And for the homegrown talent here, What do you What's your thoughts and your….

Speaker 2

If you see us….. Throughout the history, Dubai, and UAE as a country is an inter connection between trading routes. doing business with other we are in a very open society by design, we are very opening even I think in the DNA of the UAE nationals, they have that DNA of taking risk of being open to other other countries. So we cannot be in a framework of Okay, get in town and forcing them to stay No, we want the town to thrive. So we have no problem that someone coming from Jordan incubated in the UAE stay for a period of time in the UAE and maybe scaling up in Silicon Valley or vice versa. So This is in our DNA, we are like moving goods moving people now also can be the hub of moving talent in the in the region and the globe. So we shouldn't be in a perspective of, you know, making it very rigid for the talent to move in and out. So that's that's, that's the key.

Speaker 1

And Thank you. And the next question is, what would be the main points for the government to tackle to enhance the start-up start-up capabilities within the UAE nationals to compete globally? So we're saying yes, we want to get the Nationals And that happens within the education system, the best education all done, but how we can get you in nationals to bring the best of the biggest companies in the world?

Speaker 2

I think there is a lot of large effort to be done into changing the mindset. changing the mindset biggest being an entrepreneur by design, you are able you need to embrace failure. And I'm not I'm not talking about the in all Eastern cultures, Failing is kind of shame, you know, or losing your job or like starting your business new feels like Oh, What are the other people they're going to talk about me? I'm a loser. No, we need to

change that mindset, which is, you know, His Highness Sheikh Mohammed, he said is like the biggest risk is not to risk anything at all. So we need to really to make sure that through the childhood to a university level, the UAE National the UAE talent they can embrace to take risk, and there is no problem to fail in an endeavor as an entrepreneurial endeavor. So that's, that's one because so many people they are having this taboo is like, if I'm going in business, I felt people they will portray me as a loser of something know, we need to change that mindset. We need also to expose them to the entrepreneurial world, whether why they are studied, so there is no point to tell them, okay? Either your drop university to be an entrepreneur, or vice versa, right. So we need to make sure that this two journeys could be even hands in hands. So for example, a UAE talent, student in universities at computer science student, He can start working on his app dream app that is going to be the next Uber or the next careem. While he's in university, we need to enable that to happen. On the same time when it also to not to be to be in a binary kind of dynamic, either university or start-up, we can design something to empower that to direct the the jump to the entrepreneurial, entrepreneurial work. So I think this is very key to, you know, changing the mindset and making sure that, you know, exposing the student and the HR talent to entrepreneurship while they are even studying.

Speaker 1

The next question is, you mentioned the, the the child like starting from the, from childhood, changing the mentality and the mindset of the skills that we have within the education sector, Enough now for in the within the innovation or gives us enough innovation capacity within the students?

Speaker 2

I think the movement is starting, His Excellency, I might behold is making a huge progress to in the future skills agenda. And it has he has a multi year strategy, I would highly recommend that you can you can, you know, have a look at it. to really build the skills for the future. One of them is like the entrepreneurship kind of mindset. Besides the critical thinking, the design thinking all the the skills of the future that we need, in the fourth in the era of the Fourth Industrial Revolution, the moment and just starting

our day, Is this the end picture that we want, we are not there yet, but I am very positive and optimistic about the path that we are taking because we are very locked on the division 2021 and the vision 2071 one, This is kind of our North Star in government as a country. And if I remember His Highness Sheikh Mohammed Zaid, when he mentioned at the World Government summit, he said we need to celebrate that last round of all, And, you know, and also to prepare the next generation who's going to take the flag, But in his in his word, he's telling us to Okay, we need to education is key to enable that change that shift to happen. And the education I mean, is like equipping the future generations with the skills of tomorrow. And one of them is entrepreneurship

Speaker 1

The work is has started within the education ecosystem ecosystem, But in which level from, from your experience which level need the urgency… they need the quick reform, is it the primary or secondary in higher education …. again, connected to the innovation ecosystem?

Speaker 2

To be frankly, I don't have a very deep knowledge about it. But I think it's we should have these actions to all the career of the UAE talent of the national from the primary to, to the higher education. So maybe at the primary school is like we need to encourage students, for example, to sell buy stuff, for example, just to experiment with, you know, trading, you remember, like monopoly, if I remember, you know, it gives you that kind of pleasure that you are achieving something, and you are risking something that's so that's one gamification of kind of entrepreneurship at that level, or moving to the more higher education, we need to equip them with the skills of the entrepreneurship. You know, there are certain soft skills and also hard skills to, you know, to kind of inject in our curricula. And I think the best the best point to get this data from I think if you can align a discussion with the Ministry of higher education

Speaker 1

the within the, you know, you with your work before, And now with the Dubai future Foundation, which would say which sectors, you think the UE should, you know, focus its innovation ecosystem, or they announced seven sectors, And those seven sectors, From what I heard is the sectors that would be the sectors of the future. But for the short term innovation for the next 10 years, six of the things,

speaker 2

we need to be very pragmatic in our approach, of course, that seven sectors, the high level kind of aims, We need to prioritize the sectors we have kind of a comparative, or competitive advantage versus others. So let me give you just an example aviation is a big sector in the in the UAE, right? We have one of the best airlines in the world, we have the most busiest airport, The amount of data that we are gathering from this operation in the UAE, It's tremendous. I couldn't think on any other place on Earth, If we want to have let's say, AI innovation and airlines, it could happen in the UAE. So we have some good initial conditions that give us the edge to innovate. So we are not starting from the scratch, we are building something which is already existing, and even it's going to enhance our competitive advantage. Same thing when it talks, we are talking about trade and logistics, we have one of the most busiest seaport in in the world, right?. And when it comes in the innovation in robotics, or like an advanced system to you know, move with moving goods, from air to land, sea, etc. So the multimodal transports, This is the place where we can start. So our approach, we should start with the the in the area where we have some assets that we can leverage on to build that international because that that innovation, the first client for that innovation would be a global reference such as Emirates Airlines or the DP world. And whatever works for them, it works for anyone in the in the world when it comes to those those……

speaker 1

the focus will be on the competitive or competitive advantage that the UE already had, and build on that…… While moving to the new the new sectors as well.

Speaker 2

So what I'm saying is like this is kind of a pragmatic approach to start with something that you already have you build on it, to turn it to want to take the next level, while you're thinking on the new sectors that we need to emerge the new class of the 2.0 of economic sectors that we need to have.

Speaker 2

And this this question is very important ..and the answers were building on the competitive advantage, as you mentioned, and the others are building on the survival, survival sectors, water energy are very,very important.

Speaker 2

Of course, for the these ones, they are talking about the global value chain. So it's not necessarily that we are on the leading edge for water solution. So if we solve it for here in the UAE, when it comes to, you know, let's say irrigation sector in the agriculture or like, you know, innovation in desalinating needed water, so this is a global issue. So if we innovate, to solve that issue is whatever is falling in the world is going to be you're here in the global value chain up front from day one.

Speaker 1

And there is a need to give an example water is a big leader

Speaker 2

water climate change. When it comes to, you know, healthcare, yeah, So if we just take and health care if you tell me the UAE market is a small market, relatively the same 7 billion people, they are the same human. So whatever we do innovation to enhance, to

extend their life to solve to cure cancer to cure is not not only for the you, it's going to be for the whole world.

Speaker 1

Next question is on the and the financing, which was one of the main pillars you mentioned at the beginning? What are the key financing challenges here in the UAE? And how can the government again, from a government perspective, help and resolving those challenges? If it's,….. And I don't mean by the government putting the fund but what steps could the government do to help resolving that

Speaker 2

we need to make sure to again, the government, we shouldn't be competing with the private sector. So meeting, the role of government is not to let say be the investor in start-ups. Otherwise, we are competing with the current VCs, what our we need to close the gap. The gap, for example, if you see in the current innovation, or start-up ecosystem that we have, there is a gap between the seed series and scale. So there is like a huge chasm there, The current VCs or private equity, they don't have all the kind of risk to put all the capital for that scale up. So they need someone to partner to go invest, right. This is an area where the government come as an enabler to bridge that gap, or to match their investment, for example, to idealise the transaction and to make sure that the transaction is actually going to happen. So I think we need to be the enabler, not the competitive with private sector, and to make sure that this ecosystem is is attractive enough for the eco for the VCs from all around the world to consider that this is a start-up capital in the region.

Speaker 1

My last question is, maybe we talked about education and talent and all that. But recently, many companies such as Google and other many other companies, no longer require employees to have to have a college degree, I wanted to get your thoughts on

that. And what could be if that happens, what could be the effect on the university industry collaboration and the, you know, the education sector here in the UAE, within the innovation ecosystem,

Speaker 2

Definitely, when you are talking about the gig economy, not necessarily that you need, You don't need a degree, you know, but if you are talking about things that are very fundamental in physics, quantum computing, You know, you cannot have a lab at home, you know, to experiment. So you need a kind of an institution where you can go and access this kind of facility for R&D. Currently, we have them in the universities, and they are like, it's kind of public or private, depends on which format. And definitely the future of higher education is going to be disrupted. It's not necessarily I have to stay for years to get a degree, We might have this the wise of those nano degrees. The blend between on an off campus kind of, you know, education. Also, it will either in certification, so not necessarily have to go to the same institution to go through the same program that has been pre designed in order to get that kind of certification. So I can choose, I can have a course in Columbia and the next scores may be in LSC, the other course in Singapore. And, you know, the combination of those credit that would give me like, kind of, you know, a track of you know, so not necessarily, I'm sure that you don't need Zuckerberg, he didn't need a degree in order to program the, the Facebook, neither the other the other entrepreneurs ……for me is access to knowledge, whether it's within a formal education program, educational programs, such as a university or higher education, or access into a knowledge through books or accessing knowledge to, you know, an in distributed network of sharing knowledge, you know.

Speaker 1

And the, There was a story of one person who got the can't remember which country he got the highest marks, and that person …. only saw Khan Academy Academy for for that, and he learned from that

Speaker 2

Exactly I think our education system is subject to huge disruption. I don't think it has moved since the, the era of Napoleon or even before that, so……. It's a Exactly.

Speaker 1

Thank you very much. My last question is, do you have any added additional thoughts to be added for this thesis? Are there any additional subject areas that I didn't mention within the question? We talked briefly about the r&d, the funding, the governor's the talent, the culture, education and the mindset? Is there something you think?....

Speaker 2

I think I think I should congratulation congratulate you about your thoroughness. You have been very thoroughly the questions. The last thing that I could mention, I think, UAE and Dubai, What we are trying to build with her and through our long term vision as a country, the centennial or the vision 2021 or DFF at the local level, we are here in the business of giving hope. giving hope for the youth ….making that you know, the building ecosystem that they will thrive….And This is the leadership direction directive in the in the in the UAE. And I think that we can claim that the UAE will become the start-up nation for the next step of fermentation in the in the region And the world.

Speaker 1

Thank you very much,

Speaker 2

Alex, Thank you very much. Thank you. Appreciate