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The Government Role in Creating Innovation Technological Clusters in Developing Countries (The Case of Saudi Arabia)

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A Dissertation Presented

by

KHALID MAHMOUD DASHASH

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ABSTRACT

THE GOVERNMENT ROLE IN CREATING INNOVATION TECHNOLOGICAL CLUSTERS IN DEVELOPING COUNTRIES (THE CASE OF SAUDI ARABIA)

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Many governments around the world are committed to the idea of creating high-tech industries in their territories. Often they do so by imitating other well-recognized models such as the Silicon Valley. This dissertation investigated three countries economic development plans to understand how government policies could support or hinder the establishment of an Innovation Systems in developing countries.

This dissertation claims that to create a successful high technological innovation cluster in any area, a successful innovation needs to be existed to support these clusters.

This study used a comparative qualitative pragmatic method that implemented both case study and process tracing to unfold the policies that led to create a successfull innovation systems. Comparing these cases created an understanding on how the success could be generalised and replicated to the case of Saudi Arabia.

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INTRODUCTION

1.1 Overview

This dissertation will investigate how government policies can support or hinder the establishment of innovation Systems in developing countries. I argue that massive public investments in infrastructure and buildings alone are unable to explain the success of the emerging innovation clusters in developing countries. Rather, it is the effective mobilization and connectivity between the major models of the Innovation Systems (Global, national, regional, and regional cluster) that drives innovation and success. More specifically, as developed through the Old economy theories such as Trade barriers and tax incentives or through the Triple Helix model linkages (University-Industry-government) that sustained connections nationally and internationally with leading technological hubs in the United States and elsewhere. I hypothesize that successful examples of emerging innovation clusters in developing nations all retain strong connections between the three Models of Innovation Systems through individuals, institutions, Universities, Laboratories, and firms in leading innovation hubs, such as Silicon Valley. Policies that explicitly support such connections are absent in other developing countries, where the emphasis is more squarely subsidizing real estate development and providing incentives to reduce the costs for businesses.

1.2 Background:

Starting in the 1980s scholars working on National Innovation Systems (NIS) drew their scholarly works toward investigating the political economy in developed countries.

Scholars commonly define NIS as a group of institutions at the national level that relates together and innovate within the border of a nation (Freeman, 1987; Lundvall, 1992; Metcalfe, 1995; Nelson, 1993; Patel & Pavitt, 1994).

The pioneers of this movement include Richard Nelson (an American economist), Christopher Freeman (an English economist), and Bengt-Åke Lundvall, a (Danish organizational theorist). Furthermore, these three scholars investigated the social interaction between customers and suppliers and the effect of these interactions on encouraging innovation at the national level (Boulding, 1985; Etzkowitz, H.,Leydesdorff, L., 2000; Freeman, 1987). They argue that innovation systems helped to bring about the existence of leading high-tech hubs around the world, such as Japan. Japan is one of the pioneering eastern developed countries that worked extensively on its innovation system policies. Although Japan has its deep culture in implementing the three models of innovation in their path of development, Japan relies heavily on the national level to support lower innovation levels by direct central government involvement to foster development (Freeman, 1987).

The concept of innovation system is still evolving, and there is no consensus among scholars about its precise definition, although scholars tend to emphasize linkages between the public and private institutions to nurture and support technology and innovation. (Boulding, 1985; Etzkowitz, H.,Leydesdorff, L., 2000; Freeman, 1987; Godin, 2009; Nelson, 1993). I follow the definition offered by the Organization for Economic Cooperation and Development (OECD) who defines an Innovation System as the continuous interaction between people and different types of institutions using technology and information that leads to a continual development of products and services (OECD,

1997). Such systems often exist and operate at different spatial scales, with most scholars making a distinction between national (NIS) and regional (RIS) innovation systems.

The commonly cited model of a successful RIS is northern California's Silicon Valley—The Silicon Valley is a nickname for an area in the San Francisco bay area that has a remarkable culture in creating and supporting start-ups and its the base of many technology companies in the nation. The Silicon Valley's innovation system has its origins in the late 1950s, with the emergence of venture capitalists—an individual or institution who finance early stages companies. The growth of start-up companies encouraged venture capitalist to invest in ideas and motivated entrepreneurs to seek out investors to help them fund new technology ventures. The notion of success encouraged entrepreneurs from all over the nation to seek an opportunity in the Silicon Valley. Furthermore, the exchange of benefits between venture capitalists and entrepreneurs helped in creating a culture of innovation in the San Francisco Bay area later called the Silicon Valley (A. Saxenian, 2006). For example, Fairchild Semiconductors, an early spinoff from Shockley Semiconductor, was created by the funds that came from a pioneer venture capitalist. This same venture capitalist went on to support the creation of 70 additional start-ups in the area (Maclowry, 2014). The lucrative results for the relationship between venture capitalists and start-ups encouraged venture capitalist to build their agencies and institutions and invest inordinate sums of money in technology start-ups located in different parts of the Silicon Valley region (OECD, 2013; National Research Council, 2009).

The unprecedented and rapid growth of computer hardware and software firms inside the Silicon Valley region also inspired a new generation of scholars with a regional, as opposed to a national focus. In 1985, Lundvall coined the phrase Regional Innovation Systems

(RIS), which he defines as, *"a set of networks between public and private agent which interact and give mutual feedback in a specific territory by taking advantage of their infrastructure for the purpose of adapting, generating, and extending knowledge and innovation"* (Lundvall, 1985).

In 1990s, a related, but distinct, concept emerged based upon the writings of Harvard Business School professor, Michael Porter (1990)—the Regional Industry Cluster (RIC). Porter initially defined clusters as a *"geographic concentrations of interconnected companies and institutions in a particular field that clusters and encompass an area of Linked industries and other entities important to competition"* (Porter, 1998). The RIC concept shares much in common with the Regional Innovation System. The primary difference is that an RIC is typically narrower in scope – a discrete collection of interconnected industries and institutions that are often related by membership in a common value chain. For example, one of the major clusters in the Silicon Valley is the Semiconductor clusters—Semiconductors is the major component of any electronic device including part of cars, mobile devices, and others. This cluster delivers a supportive environment that provides all services and parts to companies that produce semiconductors (Kenney & Von Burg, 1999). An RIS, by contrast, is broader and not necessarily tethered to a single value chain or group of related industries. Rather, it describes a larger system that transcends individual clusters to advance regional innovation more broadly. In short, while a region may have many industry clusters involved in technology and innovation, the regional innovation system serves to the benefit of all.

Realizing the importance of innovation systems, governments in developing countries have begun to invest billions of dollars in technological and traditional infrastructure—namely

to replicate California's Silicon Valley (Wadhwa, 2013; OECD, 2013; Feldman, 2014). After several years and billions of dollars of investments, many researchers, developers, and policymakers have begun to question whether Silicon Valley is truly replicable (Feldman, 2014). Silicon Valley stands as a unique case because it has a deep culture and reputation embodied in its innovation system. This innovation culture facilitated many of start-up companies and large corporation development and production needs, which made the Silicon Valley difficult to imitate and impossible to replicate. For example, while the second most notable RIS for its success Route 128 in New England garnered around $ 3.5 billion of equity investments in 2012, the Silicon Valley brought in the largest share of venture equity investment by exceeding $11 billion in 2012 alone. Most other areas were hardly as fortunate although they might still be home to one or more successful RISs (Regalado, 2013).

Although there were mainly failed attempts in creating an innovation system or even innovation clusters around the world, there are examples where many countries and local governments have managed to build successfully systems (Brimble, 2007; Buesa, 2006; Chen, 2011; Chou, 2011; Cooke, 2004). Some of the most widely cited examples nowadays are recent and have not even being listed in the top 46 most advanced innovation clusters in 1990. This emerging innovation clusters includes: Bangalore in India (Krishnan, 2003; Herstatt, 2008; Karna, 2013; Parayil, 2009), Jiangsu in China (Parayil, 2009), Hsinchu Science Park in Taiwan (Chen,Chung-Jen 2006; Hsu, Chiung-Wen 2001; Lai, Hsien - Che 2005; Lee, Wen - Hsiung 2000), Tel Aviv in Israel. While they might not mimic Silicon Valley, all of the above are viewed as at least partially successful models. Their systems are quite diverse, but are generally characterized by government-led

attempts at seeding regional innovation clusters through massive investments in infrastructure coupled with generous incentives to real estate developers, foreign and domestic companies, science and technology workers, and nascent entrepreneurs.

Many scholars attribute the existence and success of innovation systems among developing and developed countries to strategic investment, leadership, and cooperation among governments, industry, and universities. Together these three elements of government, industry, universities combined to form what is called the Triple Helix Model (THM) of development. Proponents of the THM model claim that it is the connectivity between these three components that creates a supportive innovation ecosystem (Meyer, Martin, Siniläinen, Tatiana, Utecht,Jan Timm, 2003; Park, Hong, & Leydesdorff, 2005; A. Saxenian, 2006).

Saudi Arabia is following a similar approach by investing massive public investment in an attempt to spur the creation of innovation clusters (Al-Filali, I. Y., Gallarotti,G.M., 2013; Al-Swailem, 2014). In 1977, Saudi Arabia created King Abdul-Aziz City for Science and Technology (KACST), with the expressed purpose of drawing and implementing the Saudi science and technology plans (NSTIP). To convey its duties, KACST established its national laboratories and tasked it with science and technology policy making, data collection, research funding and patent services (Al-Tasan, 1992).

In 2003, KACST updated its NSTIP plan and outlined 15 technological fields considered as important to diversifying Saudi Arabia's national economy. These areas include: "Water, Oil, Gas, Petrochemicals, Nanotechnology, Biotechnology, Information Technology, Electronics, Communications, Space and Aeronautics, Energy, Environment, Advanced Materials, Mathematics, Physics, Medical Health, Agriculture Technology, and

Building and Construction" (King Abdulaziz City for Science and Technology (KACST), 2012). This plan was an important step to move Saudi Arabia away from the heavy dependence on crude oil that considered more than 90% of its exports. To achieve this goal, KACST succeeded in building a relationship with major technological and educational institutions around the world to increase high-tech production. For example, IBM, Intel, NASA, MIT, and others, this relationship allowed KACST to have access to the latest technology and ensure a level of knowledge transfer between these institutions and KASCT. In 2014, KACST announced the successful launch of the thirteenth satellite to outer space. This success was part of KACST Partnership with NASA and Stanford University.

Building on the perceived successes of KASCT, in 2005 Saudi Arabia announced that it would create six new Economic Cities spread throughout the Kingdom. Some of the most prominent examples include King Abdullah Economic City in the western region, Jazan Economic City in Jazan (southern region), Prince Abdulaziz bin Musaid Economic City in Hail (central region), the Knowledge Economic City in Al-Madinah, and two more held for future development. Each city has a different focus with roots in the natural resources and industrial base of the region. All are premised on the notion that massive subsidies for real-estate development and infrastructure can spur private sector development. (Al-Swailem, 2014; Saudi Arabian Ministry of Economy and Planning, 2004; Thorold, 2008)

Despite unprecedented levels of public investment, these new Economic Cities have faced major obstacles. Much of the blame is placed on the 2008 Economic Crisis. Pointing to the slowly global economy, in 2008 the Chairman of both King Abdullah Economic City and Emmar Real Estate Development Company—a major investor in the Economic City—

announced that it would postpone major projects in the Economic City. The economic crises incident halted nearly all of the city infrastructure and services building projects except for some developments on port and shipping facilities. While two cities remain for future development, Aramco Oil Company and other foreign oil company took the responsibility of developing Jazan Economic City as an oil base industrial city. However, since 2014, oil prices is experiencing a huge decline, which could reflect adversely many parts of oil investment and the country's economy in the long run (Adelman, 2004). This state of price reduction supports the need for diversifying the country’s income and heartens innovation system development.

1.3 Statement of the Problem and Research Questions

Many governments are committed to the idea of creating high-tech industries in their territories. Often they do so by imitating other well-recognized models such as the Silicon Valley (Feldman, 2014). Morespecificly, governments, institutions, and policymakers have motivated such activity by supporting the creation of related industries. However, such effort often fails to create innovation, self-sustaining ecosystem (Cooke, Philip,Schwartz, Dafnah., 2007; P. Cooke, 2001; Feldman, 2014).

There is a strong need for a conceptual framework to clarify the hierarchical relation between the models of innovation (GIS, NIS, RIS, and RIC). The unclear linkage between the models is between venture capitalists, research university, entrepreneurs, institutions, incubators, networking, and industries in the three models of innovation systems (H. Etzkowitz & Leydesdorff, 2000; Guan & He, 2007; Leydesdorff, 2000).

1.4 Research question

My primary research question is: *Can Government Investment in Technological Infrastructure Drive the Formation of Regional Innovation Clusters?* Related to this are a number of relevant sub-questions:

- How did some developing countries succeed in building a knowledge-based economy?
- What was the government's role in creating the innovative system in these developing countries?
- What is the major component of the successful innovation systems, how do they relate to one another, and at what stage(s) of development is each relevant of multiple stage or level of these innovative systems?

In particular, I am interested in examining the application of innovation systems and industry cluster concepts in developing nations, and then applying the lessons to the case of Saudi Arabia's to provide specific advice to Saudi officials on how best to approach the technological diversification of their economy.

1.5 Rationale for Study

This study will help bring clarity to the process of creating innovation systems in developing countries at different scales (global, national, regional, and industry cluster). This creation process involves government policymakers, private companies, venture capitalists who wish to invest in future high-tech innovation clusters in developing countries, such as Saudi Arabia and others.

This dissertation will have several important outcomes for scholar and policymakers. First, it will bridge gaps in the literature between the multiple levels of innovation systems (GIS,

NIS, RIS, and RIC). Thus far, scholars have mainly focused on a single model when discussing reasons for economic innovation and development, but not the relationships between them. However, a small number of studies support the notion that the relationship between the three models of innovation also matters (Hertog, Pim den., Remøe, Svend.,Organisation for Economic Co-operation and Development., 2001).

Second, the dissertation will rise the importance of relating the attributes of the Triple Helix model government, industry, and university and other smaller components of the innovation systems' as entrepreneurship, venture capital, and incubators to form a theoretical framework for this investigation.

Third, the findings will help policy makers to implement the necessary procedures and policies to support the majority of innovation system in developing countries. These procedures will do so by identifying the importance of networking and connection in the three model of Innovation Systems.

Fourth, identifying the relationship between variables such as universities, institutions, and other within investigated cases will detect the relationships between the private and public institutions. This relationship detection will help bring clarity to the networking and connectivity that usually get involved in different cases of innovation systems.

Fifth, linking the final developed model with the result of the comparative analysis of different cases, will identify, categorize, and analyze the major factors that lead to the success or failure of the investigated innovation systems and clusters.

1.6 Summary of Research Design

This study will use a comparative qualitative historical and case study method. More specifically, I first will select a small number of cases for in-depth analysis. For each, I will use historical longitude analysis and use— Process tracing—to help explain the occurrence of events and analyze how they have shaped subsequent developments through the years. Process tracing focuses on unfolding events to explains possible causal inference (Collier, 2011). This approach will enable me to identify the historical creation and key evolutionary events, including strategies and policies that framed related public and private institutions (Patton, 1990).

I will collect information mainly from the economic development plans of the investigated countries. Furthermore, the investigation will collect information from a variety of sources including scholarly journals, books, census, official websites, and published numerical data, to help understand the relation between the three models of innovation systems GIS, NIS, RIS, and RIC.

An in-depth comparative method best fits this kind of inquiry. It allows the scholar to investigate certain phenomena deeply and intellectually using specific qualitative methods (Patton, 1990). One major issue that could usually be accompanied by choosing a small number of cases is that it may reduce generalizability. This problem may be solved by increasing the number of observations (variables) in each case that will support the relationship claim between innovation systems and make it generalizable (Brady, Henry E.,Collier, David,, 2004). Another major problem that could affect the research rigor is if the evidence was collected suboptimal. This problem can be solved by coding each variable during the process of collecting the data (Saldaña, 2013).

1.7 Outline of Dissertation

Figure (1) shows the anticipated content of this dissertation by expressing the six chapters that will elaborate the investigation process and findings. The first chapter will introduce a thorough overview by discussing the rationale of the study, statement of the problem, the research question, and a summary of the primary methods. Also, the introduction explains how this study will inform policy and help guide decision-making in countries that are attempting to create a technological innovation system.

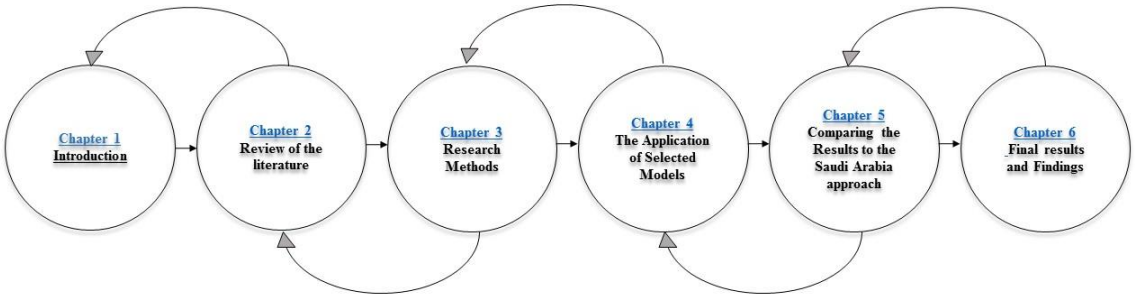

Figure 1: Outline of Dissertation

The second chapter will provide a review of previous theory and empirical research. This review includes prior work on common innovation systems in developed and developing countries. I will conclude with the discussion the Triple Helix model of innovation. The Triple Helix model is part of any innovation system, thus, understanding the model will help in understanding any innovation system.

The third chapter will describe the methodological framework. My framework will employ a comparative historical and case study based qualitative method. This qualitative method encompasses the most appropriate tools to examine the process of innovation policies in chosen countries. This longitudinal investigation tools will include process tracing. Furthermore, this chapter will provide complete information about the data collection process, analysis, and validation strategies to ensure accuracy and validity of the data.

The fourth chapter is the core chapter that will produce the applications of the innovation systems models in the selected cases.

The fifth chapter will compare the results of the investigated cases with each other and will indicate major differences and commonalities. Furthermore, it will give a roadmap for a successful Innovation system.

The sixth and concluding chapter will introduce the final results of the comparative study by creating a model of interaction between different stages of the innovative systems.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Innovation Systems Overview

In late 1980s, academics and policy officials began to focus on innovation systems as models for technological development. (Asheim, Bjorn T,Isaksen, Arne, 2002; P. Cooke, Boekholt, & Tödtling, 2000). The concept of Innovation Systems that was produced by B. Lundvall in 1985 emerged from the economist Fredric list conception of "The National System of Political Economy" in the19th-century (List & Colwell, 1856). List's concept is likely what Lundvall and others referred to as the National Innovation System (NIS) in the Mid-1980s (Freeman, 1995). However, there is one major difference in the new model, this differentiation is including Innovation system within the conception category. Extensive studies indicated that Innovation Systems does not only operates on the National level, but it also operates on multiple or overlapping scales as global, national, regional, cultural and sectoral level as shown in figure (2).

For a deep understanding of the Innovation systems phenomenon, we need to define each word separately. Innovation has different meanings and identifications depending on the category that it is posted in, but widely known as continues creation of new products, methods, and services (Johnson, 2001).

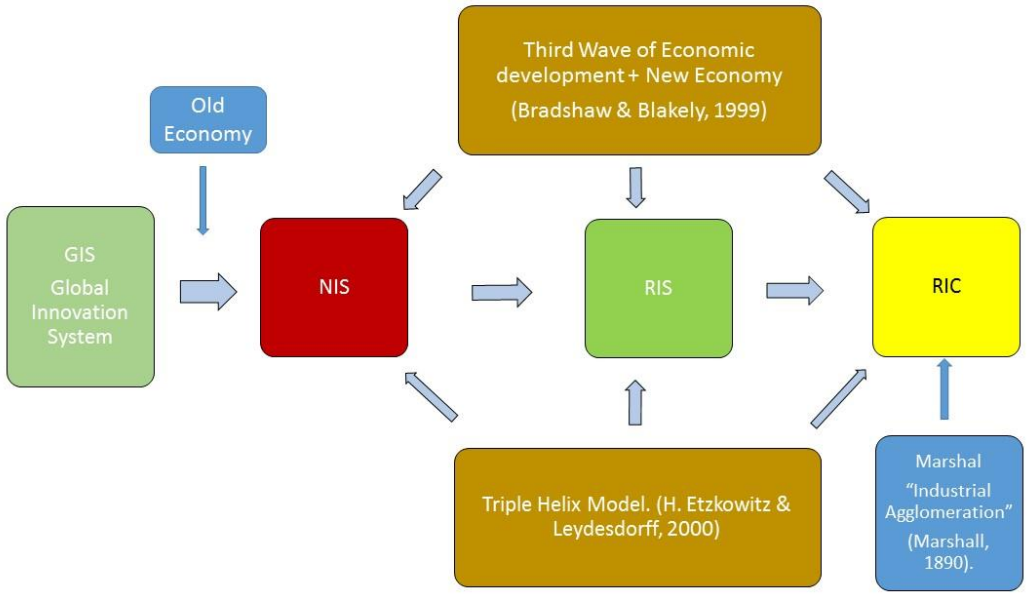

Figure 2: Literature Review Approach

In his book (The World as Total Systems), Boulding (1985) identifies systems as *"anything that is not chaos."* More precisely, a system is a combination of a sum of elements and the connections between these components.

Following these definitions, we can understand innovation systems as a spatial category that contains elements that interact and linked together to generate, distribute, and consume knowledge base products. Thus, knowledge-inquiry is an essential part of any Innovation System. Here, Knowledge is defined as an increased awareness and understanding of a phenomenon or an object that formed by implementing education or experience (de Brabander, 2000).

2.1.1 Innovation Systems debate.

In the past several years, there has been a debate over the definition of NIS, RIS, and RIC. This distinction is not purely academics as it affects how each model is applied in the real world. The differentiation within each model is in the model relation to central decision making (government). The degree of this relationship affects each component of any innovation system model. While the financial and logistic support for the NIS by governments is high, governments are not as interested in lower regional and cluster levels. Furthermore, this differentiation follows each countries' special characteristic and culture. In other words, what applies in a particular part of the world does not apply necessarily to another part. However, there are some common components of each innovation system in different spots either on the national, regional or cluster level. Arguably, there are some mandatory common components that Innovation System cannot function properly without it. Theses components are Government institutions, industries, venture capitalists, entrepreneurs, educational institutions, laboratories, networking, incubators, and land (Saxenian, AnnaLee,Sabel, Charles, 2008; A. Saxenian, 1994; A. Saxenian, 2006)

2.1.2 The roots of the three models of Innovation

The development of the three models of Innovation Systems NIS, RIS, and RIC occurred in the mid-1980s through the 1990s. Since then the three models have been adopted broadly by many national and local government officials as part of their economic development policies. All three paradigms are considered a fruitful source of enhancing growth and economic development within countries, regions, and even rural locations. To understand The NIS, RIS, and RIC framework differentiations, commonalities, strengths, and

weaknesses of each paradigm, this literature will review and investigate the first attempts to understand "Industrial Agglomeration" by Alfred Marsha, an English economist in 1890. The Major purpose of Marshal's Industrial Agglomeration theory is to understand and analyze the reasons and benefits that motivate industries to cluster and locate near each other (Marshall, 1890).

Marshals indicated many reasons for industrial proximity in the late 19th century. One main reason for this industrial clustering is the cost benefits. He realized that industrial proximity would reduce the cost of many services in any industrial concentration. For instances, the cost of transportation and infrastructure by sharing services with several industries and employees. Another major benefit for agglomerations is the proximity of consumers and suppliers were each industry can benefit from each other's products especially in industries that share similar characteristics. (Marshall, 1890).

All three Innovation Systems paradigms have their roots in the 1890s Marshal's writing in describing industrial agglomeration benefits were shared services and infrastructure will enhance productivity (Marshall, 1890; A. Saxenian, 1994). The three model of innovation each benefits from networking within each mode components. Institutions, universities, industries, laboratories, and entrepreneurs all are highly embodied in any innovation system, and all share the same purpose of innovation production. As in Marshal's agglomeration theory, all cluster components are benefiting from each other in both the innovation systems and the industrial districts.

In the 1930s and after the great depression, governments started to adopt some of Marshal's ideas about agglomeration and started to give incentives to firms to relocate in their areas.

Not long until theorist and officials realized that this strategy is considered a zero-sum-game were a benefit of one area will result in the loss of another area. Thus, the second wave of economic development took place in the 1960s that focused on retaining industries and supporting entrepreneurs to build their enterprise and companies throgh incentives and tax reductions. These ideas helped in the growth of the Silicon Valley region, one of the most prominent examples of both NIS and RIC. However, the result of these ideas has not been identified until Michel Porter introduced his model of the cluster in 1990. In 1990, the third wave of economic development.

2.2 The Third Wave of Economic Development (THVED):

The third wave strategy embodied to build and generate institutions and to recruit industries through state entrepreneurial programs. The THVED reflects the networking and business collaboration between businesses, institutions, and universities. All of these components usually function according to THVED usually function within clusters. (Bradshaw & Blakely, 1999)

Regions that adopted the THVED paradigm helped state officials to focus on industries that share similar interests and products to help industries benefit from each other products, experiences, infrastructure, education, and even job market. (Cencula Olberding, 2002). These new strategies helped reduce the cost of incentives that legislators tend to involve in each strategic planning to encourage industries to relocate that tends to be in old economic development waves (Bradshaw, Blakley,1999). These activities tend to be major components and commonalities in NIS, RIS, and RIC.

2.3 National Innovation System (NIS):

National Innovation System (NIS) was first developed as a conceptual framework in the mid-1980s in the contemporary science and technological studies. This illustration has been developed by pioneering scholars in the field such as Freeman, Nelson, and Lundvall. Each scholar has his theme that define the NIS model (OECD, 1997). However, they all share the notion that The NIS is a group of institutions that relate together and innovate within the border of a nation (Freeman, 1987; Lundvall, 1992; Metcalfe, 1995; Nelson, 1993; Patel & Pavitt, 1994).

The concept of NIS rests on the premise of understanding the linkages between the individuals and institutions tangled with innovation as key factors in nurturing and supporting technology. These institutions that play as actors in the national innovation system can be private or public enterprises, educational institutions, or research laboratories.

The National innovation system model has gained increased importance in the field of technology development due to three reasons. These reasons include the acknowledgment of the economic significance of knowledge; the growing use of systems approaches; and the rising number of institutions participating in knowledge production (OECD, 1996).

2.4 Regional Innovation System (RIS):

The regional innovative system is one of the most widely cited innovative systems. A major reason for such importance in the innovation realm is because of its association with successful regions, namely Silicon Valley in California (A. Saxenian, 1994).

After the development of the NIS by Nelson, Freeman, Lundvall, and others in the 1980s, there was a clear gap in explaining the regional advantages in innovation systems in the Silicon Valley and other innovation regions in the U.S and Europe. This gap motivated other scholars such as Philip Cook in the early 1990s and other later on such as Asheim and Isaksen to do extensive researches in areas in the U.S and Europe. These studies produced the RIS as a deeper understanding of Innovation Systems at the regional level (B. T. Asheim & Isaksen, 1997; Asheim, Bjorn T,Isaksen, Arne, 2002; P. Cooke, 1992; P. Cooke et al., 2000; P. Cooke, 2001).

Arguably, RIS is smaller than NIS and a wider concept than RIC, because it potentially transcends any one cluster so long as the clusters interact with each other within the boundary of the region in a systematic way (Malerba, 2004). The major practical differences between RIS and NIS is that NIS have more authority over taxes, traits, and other National policies (Chung, 2002).

Chung (2002) also indicated that RIS do not concentrate on a single industry or firm such as RIC. On the contrary, it contains a multiple industry operating at multiple levels of production. According to Cooke (2007), RIS encompass five major components *"Regional knowledge culture, Regional social capital, Globalizing network relation, Regional Institution, Policy, and knowledge transfer"* (Cooke, 2007).

2.5 Regional Innovation Cluster (RIC)

The term RIC was coined in the 1990s largely due to the popularity of the writings of Michael Porter (Porter, 1990). Porter imagines clusters to be specific groups of interconnected activities located in a particular field in the area or a region (Porter, 1990).

However, many scholars critiqued Porter's geographic model of clusters claiming that geographic spaces do not determine clusters, rather connectivity within clusters could take other forms namely, clusters as a network (Aktouf, 2004; Allio, 1990; Speed, 1989; Yetton, Craig, Davis, & Hilmer, 1992). The term cluster is founded upon the descriptions of the dynamics of industrial districts by Alfred Marshal at the turn of the 19th century (Marshall, 1890). The differences were specification and concentration of the final products, goods, and services. While industrial clusters may include specific industrial districts, they produce a typical larger variety of products. Still, both clusters and districts are observed as spaces were close and strong communication located, sociocultural structure and institutional atmosphere may arouse socially and local imported collective learning culture and continuous innovation (Asheim, Bjorn T, Isaksen, Arne, 2002)

Thus, RIC is defined as *"a special and sectoral concentration of firms; and we measure success by the ability of the cluster as a whole to grow, typically through the expansion of entrepreneurial startups"* (Bresnahan, Gambardella, & Saxenian, 2001)

While Porter's model focuses more on the geographical concentration of linked industries, the NIC focuses more on innovation and growing by supporting the needs of start-ups. The framework of the RIC is clarified as contingent innovative activities in the paradigm of economic development. These activities are concluded in the presence of skilled labor and access to transportation, juxtaposition to markets and suppliers, the presence of graduate educational institutions and research institutions, and organizational supports for entrepreneurial activity.

The majority of literature indicates that firms, especially immature science-based entrepreneurial start-ups benefit from immediate access to these external resources because they lack the internal capacity and scale advantages of larger firms (Feldman, 2014).

All three-innovation model NIC, RIS, and RIC are advocated as having the ability to absorb knowledge and foster innovation entrepreneurs. However, the major weakness of these paradigms is their failure to indicate a road map for other regions to follow by seeding and nurturing new companies and entrepreneurs. This leaves the door open to each region to adapt and develop these frameworks to develop their models of regional success.

The Main point to Silicon Valley Semiconductor industry and it's related supporting sectors and institutions is a successful model of RIS. However, it is important to distinguish the semiconductor cluster in Silicon Valley with its various types of knowledge flows and institutions that may mutually benefit many individual clusters in the region from the overall RIC with regional industrial clusters in the semiconductor clusters in the Silicon Valley (Kenney & Von Burg, 1999).

2.6 The Triple Helix Model (THM):

Universities have long been recognized as an important vehicle for economic development in the North America. Areas such as the Silicon Valley and Route 128 are well-recognized for understanding the potential role that universities can play in creating an environment that can foster new knowledge and generate complimentary activities such as private sector research and innovation and technology start-up (A. Saxenian, 2006). The unprecedented rapid technological and innovation growth motivated scholars such as Leydesdrorff to investigate the major actors active in innovative and high-tech production areas. Accordingly, Leydesdorff produced one of the major theories that clarified the major actors in any innovation system as the Triple Helix Model (THM) (Leydesdorff, 2000). The THM claims that universities should be the primary innovation mechanism in building linkages between the three innovations component (government, industry, and university. (H. Etzkowitz & Leydesdorff, 2000)

Although this theory explains some of the main features of industrial clusters and innovation systems in North America and other developed economies, It is difficult to adapt to emerging economies around the world. The barriers that challenge the University's ability to successfully partner and collaborate with businesses can vary greatly from country to country and from region to region. Third World countries like Thailand suffered from excessive bureaucracy and centralized decision-making causing the abatement of many innovation activities in this country. This case calls for an immediate reform of the larger political system as a processor to changes in the university linkage system and development infrastructure. Consequently, this example highlights the importance of

leadership, which may be considered a critical aspect of the government element of the THM. (Brimble, Peter, Doner,Richard F., 2007)

A poor educational system is another significant barrier commonly associated with emerging economies. Lacking a solid educational system; it is unrealistic to expect the university to generate spinoffs as the system may lack the knowledge capacity to provide to business partners.

Certainly, one of the greatest challenges that stymie the ability of industry and universities to nurture businesses and create innovation clusters is its relationship with government. These relationships are critical to eliminating the obstacles that motivating development. This relationship could be enhanced by imposing a mediation institution that can collaborate with parties. This institution could be banks, venture capitalist, incubators, or other supportive facilities (A. Saxenian, 2006).

The second major obstacle that hinders University-based development under the THM is the lack of absorptive capacity. That is necessary to transform knowledge into the creation of a final product. The occurrence of this phenomenon considered a serious jeopardy for the mechanism of development and relationship when choosing university as an economic development motivator (Cohen & Levinthal, 1990).

The third barrier for universities to successfully partner with industries is the lack of autonomy in any university system from governments. Countries like Saudi Arabia and Japan have a tradition of deep links between the educational institutions and government (Freeman, 1987; Salem, 2014; Shin, Lee, & Kim, 2011). Theses links give a considerable

government control over university activities, with many universities reliant on government consecutively for financing and support almost entirely. Accordingly, the financial position of any educational institution bound by the government ability to finance any project. In other words, the innovation capabilities will be part of the government system, economic and financial position either support or leave any project if no funds available (Shin et al., 2011). Similar consequences faced countries such as Japan that have a tradition of knowledge transfers suffered from a grant reduction for entrepreneurial support (Daly, 1998).

To develop a well-organized partnership and knowledge transfer, officials and policy makers need to enhance knowledge transfer and spin-offs by increasing training for potential entrepreneurs and providing mentoring and consultation services and improve research.(Lundvall, 2004; Nelson, 1993; Porter, 1998)

CHAPTER 3

RESEARCH DESIGN

3.1 Overview

This dissertation will use a qualitative pragmatic method to investigate the government's role in developing an Innovation System. Under the pragmatic method, the scholar uses various approaches and data sources to answer the question rather than rely on a single method or source (Patton, 1990). Furthermore, the pragmatic researcher is free to choose the best procedure and technique in investigating the cases (Creswell, 2014).

By using qualitative methods, the investigator seeks to understand the innovation system phenomenon, which may encompass multiple points of views and perspectives. Furthermore, the qualitative method helps facilitate our understanding of the complexity of the models of the Innovation Systems by involving different policies regarding political, economic and social points of view accompanied by analyzing its observable policy implications (Brady, Henry E.,Collier, David,, 2004; Creswell, 2014). Qualitative approaches typically involve in-depth analysis of a small number of case studies (small-N analysis). Thus, it is particularly important to identify a case selection procedure that avoids sample selection bias and increase the possibility of generalization (Patton, 1990). In this case, I intend to be able to generalize my results to show how innovation can be replicated in other areas. Although this investigation is focused on three developing countries, its results can be generalized to other developing countries and areas within investigated nations. The generalizable findings are a result of the theoretical framework that this investigation is built on. Each step in this study is constructed upon theories and findings that scholars and official agreed on its accuracy and validity such as Marshals

industrial agglomeration economy theory, and Joseph Schumpeter innovation theories; and other theories and theorist approaches.

According to Abbott (2004), small-N analysis requires us to choose from a sufficient number of applicable cases. Applicable cases in this investigation, are countries where innovation and knowledge-based economy transformation takes a huge part of their economic policies and configuration. Thus, leads to a successful creation of RIC. To facilitate this requirement, I will choose cases that share the same geographical, cultural, political, and economic circumstances (Anckar, 2008). The result of this investigation will help us in understanding each system, and it's replicability in other places within each country.

3.2 Case Selection

3.2.1 Choosing on the depended variables

The case selection strategy is based on selecting cases based on the dependent variables, which is the existence of an innovation system in the selected cases. All chosen cases were investigated based on the occurrence of the phenomena's outcomes (innovation clusters on different industrials focus in each country). The main reason was that we could not infer by selecting cases only on the independent variables, such as universities, financial institutions, government research institutions, and industries. Investigating the independent variables were the phenomena do not occur (innovation clusters) is a waste of time and effort because the reason for the investigated phenomena may not exist. Another important reason for the difference between the three cases is to increase the validity of the results and to support the findings. Based on the mill method of a difference the chosen countries are India, South Korea, and Saudi Arabia (Mill, 1847).

All three countries' innovation systems are different in their outcomes (industrial specialization).

- Outcomes difference:

In the 1990s, India decided to be the world hub of information technology. To achieve this goal, India concentrated its activities and effort to develop its institutions to cope with this objective (India, New Delhi: Planning Commission, 2013). South Korea chose to take a different path and decided to be the world high technological hub in the early 1990s. To achieve this goal, South Korea's efforts were concentrated to develop the institutional and industrial infrastructure that supported this objective (OECD, 2016). Saudi Arabia also followed a different path and decided to increase its effort and be a pioneering country in oil and petrochemical production (Lempinen, 2011). The country's effort was concentrated in developing this industry and built a robust infrastructure and institutions that helped to achieve this goal.

- Administrative difference:

India has been considered as a federal country where each state has its unique power over its territory (India, New Delhi: Planning Commission, 2013). In South Korea, the case was different in that it was ruled by a dictatorship until the late 1970s when it was transformed to be a republic country (Mahlich, 2007). Saudi Arabia is different in that it is ruled as a complete monarchy country were central decision-making is important to support the economy. This difference shows that even if there were a variation in the administrative level the policies to support the innovation systems and to build a Regional Innovation System would have commonalities.

- Population difference:

India is different than the other countries that it has more than 1billion inhabitant (India, New Delhi: Planning Commission, 2013). South Korea population is way below India, South Korea's population is around 51 million, which will give the dissertation richness in dealing with such conditions (OECD, 2016). Finally, Saudi Arabia population is around 30 million, which varies significantly from the other two cases.

3.2.2 Addressing selection bias

Selection bias is one of the major problems of inference. Selection bias is defined as *"systematic error that arises either when cases are selected according to an unrepresentative sampling rule, or when some (often unknown) nonrandom process assigns cases to cases"* (Brady, Henry E., Collier, David, 2004).

In their book Designing Social Inquiry, King et al. (1994), describes two major types bias involved in selecting cases. The first bias occurs when selecting cases on the dependent variable and the second bias rise upon selection on the explanatory variable. The major problem with selecting cases on the dependent variable is that variation is trimmed where observations do not include the full range of variation possible in a particular case. Thus, "any selection rule correlated with the dependent variable attenuates estimates of the causal effect on average" (Achen, 1986). In qualitative research, this means that the true causal effect may be larger than that estimated by the scholar. However, King et al. (1994), claim that bias resulting from the selection of the dependent variables can be mitigated by:

- Avoiding cases where there is no natural variation in the dependent variable. These circumstances do not support causal inference because the result (the dependent variable) will be the same even if the cases and the independent variable vary. These have been succeeded by choosing three different cases in different countries and

different industrial focus. India focuses on IT industry; South Korea focuses on Heavy industry and High technology; and the Saudi industry focuses on Oil.

- Preparing a list of alternate cases that encompasses similar circumstances as the selected cases to use when insufficient data may threat the validity of findings. Other cases that can be investigated that have a list of successful are China such as Hong Kong Innovation cluster and Taiwan Hsinchu Science Park (Chen, Wu, & Lin, 2006).
- Preparing lists of alternative data sources to use in the possibility that restricted access to some data may affect the dependent variable. Alternative data sources are available from the OECD and the UN data and research investigation.

The most different case selection strategy can be biased when the full range of variables is not representative. However, the process of causal analysis begins by identifying a universe of possible observations to theses variables. In our case, the observations are policies that affect our independent variables. These policies range from economic, organizations, education, innovation, taxes and incentives anything that can lead to the successful creation of RIC. Some common yardsticks then measure the effectiveness of these policies such as codes (Abbott, 2004). Thus, unsuccessful coding is one of the most threatening factors in the most different case selection strategy.

3.3 Case study analysis

Yin (2009) describes the case study approach as a mode of inquiry that bridges the gap between a contemporary phenomenon and its context, especially when the boundaries between phenomenon in the real context are not identified. This dissertation will adopt a comparative methodology that will investigate the historical evolution of each case

through an approach known as process tracing. Specific observations from each case are associated with theories to help generalize the findings. My particular approach to case study investigation focuses on analyzing and documenting instances of institutional evolution as they may pertain to the success of each cluster.

3.3.1 Historical investigation:

This study will use a comparative longitudinal analysis to identify key historical legislative plans that helped to shape current situations, institutions, policies, and political events in each case, and then compare these occurrences across cases. Longitudinal case-study analysis indicates the sequence of events, procedures, and consequences that provided chances to create many advanced levels of assurance that observed correlations as causal relations (Winship & Morgan, 1999).

Lecours (2005) and Lieberman (2001) state that the most important question of comparative longitudinal analysis, what is the best period to be compared? Not every historical observation is formed equally, and some insights provide more analytical understanding than do others. Accordingly, four different periodization strategies must be defined in each case in the comparative historical investigation to indicate causal inferences. The first strategy is institutional origins, which measures the change in the outcomes and institutional variation across cases. Second, is the institutional change strategy. This strategy measures the divergence or convergence of outcomes across cases that are related to the institutional convergence or divergence. Third, is the exogenous shock strategy, which measures the change in the outcomes that are related to the institutional variation across cases. The final strategy is rival causes. Rival causes

measure the change in the outcomes that are related to the shock in rival explanatory variables within and across cases.

3.3.1.1 Process tracing:

Process tracing is an important mode of both discovery and causal analysis in the case study method. It was first initiated in 1979 and was adopted extensively by George and Bennett as illustrated in their book *Case Studies and Theory Development in the Social Sciences (2005).* Scholars usually use process tracing when examining evidence that either supports or falsifies an explanatory hypothesis within cases or to compare two or more cases bounded by a spatial and identified phenomenon or event (Yin, 2009). Process tracing focuses on observable variables in the cases that seek to identify causal mechanisms by testing a single theory using causal steps. During process tracing, scholars need to be aware of the sequences of the causal process to prove the hypothesis (Collier, 2011). Also, the researcher needs to identify the observable implications of the hypothesis by observing the data at a more detailed level of analysis, such as observing explanatory variables during case investigation. This means that I need to seek a relation between independent variables that can explain the dependent variable to successfully elaborate the causal mechanism for a specific observation with a case. In process tracing scholars should ask "how does *X produce a series of conditions that come together in some way or do not come together to produce Y? By emphasizing the causal process that leads to certain outcomes, process tracing lends itself to validating theoretical predictions and hypotheses*"(Bennett, 2010).

While process tracing can be valuable for investigating causal relation, it is particularly valuable to investigate the sequence of events within cases. I will use a process tracing

approach to investigate the the Innovation Systems within the chosen countries. Each country, region, and cluster has its characteristics and events that lead to develop an RIC successfully. According to these events, a series of governmental policies lead to the connectivity between the models of Innovation Systems GIS, NIS, RIS, and RIC. Using process tracing in this qualitative investigation will answer not only formal events and anticipated results, but it will also examine informal configurations and unsuspected relations (Patton, 1990).

King et al. (1994) point to several potential problems associated with the application of process tracing to the case study method. Among them are problems associated with infinite regress. There are countless variables to consider, and selective inclusion or exclusion of factors may influence the validity of the findings. Another problem with the case study method can be described as the degree of freedom of case. The degree of freedom is the ability to indicate the exact degree of variance in the independent variable that makes any system function successfully. While zero variance makes the dependent variable constant, having a high degree of variance could affect the observation validity adversely in the most different case selection strategy.

The response to both critiques is that not all data are equally important. The investigator does not need to examine each variable or detail at an equal level. It is possible for one portion of data to improve intensely one explanation and disapprove others while other portions of data might not favor among explanations. What matters is not the portion of the evidence, but its contribution to different alternative hypotheses (Brady, Henry E., Collier, David, 2004).

3.3.2 Data Collection:

This study will implement its qualitative case study historical method using data gathered from a variety of published documents. In particular, I will examine the five-year strategic plans that affect the relationship between the multiple stages of innovation models and institutional connectivity in each country to explain the evolution of policies throughout the years. All three countries started producing their five years strategic plans for economic development in the 1950's and 1960's, and this period also provides a good starting point for historical reasoning. Since the implementation of the five years' annual plan, each country has established institutions and implemented policies through the years to create its economy including the attempts to change this economy in the past years to a knowledge-based economy.

The investigation of the content of these plans will be supplemented if needed by documents produced by OECD and UN document that reflects the technological evolution of each case. Through the course of my investigation, I will likely discover other relevant documents, reflective journals, and official sites that contain pertinent information. I will compliment the information gathered through the analysis and codification of documents with quantitative indicators. This information will be collected from established secondary data sources, such as the OECD, UN, as well as National Statistical Bureaus of each country if needed.

3.3.3 Improving data quality:

There are several ways and guidelines to improve the quality and validity of data collected through documents. Among them is data coding. Coding is used to categorize data and keep track of the information to facilitate analysis (Saldaña, 2013). Each chosen country

will be investigated through different codes starting from size, location, population, industrial characteristics, economic performance, innovation policy, and institutional decisions. These analysis codes will allow me to draw models and relations from a set of comparable innovation systems. Consequently, these codes will allow me to identify the policy and decisions that have been made and affected the innovation performance of the adopted Innovation Systems. Furthermore, this type of analysis will clarify the relationship between the different levels of the innovation categories GIS, NIS, RIS, and RIC.

A second method of improving data quality is to evaluate a theory and collect as much data of its observable implication as possible because each observable implication will provide another context to evaluate its veracity (Creswell, 2014). In my case, such theories can be drawn from past investigations of Innovation systems. For instance, the old economy theories that explain our independent variables between the Global Innovation Systems and National Innovation Systems. Old economy theories such as marshal's agglomeration economy theory; Frederic list's National system of political economy; Joseph Schumpeter theories in innovation and entrepreneurship; and others. These theories justified many of the independent variables such as reducing trade barriers, tax reduction, and incentives. Also, the Triple Helix model illustrates the relationship between the NIS and RIS using three different Independent Variables University, Institutions, and industry.

The third guideline is to develop a roadmap of the inferential process. A detailed documentation of the process helps ensure that the data collection procedures are reliable and replicable. Reliability means that applying the same investigation technique, in the same manner, will always produce the same outcome. In other words, the investigator

needs to keep track of all information as well as the procedure that the investigation went through in analyzing the possible cases. So that other researcher following similar procedures would arrive at similar conclusions (Patton, 1990).

3.3.4 Data Analysis:

In their book Rethinking, Social Inquiries David Coiler (2004) and his colleagues identify three major themes of comparative historical analysis. The first involves choosing well-defined cases that comply with an established case selection procedure. The second involves using time sequence as a process tool to identify causal mechanism within cases as they unfold. Third, preparing a systematized comparison to explain and evaluate the outcomes (Brady, Henry E., Collier, David, 2004).

Accordingly, I will investigate the three chosen cases separately then compare the result in the final chapter. In each case, as shown in figure 3, my independent variables will vary between the models of innovation systems. For instance, the relationships between Global and National Innovation Systems will focus on three major independent variables that pertain to both innovation and success. The indicated variables are trade barriers, tax reduction, and incentives policies. Major policies have been implemented to create the knowledge-based economy depending on the old economy model including the policies that affected the previously mentioned variables. To explain the relationship between the NIS and RIS, I will focus on independent variables prescribed by the Triple Helix model of innovation, namely the inter-relations between University systems, Government, and Industry. Finally, the relationship between The RIS and RIC will be investigated through the University system, the national innovation agencies, the industrial system, and the research and development policies.

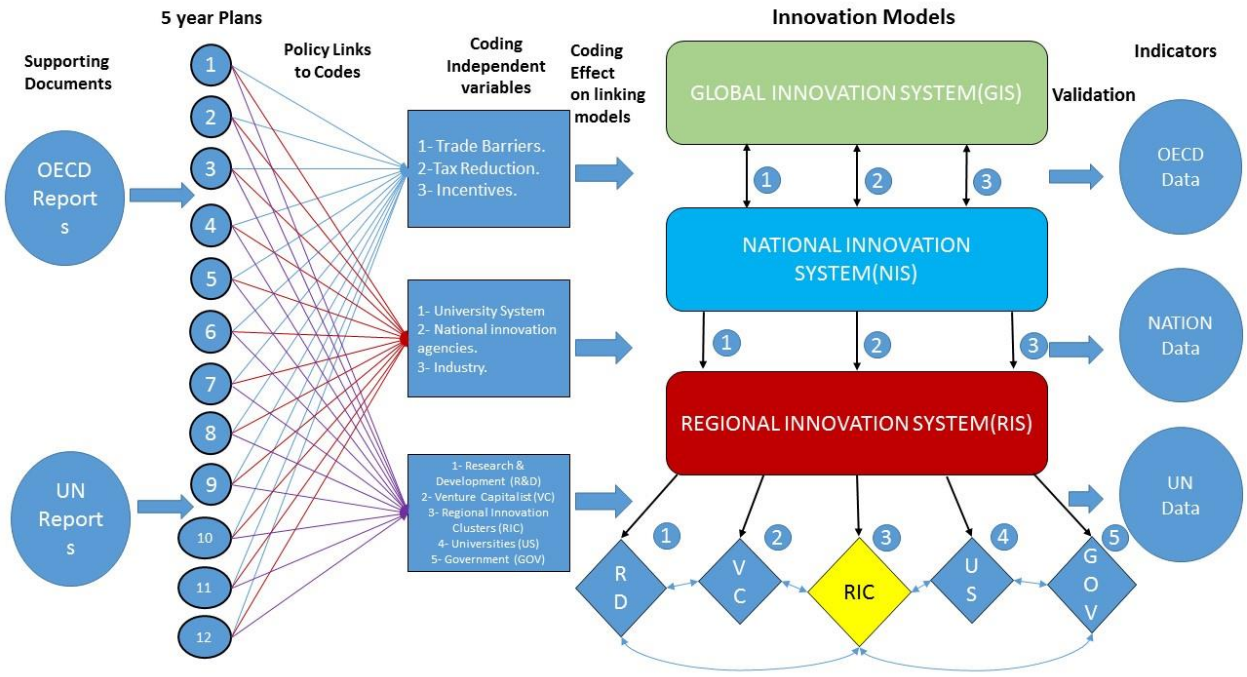

Figure 3: The process of investigating each case

Coding and tracing each policy that affected our independent variables will increase our understanding of the government's role in the development process. To identify policies that ultimately led to successful RICs, I will explore the degree of government involvement in theses variables through the analysis of official policy documents (i.e. the five years plans). The plan that the government implements to draw strategies and policies in the economy will demonstrate the connectivity is evolving between the innovation systems through the years and the government role using these policies as a tool for investigation. The independent variables will be investigated and coded a common point of agreement among scholars who explained these outcomes of successful RIC. Scholars often associate successful outcomes to factors emphasizes in "third-wave" economic development strategies such as entrepreneurs, universities, laboratories, institutions, incubators and trade barriers.

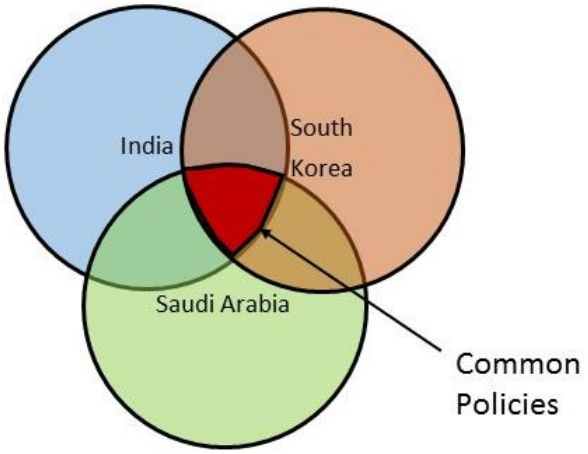

Figure 4: Common policies between the three innovation models

Finally, I will compare the result with each case as shown in figure 4 to indicate the importance of the connectivity as hypnotized earlier in this proposal between innovation models. Furthermore, these results will provide a deep understanding of policies and procedures for developing countries to replicate the success to other areas and will answer the major question of this investigation of the validity of huge government investment in supporting RIC.

3.3.5 The Role and background of the Researcher

As a former government employee at the municipality of Jeddah in Saudi Arabia, I had the chance to observe several comprehensive projects around the kingdom of Saudi Arabia. The majority of these projects were focused on enhancing economic development by building multiple complex projects in isolated areas. On the contrary, many of these projects remain only on paper and are never built. Moreover, the government of Saudi Arabia channeled their efforts in building a knowledge-based economy, by building the new Economic Cities and encouraging venture capitalists to invest in an entrepreneur.

I served the role of a mega project reviewer at the municipality of Jeddah in Saudi Arabia. During my time there I reviewed several mega projects that served the role of enhancing economic development. Many of the residential and multiple complex projects were depending on the growth of the New King Abdullah Economic City because of its proximity to the second largest city in Saudi Arabia, which is Jeddah, around 60 miles distant from the new Economic City. This city that was supposed to be the major knowledge-based economic hub in the region faced lots of obstacles and problems and started to transform from an industrial innovation cluster to a regular industrial cluster as its sister economic city in Jazan south of Saudi Arabia.

I remember the time when many investors came to the municipality and withdrew their projects and transferred their investment to other more promising countries. Even now, when I am away for graduate school, I occasionally ask my previous colleagues about the projects. They say that the pace of the new projects is not like when the government advertised for the new economic cities. Although these can be the reasons for other economic and financial issues, most investors claim that these delays are because of the delays in King Abdullah Economic City projects.

During my senior year at the University of Massachusetts, I took a class entitled Economic Development Issues in Planning. In this class, I read for the first time an article about waves of economic development that took place in the last couple of decades. I was shocked, as I realized that many policies that have been adopted by policy makers in the five years' development plan in Saudi Arabia are based on older models of economic development theories especially the parts that focus on knowledge and innovation as an economic development base

Also, I took another class at the University of Massachusetts Amherst about industrial issues in planning. This class opened my eyes on other countries' models of innovation systems when I read an article from Annalee Saxenian describing other countries efforts in building a knowledge-based economy.

My experience and current educational level motivated me to write my dissertation on this area that encompasses both personal and professional passions. As a mega project reviewer, I believe that I can share my personal experiences playing this role and understand more holistically how this phenomenon occurred in these developing countries and how other countries can play the same role in succeeding in the innovative world.

CHAPTER 4

CASES STUDY

4.1 India innovation system

4.1.1 The methodology of the study

In the following section, a process tracing investigation will be conducted to investigate the India innovation system development through the five years' economic development plan. The study will investigate five major subjects in each plan to discover if the government spending and policies can create an innovation model in developing countries. These five major subjects are the plans' major objectives, the financial system development, the educational system, the government research institutions (GRIs), and the industrial sector systems. In each system, the study will investigate the policies and objectives that affected these institutions connectivity vertically between the four major innovation systems: Global innovation system(GIS), National Innovation System(NIS), Regional Innovation System(RIS), and Regional Innovation Cluster(RIC). The study will also investigate how policies affected the connectivity between the educational, financial, research, and industrial system horizontally and led to create an environment of innovation in each of these chosen developing countries.

The study has been coded to search for major policies that affected the development of the major four systems that led to the connectivity between the institutions. These investigated elements are incentives, taxes, tariffs, intuitions, funding sources, international agreements, and government objectives and area of interests.

The country investigation will be organized into six sections each section will be investigating the five-year plan's major objectives, the financial system development, the educational system, the government research institutions (GRIs), add the industrial sector systems and institutional connectivity policies. Each section will be investigated through the five years' development plans. In each plan, there will be a table describing the policies that affected the GIS, NIS, RIS, and RIC.

4.1.2 India overview

India is considered one of the important countries in the world and is one of the G20 countries consortiums that consoles 2/3 of the world's trade. India was colonized by Great Britain since an 1800th century and had gained independence in the year 1947. India had transformed to the Republic of India in the year 1950 to start after that its path in developing the economy through the five years' economic development plans until it reached twelve plans (India., 2013).

India is the Federal Democratic Republic with 28 states, and the capital is New Delhi as shown in figure number 1. The literacy percentage is about 61% of the total population amount.

Figure 3 India's map including states distribution

India is considered the second most populous country in the world. According to the world bank census in 2013 India's population had reached 1,252,000,000 persons. The country's total area is around 3287590 km2. 28% of the countries income depends on agriculture, 54% depends on services, and 18% depends on industrial production (India., 2013).

4.1.3 India source of economic and S&T policies

In India, the planning procedure was conducted by collecting all information and statistics from all ministries and government agencies. The information that was provided to the Planning Commission to coordinate Planning the needs for each ministry and

implement policies and needs accordingly to be approved by the government along with its budgeting.

4.1.4 Vertical connectivity (GIS, NIS, RIS, and RIC)

4.1.4.1 India evolution of its government innovation objectives toward the economy

4.1.4.1.1 Overview

This section will explore the major Korean objectives and policies in the economic development plans from the early 1960s until now. These policies and objectives illustrate the government major principles, priorities, concerns, and new industries that helped shape the economy. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of South Korea. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the innovation models.

Each plan will have its table that explains the major policies and objectives. Moreover, at each point, there will be an arrow that shows the level of connectivity between the Global Innovation System (GIS), National Innovation system (NIS), Regional Innovation System (RIS), and Regional Innovation Clusters (RIC). These innovation systems existed in the 1980s and 1990s by famous scholar such as (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992). to indicate them at the early economic stages will explain the effect of these early policies in developing the models of innovation systems. Thus, the arrows will explain the effect and relations between the international, national, regional, and rural economy in the country at the early stages.

4.1.4.1.2 Reformed the government, controlled large industries and supported farmers

- **1951-1956 India First Economic development plan (IFEDP)**

DP	NUM	Objectives	GIS	NIS	RIS	RIC
1st	1	Reformed the whole government system		→		
	2	Reduced the adverse effect of whole production machines		→		
	3	Redistributed the occupational workforce		→		
	4	Increased the vocational and technical training		→		
	5	Controlled all Key industries in the country		→		
	6	Provided funds for farmers		→		
	7	Increased the exports and reduce the imports	←	→		

Table 1 the Indian First economic development plan (major objectives evolutions)

After India independence from Great Britain, the government of India started to reform the whole government system as its main objective of the First Economic Development Plan IFEDP (table 1). The new reform had reached the industrial, research, educational and monetary systems in central and regional and rural areas (INDIA Republic of India., Planning Commission, 1953).

The following schemes and objectives were crucial to developing the whole economic system of India during the IFEDP. As shown in table 1, the government major aim during the plan was to reduce the adverse effect of whole production machines on the local economy that existed and imported during the British Colonial era. These machines led to an advantage in reducing the cost of goods for local customers but had put many poor handicraft businesses out of business. Mass production created some unbalanced social problems in overpopulated areas, which led to the central government intervening by implementing policies that reduced mass productions in handicrafts areas. The third major aim as shown in table 1 was to redistribute the occupational workforce that was

concentrated in agricultural jobs by 68%; 14% in small and medium size businesses, 8% in trade and transport, and 10% in profession and services from central to rural areas. The fourth aim was to increase the employment rate of the educated middle class that had been slowed down after the Indian and Pakistani war. The fifth aim was to increase the vocational and technical training in the whole country in all economic fields, such as agriculture, mining, fishery, and industrial activities. The sixth aim was to take over and control all Key industries in the country, such as "coal, iron, and steel, aircraft manufacture, shipbuilding, manufacture of telephone, telegraph and wireless apparatus, etc." (INDIA Republic of India., Planning Commission, 1953).

Furthermore, the government undertook all large private enterprises whose operation affected public services and infrastructure. Thus, there were no private enterprises free of government intervention during the first Indian development plan. The seventh aim was to create credit guaranty funds for farmers, and to provide seeds and fertilizers for local farmers and free them from the control of the private lenders, traders, and intermediaries in the land. The eighth aim was to increase the exports and reduce the imports to control inflation and protect small and medium sized business from the high competition. These policies and objectives were very important in developing the basic Indian economy after years of the unstable, unbalanced economy. The new objectives were meant to develop the national, regional and sectoral Institute around the country that lay down the basis for the following years growth (INDIA Republic of India., Planning Commission, 1953).

4.1.4.1.3 Increased connectivity and support to local farmers

- **1956-1961 India Second Economic development plan (ISEDP)**

DP	NUM	Objectives	GIS	NIS	RIS	RIC
2nd	1	Developed the rural areas in the country		→		
	2	Controlled all large enterprises that were involved in public services		→		
	3	Allowed smaller companies to invest in smaller investments		→		
	4	Focused on smaller villages and rural areas and created the panchayats		→		
	5	Connected all states with the central government		→		
	6	Provided financial assistance to regional and rural areas		→		
	7	Provided technical and financial assistance to local agricultural producers		→		
	8	Established management, marketing, and financial institutions to support local farmers		→		

Table 2 the Indian Second economic development plan (major objectives evolutions)

After laying down the major character of the economy during the first plan, the government continued the same path of developing the country during the Second Economic Development Plan (ISEDP). One of the main aims in ISEDP was to rebuild the rural areas in the country. The government laid down the foundation of heavy industries in central and regional areas and farmers and handicraft industries in rural areas. The general motivation for this governmental policy was to secure balance in the economic development as a continuous goal from the first plan. This policy was also important to increase employment, production, and income in all of India (INDIA Republic of India., Planning Commission, 1956).

At the beginning of the second plan ISEDP, the government initiated a policy that controlled all large enterprises that were involved in public infrastructure and put them under its direct authority. Consequently. The government allowed private small businesses to invest in farming in rural areas. This initiative led to a huge expansion in the public sector and extensive reduction of the private business, which harmed the economy badly in the fallowing years (INDIA Republic of India., Planning Commission, 1956).

Before the initiation of the five years' plan, there were only three tiers of government control on all parts of the country: District, state, and central government, which weakened the control of the central government on the rural areas. Thus, the government aimed to widen its control by focusing on the smaller villages and rural areas and created the Panchayats[1]. The government organized its system by dividing the administrative levels into four levels. The highest level was the central government. Then the central government had several states. Within those states there where several districts. In these districts, there were blocks. In each block, there were villages, which were the smallest level. Each village was ruled by a panchayat. This categorizing helped the government in further developing the rural areas by easing the control on these areas. Multiple districts connected with states authorities. Also, All states connected with the central government. This new administrative policy was made to enhance the central government's control in all parts of the country (INDIA Republic of India., Planning Commission, 1956).

The new government system increased the central government understanding of the true needs of the rural areas and helped the government in drawing their employment, educational, industrial, and technological needs accordingly. Furthermore, the new governmental system supported the government in providing financial assistance for regional and rural areas (INDIA Republic of India., Planning Commission, 1956).

The major task for the central government regarding rural areas during the second plan was as follows:

1- To provide technical and financial assistance to local agricultural producers, community projects, and village & small industries.

2- To create government organizations and public enterprises to undertake and build all public infrastructure and management systems.

3- To establish management, marketing, and financial institutions to support the local and national economy (INDIA Republic of India., Planning Commission, 1956)

4.1.4.1.4 Supported agricultural exports

- **1961-1966 India Third Economic development plan (ITEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Expanded exports as one of its primary objectives		→		
	2	Controlled domestic consumption and reduced it to a reasonable rate and created surplus in local production		→		
	3	Increased the national income, the agricultural production, and the industrial production		→		
	4	Increased the support to the small and medium-sized businesses		→		

Table 3 the Indian Third Economic Development Plan (major objectives evolutions)

After the development of the agricultural sector in the second plan, the government moved to increase agricultural activities and turn into export during the Indian Third Economic Development Plan (ITEDP). To achieve this objective, the government-controlled domestic consumption and reduced it to a reasonable rate to create a surplus in local production. The surplus in local productions was intended to increase export to international markets and increase the Indian products comparative advantages in the long run. (INDIA Republic of India., Planning Commission, 1961).

The government also implemented several other objectives in its third plan. These objectives were increasing the national income, the agricultural production, the industrial production, and the knowledgeable workforce that could play a significant role in the future Indian economy (INDIA Republic of India., Planning Commission, 1961).

In the ITEDP, the government aimed to prevent enterprise monopoly that had started to increase in publicly owned enterprises. Accordingly, the government started to increase the support to the small and medium size businesses by creating new industrial organizations that could play a significant role in helping the small and medium size businesses grow. The government started to spread the idea of the need to defuse large enterprises and open the door to new entrants and liberalize the public facilities.
The government eased the process of creating new businesses by forming new financial organizations, such as the "Industrial Finance Corporation, the State Finance Corporations, the Industrial Credit, and Investment Corporation of India and others" (INDIA Republic of India., Planning Commission, 1961).

- **1969-1974 India Fourth Economic development plan (IFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Developed the agriculture industrial productions		→		
	2	Nationalized the banking system and increase the credit availability to all economic sectors, especially the agricultural sector		→		
	3	Decreased the rupee (the Indian currency) value to solve the country's exchange problems and increase local exports with the global market	↔	↔	↔	↔
	4	Provided import entitlements against exports	↔	↔	↔	↔
	5	Provided special finance to selected products		→		
	6	Relocated research centers		→		
	7	Increased collaboration accompanied by technology transfer and training	↔	↔	↔	↔

Table 4 the Indian Fourth Economic Development Plan (major objectives evolutions)

During the IFREDP, the government focused mainly on developing the agricultural industrial production and considered it as a primary concern in developing the country's economic base as shown in table 4. The Small Farmer Development Agency played a pioneering role in developing the farmers' capabilities and directed them to grow by providing central assistance for these industries.

The government also aimed to nationalize the banking system and increase the credit availability to all economic sectors, especially the agricultural sector. Another government objective was to increase the employment opportunity in all rural areas. All these opportunities were made available through the farming activities, such as minor irrigation and soil conservation (INDIA Republic of India., Planning Commission, 1970). To enhance the competitive power of domestic products in international markets, the government worked on decreasing the rupee (the Indian currency) value to solve the country's exchange problems and increase local exports with the global market. Also, the government schemes in international trade were enhanced during the plan by providing import entitlements against exports. The government also announced a liberalized policy for 59 priority industries and a number of export industries because of its extreme importance to the country's economy. Also, the government provided special finance to these selected products (table 4). These activities were meant to develop the local and central areas and enhance their connectivity (INDIA Republic of India., Planning Commission, 1970).

Regarding research, the government conducted a pilot investigation in different parts of the country to locate and relocate laboratories and research facilities. The new search was conducted by a methodological outlay to figure out the reasons and needs to relocate each research facility.

In foreign collaboration, the government decided to restore the economic collaboration to fill the technology gaps in the Indian economy. Thus, the collaboration approved if it was

accompanied by technology transfer and training (INDIA Republic of India., Planning Commission, 1970).

- **1974-1980 India Fifth Economic development plan (IFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Increased developing agricultural products		→		
	2	Reduced the dependence on foreign machinery, equipment, and other industrial imports		→		
	3	Increased the export of local manufacturing goods		←		

Table 5 the Indian Fifth Economic Development Plan (major objectives evolutions)

The government of India continued drawing its objectives to increase the export of local agricultural and goods and to reduce the dependence on foreign machinery, equipment, and other industrial imports accordingly (table 5). This objective had increased the Indians international connectivity through exports but reduced the imports and the technology that accompanied it. The result was an increased export from 7% in 1960-61 to 12.6% in 1973-74. The share of manufactured goods had risen from 47.5 % to 59.2 % by the end of the previous plan (India., Planning Commission, 1976).

4.1.4.1.5 Increased the support of rural areas through skillful workers and high-tech machines

- **1980-1985 India Sixth Economic development plan (ISIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Increased the diffusion of skilled and technical workforce to regional and rural areas		→		
	2	Increased the diffusion of technological equipment in the new rural areas		→		
	3	Provided incentives to entrepreneurs that were willing to work in segregated areas		→		
	4	Modernized existing facilities with technological capabilities		→		
	5	Applied the market mechanism for the supply and demand for local products		→		

Table 6 the Indian Sixth Economic Development Plan (major objectives evolutions)

To fulfill the technology gap that perversely objectives caused by stopping the importation of high technology machines. In the Sixth Economic Development Plan

(ISIEDP), the government worked extensively on distributing skilled and technical workforce to regional and rural areas to balance the regional disparities. This objective required an increased central to rural connections and an increased diffusion of locally built technological equipment in rural areas and regions along with the skilled labor force (table 6). (India., Planning Commission, 1981).

The central government allowed the local level governments to conduct sub plans for developing rural areas and to manage financial and technical policies. The government also implemented financial spending discipline to be sure of what was spent on the actual intended projects in the new sub plans.

To ensure successful implementation of these policies, the government required that all projects should be worked through special organizations within their discipline. The government also provided incentives and penalties for staff and members that would agree or refuse to work in segregated areas. The government also provided incentives to private entrepreneurs that were willing to work in what the government considered a "backward" area to increase its development. The incentives took the form of central investment subsidy schemes, tax breaks, and interest subsidies for engineering entrepreneurs (India., Planning Commission, 1981).

The government also applied the market mechanism for the supply and demand for local products to ensure fair trade in all industries (table 6). However, the government provided a marketing support system to protect the small businesses from exploitation. The supportive system was meant to provide extra employment opportunities to poor workers

and to provide essential minimum needs to local growers and businesses (India., Planning Commission, 1981).

- **1985-1990 India Seventh Economic development plan (ISVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Increased agricultural activities in rural areas				→

Table 7 the Indian Seventh Economic Development Plan (major objectives evolutions)

During the ISVEDP, the major aim was to encourage the development of the rural areas through the increase of employment opportunities and industrial capabilities in local industrial and agricultural land and facilities. The National Rural Employment Program (NREP) took the opportunity to conduct such operations in the local areas. NREP also aimed to increase the wages and rural infrastructure in these areas (India., Planning Commission, 1985).

4.1.4.1.6 Removed bureaucracy, increased technology imports and eased international trading

- **1992-1997 India Eighth Economic development plan (IEIEDP)**

DP	NUM	Objectives	GIS	NIS	RIS	RIC
8th	1	Removed bureaucratic controls from industrial development activities		→		
	2	Implemented an antimonopoly legislation		→		
	3	Allowed importation manufacturing machines from international companies		→		
	4	Increased the reliance on domestic resources to finance local investments		→		
	5	Transferred financial support to develop the S&T industrial infrastructure		→		
	6	Liberalized the foreign trade operations		→		
	7	Reduced the import duties		↔		
	8	Reduced the tax rates		→		

Table 8 the Indian Eighth Economic Development Plan (major objectives evolutions)

Due to the extensive development in India during the previous plans, in the Sixth Economic Development Plan (ISIEDP) the government decided to accelerated

development and removed bureaucratic controls from industrial development activities (table 8). All the industrial activities requirements were abolished especially in licensing new industrial firms. The government also had implemented an antimonopoly legislation that affected public and private enterprises and freed all industrial practices in the country. Accordingly, an increased number of public enterprises were opened to private investments. Also, the government allowed the firms to freely acquire parts and manufacturing machines from domestic and international companies (India., Planning Commission, 1992).

The government also aimed to increase the reliance on domestic resources to finance local investments. The investments aimed to transfer financial support toward developing the technical capabilities and S&T industrial infrastructure. The major advantage of this policy was to increase competition in Indian industries (India., Planning Commission, 1992).

The government increased the international relation by liberalizing the foreign trade operations and abolishing many products from import restrictions to best fit the international trading policies (table 8). To increase the trade between India and other countries, the Union Budget of India reduced the import duties from more than 300% to 150% by the end of the year 1993 and to 110% by the end of the eighth plan. Also, there were several raw materials that had been freed from tariff and taxes, such as petrochemicals and other manufacturing needs. This leads us to another major objective in the eighth plan that was reducing the tax rates to a reasonable amount for consumers but with stricter enforcements (India., Planning Commission, 1992).

4.1.4.1.7 Strengthen technology base and implemented new High-tech industries

- **1997-2002 India Ninth Economic development plan (INEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
	1	Implemented elite technological solutions to empower the agricultural growth			→	
	2	Supported to the Panchayat as a useful tool to connect the rural areas with central decision makers			→	
	3	Increased the support to the emerging fields in S&T, such as IT and Microelectronics			→	

Table 9 the Indian Ninth Economic Development Plan (major objectives evolutions)

At the beginning of the Ninth Economic Development Plan (INEDP) the government continued its previous policies in supporting the agricultural sectors and implementing elite technological solutions to empower the sector growth. However, the government started to implement new technology fields in the Indian economy and in its S&T base such as Information Technology (IT) and Microelectronics and spread this vision to all parts of the economy (table 9) (India., Planning Commission, 1999).

4.1.4.1.8 Increased international relation and technology role in the economy

- **2002-2007 India Tenth Economic development plan (ITEEDP)**

DP	NUM	Objectives	GIS	NIS	RIS	RIC
10th	1	Avoided financial crises that affected the Asian countries			→	
	2	Allowed each state to control its plan			→	
	3	Used information technology and E-Governance as a tool to control economic activities			→	
	4	Joined regional trade organizations with extremely low rates of tariff			↔	
	5	Joined the GATT consortium			↔	
	6	Allowed the movement of the professional technician freely			↔	
	7	Used multidisciplinary professionals to support Information and technology			↔	

Table 10 the Indian Tenth Economic Development Plan (major objectives evolutions)

The Tenth Indian Economic Development Plan (ITEEDP) was considered the critical juncture that changed the Indian entire economy to be a technology hub and increased its relationship with the global world (table 10). At the beginning of the ITEEDP, the Indian government realized that the major problem of the world financial crises in the late

nineties was its exposure to several external effects. These effects were mainly the declined value of the financed assets and the reduction of the foreign capital flow toward local industries. The rapid credit expansion that had been occurred in the developing countries was a result of huge foreign capital inflow. This behavior made the developing countries widely vulnerable to market and prices. This major late ninety incident lead to a major government objective that restricted certain financial activates in the county. Accordingly, the country started to protect the payment system, limited central bank intervein in liquidity support, and maintained monetary control (India., Planning Commission, 2002).

The second major objective was to give each state a direct control of its plan by giving the states the opportunity to plan their major needs with the central government political and financial support.

The third objective was to use information technology and E-Governance as a tool to control all operations in all industrial including capital flow procedures in the fallowing years. This system was essential in controlling all parts of the country and processing all activates accordingly (India., Planning Commission, 2002).

India also joined several regional trade organizations with extremely low rates of tariff, such as the South Asian Association for Regional Cooperation (SAARC) and the Association of South East Asian Nations (ASEAN) (India., Planning Commission, 2002).

The Indian government also joined the GATT consortium that covered cross borders supply services and helped the flow of goods between the countries with a reduced tariff. The Indian government also allowed the movement of the professional technician and

computer services to many parts of the world without restriction. Also, the Indian government decided to employ all their highly skilled workforce, such as "lawyers, chartered accountants, cost accountants, company secretaries, computer and electronics based scientists/technicians, information technology/communications, scientists/technicians, engineers, doctors, and others" in its technological operations (India., Planning Commission, 2002).

4.1.4.1.9 Transformed the economy to a knowledge based economy

- **2007-2012 India Eleventh Economic development plan (IELEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
11th	1	Spread the vision to be a world information technology hub	↔			
	2	Increased the authority of e-governance system to all regional and rural areas	↔			
	3	Conducted the innovation system to focus on information technology	↔			
	4	Transformed the economy to a knowledge-based economy	↔			
	5	Increased the linkage between India and other developed countries	↔			
	6	Created a national innovation policy scheme			↔	

Table 11 the Indian Eleventh Economic Development Plan (major objectives evolutions)

After the huge effort in developing the IT infrastructure in the tenth plan, the government in the Eleventh Economic Development Plan (IELEDP) implemented a major goal to change to a knowledge based oriented economy. To achieve this major objective, the government started to spread its vision to be a world information technology hub to all rural areas. Consequently, the government increased the authority of e-governance system to all regional and rural areas and connected them with the national and the world Information Technology system. The government also used these polices to change from agriculture as a major source of the national income to high technological services and products as a major source of income.

The government aimed during the eleventh plan to create an integrated rural market to increase the connectivity with the central areas. Furthermore, the government increased

its investments in rural areas' infrastructure and increased the creation of major institutions that could foster development in all rural areas. The major government aim of all these investments was to transform the country into an IT- friendly country. These steps were crucial to transfer the county's economy to a knowledge-based economy (India., Planning Commission, 2008).

Another major objective for the Indian economy during the eleventh plan was to transform the society through S&T to be more productive. The major step for this social change was through implementing innovation into the economic activities and enhance the related capabilities of individuals and infrastructures. The government step was not only through increasing the domestic capabilities, but it was also through increasing the linkage between India and other developed countries under different categories, such as industrial investments, industrial development, entrepreneurship, GRIs and other connections grounds.

To achieve all the plan innovation objectives, the government decided to create a national innovation policy scheme that focuses on encouraging connections and enhance productivity between enterprise (India., Planning Commission, 2008).

4.1.4.1.10 Increased innovative capabilities

- **2012-2017 India twelfth Economic development plan (ITWEDP)**

DP	NUM	Objectives	GIS	NIS	RIS	RIC
12th	1	Created the National Innovation Council			→	
	2	Started negotiating several deals with international organizations and countries		↔		
	3	Transformed the government role from controlling to evaluating			→	

Table 12 the Indian twelfth Economic Development Plan (major objectives evolutions)

After changing to a knowledge based economy in the eleventh plan, the government decided to increase the Indian innovation capabilities in the whole country and creating

the National Innovation Council in 2010 (table 12). The effort of this agency was meant to be a motivator to create an innovative ecosystem in the whole country in general and in innovation clusters specifically (India., Planning Commission, 2013).

To increase innovative capabilities in the Twelfth Indian Economic Development Plan (ITWEDP) the government decided to increase the international trade and relation. Accordingly, the government started negotiating several deals with international organizations and countries. For example, there was "The Broad-based Trade and Investment Agreements." Also, there were several trade and marketing agreements, which had been made by the Indian government with countries consortiums, such as "Asia and ASEAN, Latin America and Africa" (India., Planning Commission, 2013). During the ITWEDP, the government aimed to transform its role from "command and control to a steering end evaluate role" in all universities and GRIs and R&D related activities. The government aimed to increase transparency in all fields and allowed the flow of information in all sectors (India., Planning Commission, 2013).

4.1.4.1.11 Conclusion

At the early planning staged the major concern for the government was to reconnect all rural areas with the central government and decision making. Thus, the decision makers worked on reforming the government control and administrative levels during the fifties as a major objective. The government also nationalizes and controlled al large private enterprises. On the other hand, the government started to support all farming activities and allowed the private sector to invest in it. The major government concern was to fulfill the agriculture need domestically and reduce foreign agricultural imports. In the late sixties, the government started to change its objectives and started supporting the

agricultural exports. In the early 1990s the government started to allow technology transfer through the importation of high technology machines. These machines were directed to support rural areas agricultural needs, which increased the connectivity between the Global, national, regional, and local levels.

In the 2000s, the government started to change its objectives to be a knowledge based economy and draw its international relations accordingly. The government worked on allowing the networking between local, national, and international companies to build a national innovation ecosystem that could serve in transforming India to and international technology hub.

4.1.4.2 University + Higher educational system

4.1.4.2.1 Overview

This section will investigate the Indian economic development plans to understand the evolution of the university system. The study will explore the University system policies, incentives, major institutes, and educational focus through the years. These policies and institutes will reveal the role of the industrial firms in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of university system in building a robust innovation systems had be identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of India. There will be arrows in front of each policy to indicate the level of connectivity between the GIS,

NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the university sector. The Indian government increased its policies to establish new universities in rural areas (Figure 4).

The following discussion will develop an understanding of the evolution of the university system and its role in developing the connectivity of the innovation systems.

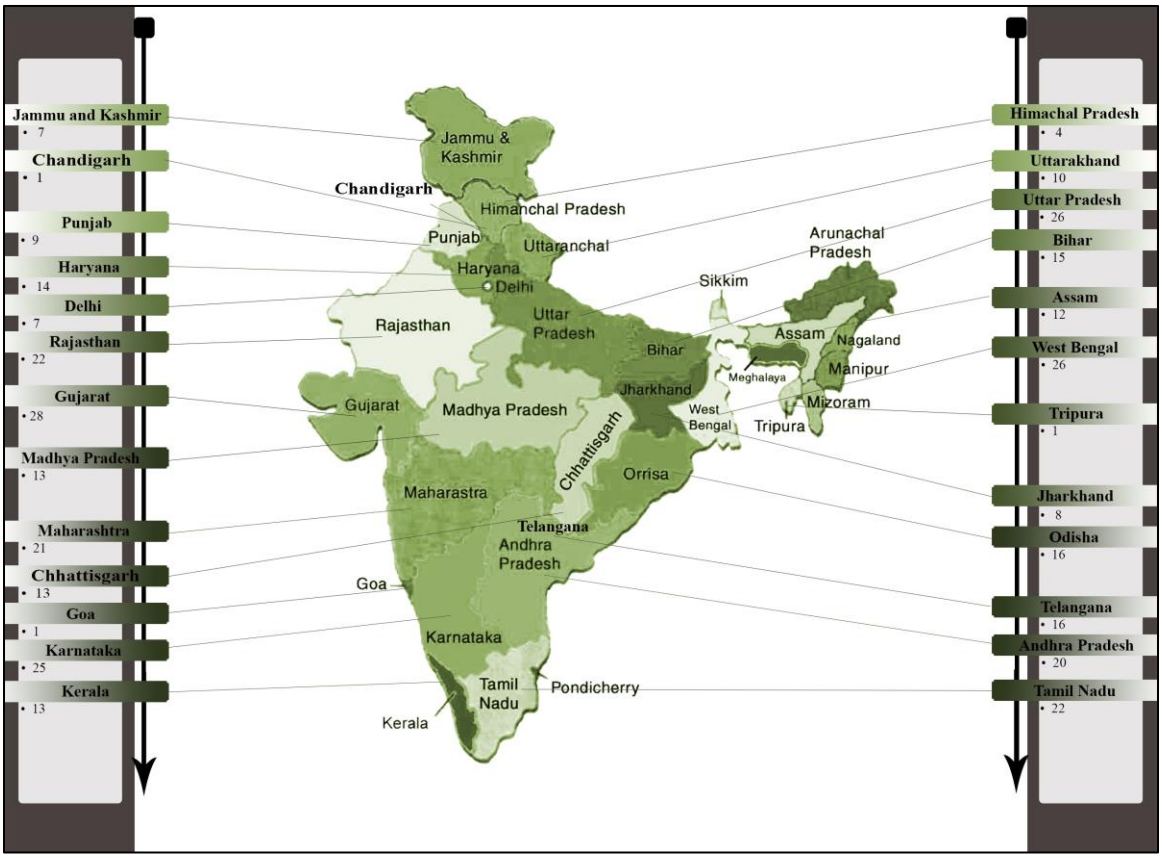

Figure 4 India's government university distributions- combined by the researcher

4.1.4.2.2 Develop vocational and technical infrastructure

- **1951-1956 India First Economic development plan (IFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Focused on practical educational programs			→	
	2	Worked on developing the existed training centers in all regions and areas			→	
	3	Increased the number of higher educational institutions			→	
	4	Provided scholarships to students to complete their education in developed countries		←	→	

Table 13 the Indian First Economic Development Plan (educational system)

At the beginning of the 1950s there were 27 universities in all India. So, at the First Five Years Economic Development Plan (IFEDP) the government worked on increasing the number of universities and develop it qualitatively. The government increased its focus on universities, technical institutions and vocational institutions that concentrated on practical educational programs (table 13). The new government policies targeted the urban and rural areas to increase the existed artisans' and technicians' knowledge and capabilities. Furthermore, the government worked on developing the existed training centers in all regions and areas to meet the new government projects' requirements. One of the major supporters of the vocational programs and community development in India was the Ford Foundation of America. The Ford Foundation alone supported more than 30 centers in India. These centers had more than 70 trainees in each center. These centers worked on educating the locals on new agriculture techniques (INDIA Republic of India., Planning Commission, 1953).

The increased number of students in the public schools led the Indian government to increase the number of universities from 27 in 1950 to 47 universities in 1960 (table 13). The huge investments in the university facilities had led to increased problems in providing the adequate services and infrastructure to the students in these facilities.

Accordingly, the government decided to provide scholarships to students to complete their education in developed countries. This helped the university system gain trained faculty members, university leaders, scientists, and administration (INDIA Republic of India., Planning Commission, 1953).

4.1.4.2.3 Developed engineering and research universities infrastructure

- **1956-1961 India Second Economic development plan (ISEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Enhanced the training for engineers in several states and regions			→	
	2	Created the Institute of Technology in Kharagpur and the Indian Institute of Science in Bangalore			→	
	3	Increased the capabilities of existed colleges and schools			→	
	4	Provided scholarships for international students to study in India			↔	

Table 14 the Indian Second Economic Development Plan (educational system)

Increasing higher educational opportunities in all India was a priority during the first economic development plan. After choosing agriculture as a national motivator for economic development in the first plan, the government in the Second Development Plan (ISEDP) started to increase its higher educational research capabilities especially in the agricultural and farming fields. This new policy helped in creating regional and rural knowledgeable workforce capable of conducting agricultural production and development. The first step to enhance the research and engineering capabilities was by establishing training centers for engineers in several states and regions through higher educational facilities (table 14). the central government aimed to add 18 colleges and 62 engineering institutions around the country in all states and many rural areas. Also, the government aimed to increase the support and expand the existed institutions. (INDIA Republic of India., Planning Commission, 1956).

The second step was by creating focused engineering and research universities as in the case of the Institute of Technology in Kharagpur and the Indian Institute of Science in Bangalore. The central government created 4 new colleges and 19 Polytechnics institutions in agriculture and other related fields. Furthermore, the government worked on increasing the capabilities for 20 existing colleges and 30 schools in all India through the Council of Technical Education. Accordingly, the Indian engineering institute had reached 45 institutions for graduate and 83 institutions for the diploma level by the end of the first plan (INDIA Republic of India., Planning Commission, 1956).

To increase thses colleges role in developing rural areas, the government implemented a policy that obligated all farms and workshops to be attached to a college or school and link the practical education with theoretical education.

The Indian government also provided scholarships for international students to study in India from Asia, Africa, and other international countries. Furthermore, the government of India provided scholarships for qualified Indian scholars to study abroad in advanced countries, such as the United Kingdom and the United States of America (table 14) (INDIA Republic of India., Planning Commission, 1956).

4.1.4.2.4 Increased universities establishment and scholarships grants

- **1961-1966 India Third Economic development plan (ITEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Increased the number of students studying science		→		
	2	Provided scholarships from the University Grants Commission	←	→		
	3	Encouraged all ministries and states to provide scholarships for promising students		→		
	4	Increased the number of universities		→		

Table 15 the Indian Third Economic Development Plan (educational system)

After increasing the number of colleges and universities in specialized fields in the second plan, in Third Economic Development Plan (ITEDP) the government increased the number of students to 400,000 students. There were 60% of them attending science classes in all colleges in central and rural areas (table 15). The number of scholarship holders also expanded from 360,000 in 1951 to 880,000 in 1957. Most of these scholarships were provided by the University Grants Commission and Scholarships schemes in fields, such as agriculture, health, scientific research, etc. The central government encouraged all ministries and states to provide scholarships for promising students and allow them to complete their education, especially in technical fields, such as science, health, and engineering (INDIA Republic of India., Planning Commission, 1961).

Regarding educational facilities' increases, the number of universities had increased from 27 in 1950-51 to 32 in 1955-56 and 46 in 1960-61. More than12 universities were added during the third plan. Most of these universities were in the fields of science and engineering. 11 of these universities were considered as rural institutes that could provide higher education in rural and segregated areas (INDIA Republic of India., Planning Commission, 1961).

During the ITEDP, the universities took the major initiative to undertake fundamental research in all branches of science. The importance of the university role in science had grown rapidly for two reasons. The first reason was the availability of a large educated workforce within the laboratories and university facilities in India. This workforce helped in operating the large amount of universities especially in engineering and agricultural fields. The second reason was the availability of several sponsoring agencies that took the responsibility of funding these universities researchers, such as "the Council of Scientific and Industrial Research, the Indian Council of Agricultural Research and the Indian Council for Medical Research" (INDIA Republic of India., Planning Commission, 1961).

- **1969-1974 India Fourth Economic development plan (IFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Started developing the existing technical educational curriculum			→	
	2	Increased attention was given to the advanced scientific institutions			→	

Table 16 the Indian Fourth Economic Development Plan (educational system)

After the huge expansion of higher educational facilities during the previous plans, the government during the Fourth Economic Development Plan (IFREDP) focused on qualitative aspects rather than quantitative in developing the educational system. In other words, the government started developing the existed technical educational curriculum and programs rather than increasing the number of universities or buildings. Furthermore, the government focused on increasing the quality of teachers by increasing the training opportunities and services (table 16). The government also worked on increasing the graduate, doctorate, and post-doctorate programs in the university systems (INDIA Republic of India., Planning Commission, 1970).

Special attention was given to the advanced scientific institutions, such as "the Indian Institute of Science, Bangalore, the National Institute for Training in Industrial Engineering, Bombay, the National Institute of Forge and Foundry, and others" (INDIA Republic of India., Planning Commission, 1970). These institutions had been created to build up a closer link between science and technology domestically and worldwide afterward.

4.1.4.2.5 Controlled university spending and use selective support

- **1980-1985 India Sixth Economic development plan (ISIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Prepared citizens in all major scientific fields through all educational institutions		→		
	2	Provided a selective support to universities that improved their scientific based research		→		
	3	Provided incentives to universities to update their computer facilities and instruments		→		
	4	Tightened the gap in R&D by focusing more on fields as in information technology		→		
	5	Encouraged the development of workforce in new fields as in IT		→		

Table 17 the Indian Sixth Economic Development Plan (educational system)

By the end of the fifth plan, the universities in the country reached 119 universities, which conglomerating about 1050 colleges, 5 institutes of technology, 150 engineering colleges, and 100 medical colleges (India., Planning Commission, 1981).

The major objective regarding the educational system for the Indian government was to prepare citizens in all major scientific fields through all educational institutions including agriculture the main employment entity in India. The government worked on securing higher education for all parts of the country and on providing the opportunities for the locals to increase their knowledge at the university level as shown in (table 17) (India., Planning Commission, 1981).

The government also aimed to provide a selective support to universities that improved their educational quality through scientific based research. This step was provided through the University Grants Commission that provided financial support to universities to update their computer facilities and instruments for advanced studies in science. The government also worked on tightening the gap in R&D programs by focusing more on fields, such as information technology and newly emerging areas.

The government also encouraged the development and training of workforce in new fields, such as "computer science, product development, maintenance engineering instrumentation, and biosciences" (India., Planning Commission, 1981).

4.1.4.2.6 Established the infrastructure for the emerging high-tech departments

- **1985-1990 India Seventh Economic development plan (ISVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Strengthened the R&D linkage between universities Science and Technology programs			↔	
	3	Created an infrastructure for the emerging technological fields			→	
	4	Educated and trained workforce on information systems and technologies			→	
	5	Created 17 centers in regional areas for information technology training			→	
	6	Created an international center to coordinate with the regional and national centers		↔		
	7	Upgraded the laboratories of the Indian Institute of Technology for new technologies			→	

Table 18 the Indian Seventh Economic Development Plan (educational system)

In the sixth economic development plan the government implemented the first seeds for Information technology and computer science in the higher educational system. In the Seventh Economic Development Plan (ISVEDP), the government strengthened the R&D linkage between the Science and Technology programs in universities. The government aimed to encourage technical education in all educational facilities by consolidating and modernizing the infrastructure and already existing facilities. The government also increased the technical education by creating an infrastructure for the emerging

technological fields that are vital to the economy, such as information technology and semiconductors, electronics, computer systems, satellite communications, nuclear science, environment engineering, bio-engineering and non-conventional energy (India., Planning Commission, 1985).

The government also aimed to train workforce on information systems and technologies through educational facilities to assist technical education. To achieve this goal, the government created 17 centers in regional areas for information technology training and connected them with the Institute of Applied Manpower Research. The government also created an international center to coordinate with the regional and national centers regarding the latest technology and research availability in the market. The government also aimed to upgrade the laboratories of the Indian Institute of Technology and all other regional colleges to be able to work with the new technologies in all fields (India., Planning Commission, 1985).

4.1.4.2.7 Increased university autonomy and increased international relation

- **1997-2002 India Ninth Economic development plan (INEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
9th	1	Increased the university system connectivity with the global innovation systems	↔			
	2	Supported the researchers and empowered them with their needs	→			
	3	Increased all university systems' autonomy from direct government control	→			
	4	Created the Regional Sophisticated Instrumentation Centers (RSIC) inside universities	→			
	5	Encouraged students to complete their doctorate and post-doctorate in foreign countries	↔			
	6	Created the National Assessment and Accreditation Council (NAAC)	→			
	7	Aligned the job market with the university courses	→			

Table 19 the Indian Ninth Economic Development Plan (educational system)

In the previous plans the government worked on increasing the computer and information technology educational infrastructure domestically. In the India Ninth Economic

development plan (INEDP), the government aimed to increase the connectivity of the developed university system with the global innovation systems. This step had been achieved by investigating and aligning the international market trends and local needs with university curricula (table 19). The government also encouraged the faculty members exchange between the universities and in-house industrial research facilities (India., Planning Commission, 1999).

The government also encouraged the academic communities to support the researchers and empower them with their needs. These needs would be provided through all applicable facilities in the university system. To achieve this goal, the government increased all university systems' autonomy from direct government control. Also, the government encouraged all universities research centers to help researchers by connecting them to government agencies and national bodies to gain extra support logistically and financially, especially young scientists. Young intelligent scientists were considered crucial in developing the local scientific base in India during the ninth plan, which encouraged the government to increase the effort in developing them adequately (India., Planning Commission, 1999).

The government also encouraged the creation of the Regional Sophisticated Instrumentation Centers (RSIC) inside universities, in addition to the Advanced Regional Research Centers, these center were in the fields of "optical materials, condensed matter physics, low-energy accelerator research, molecular electronics, laser instrumentation, colloids and surfactants, astronomy, astrophysics, and plasma physics" (India., Planning Commission,1999).

By the end of the eighth plan, there were more than 228 universities and 6759 colleges, 3 open universities in different central and rural areas. These facilities were serving 0.2 million in 1950-195, but in the 1996-1997 academic year, it increased to serve more than 6 million students (India., Planning Commission, 1999).

To raise the efficiency of the teaching faculty, the government conducted several programs that provided scholarships, fellowships, and special assistance through government funded programs. The government encouraged graduate students to complete their doctorate degrees and follow it by post-doctorate research in foreign countries to be able to cope with new technologies in the international market. To provide an assessment to the major research projects the government created, the National Assessment and Accreditation Council (NAAC) to systematically assess the new research projects. Also, the University Grant Commission initiated a program that served more than 400,00 students in 31 universities by aligning them with the job market and reconstruct the university courses to be able to cope with the job market (India., Planning Commission, 1999).

The first open University in India offered a wide selection of programs to students in different and remote areas. These programs were designed to fit the needs and conditions of the locals best to complete their studies. For example, “agriculture, computer applications, education, engineering, management, nursing, and nutrition” (India., Planning Commission, 1999).

The government also increased its support to technical education by increasing the number of these facilities from 49 in 1950-1951 to reach 418 in 1996-1997. Many of

these institutions and programs were created during the eighth plan by the help of the world bank (India., Planning Commission, 1999).

4.1.4.2.8 Increased the relation between vocational and university systems

- **2002-2007 India Tenth Economic development plan (ITEEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
10th	1	Established a link between vocational institutions and university system			⟷	
	2	Implemented vocational courses to the advanced university level			→	
	3	Provided financial assistances to qualified highly competitive Universities			→	

Table 20 the Indian Tenth Economic Development Plan (educational system)

In the Tenth Economic Development Plan ITEEDP, the government implemented a policy to establish a link between vocational institutions and university system. This link was based on implementing vocational courses to the advanced university level to turn students to practical and field work along with theoretical work in information technology (table 20).

Also, local businesses and industries were closely engaged in forming the syllabus and coursework in universities.

During the ITEEDP, the university system had suffered from reduced government financial support, which leads universities to accept “contributions, donations, gifts, trusts, private sector industries and sponsorships from the alumni.” However, the University Grant Commission had provided financial assistances to qualified highly competitive Universities in central and state universities (India., Planning Commission, 2002).

4.1.4.2.9 Increased the number of IT colleges and support the S&T infrastructure

- **2007-2012 India Eleventh Economic development plan (IELEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
11th	1	Increased the technical institution's capabilities to meet the new job market needs			→	
	2	Created new central universities that focused on IT and computers hardware			→	
	3	Launched a development programs in vocational and educational schools			→	
	4	Upgraded more than 100 information technology centers of excellence			→	
	5	Increased Ph.D. scholarships and fellowships especially in information technology		←	→	
	6	Initiated an eight years' goal to provide a skillful workforce for all section and branches			→	
	7	Created a "National Skill Inventory" and database system for all available technicians			→	
	8	Worked on enlarging all 50000 "Skill Development Centers in all central and rural areas			→	
	9	Created a national credit system that focuses on measuring and ranking all institutions			→	
	10	Moved from the system that funded institutions to a system that funded candidates			←	→

Table 21 the Indian Eleventh Economic Development Plan (educational system)

By the end of the tenth plan, there were 18064 colleges, 5625 benefited from the University Grant Commission (UGC). For other rural colleges and universities, the government increased its policies and regulations to support these institutions to upgrade them to be eligible for the UGC assistance. The government also worked on increasing the technical institution's capabilities to meet the new job market needs. The result was to strengthen the S&T base in all universities and established advanced competitive research centers within universities (India., Planning Commission, 2008).

To transform the country's economy to a knowledge-based economy, the government started creating 30 new central universities that focused information technology and computers hardware. The government launches a skill development programs that aimed to develop programs in vocational and educational schools and increase the productivity and technical skill for graduates in these programs. More than 17 ministries and departments started their efforts in pairing with these vocational institutions each in their fields. Thus, during the eleventh plan vocational training was at the core of the central government concern. During the IELEDP, there was more than 1244 polytechnics

institution under the ministry of human resources only. These branches were distributed all over the county, in central, regional, and rural areas (India., Planning Commission, 2008).

In 2004-2005, the government launched a program to upgrade more than 100 information technology centers of excellence. This step was important to increase the country's position in information technology capabilities worldwide. During the eleventh plan, there were more than 5114 Industrial training institute connects its training programs with 57 engineering institute. Of these institutes, there were 1896 governmentally controlled and 3218 privately controlled institute (India., 2008). Using these institutions the government initiated an eight years' goal to provide a skillful workforce for all section and branches of the economy. The government initiated this program as a public-private partnership between universities and industries. The program was called the Skill Development Program. The program concentrated on aligning the needs of the public privet sectors with the universities and vocational outputs. Then, the program concentrated on encouraging enterprises to create their development institutions and skill development programs.

To support the result of this connectivity and partnership, the government created a "National Skill Inventory" and database system for all available technicians' in all field. the government worked on enlarging all existed 50000 "Skill Development Centers in all central and rural areas. The government encouraged all ministries to develop and enlarge their development centers to cope with the new technologies in the market.

To support the complete system adequately, the government moved from the system that funded institutions directly to a system that funds candidates. Finally, the government

created a national credit system that focuses on measuring and ranking all institutional facilities (India., Planning Commission, 2008).

4.1.4.2.10 Created innovation clusters in universities

- 2012-2017 India twelfth Economic development plan (ITWEDP)

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
12th	1	Created successful innovation clusters with the help of other government institutions		→		
	3	Considered education as the major source of innovation.		→		
	4	Created an innovation center in each "District Institute of Education and Training"		→		
	5	Created a "National Innovation Promotion Services"		→		
	6	Created 20 different Design Innovation Centers in different central and rural RIC		→		
	7	Created 20 Innovation cluster in 20 universities around India		→		
	9	Enhanced education by creating millions of new seats to new students in universities		→		
	10	Created world-class universities and pair them with vocational institutions		→		
	12	Encouraged faculty and students to engage in an international program	←	→		

Table 22 the Indian Twelfth Economic Development Plan (educational system)

In the previous plan, the government conducted a plan to increase the number of central state universities in all states and territories to reach 65 institutions. This effort was made by the central government through a special finance provided by the government. These universities were aimed to serve all science fields including medical needs. The major aim of these intuitions was to serve as quality leading institutions, which focused on innovation as a motivator for development. Another major role of these institutions was to create successful innovation clusters with the help of other government institutions in these areas (India., Planning Commission, 2013).

In the Indian twelfth Economic Development Plan ITWEDP, the government started to consider education as the major source of innovation. Accordingly, the government created an innovation center in each "District Institute of Education and Training." The step was made to enhance both teachers' and students' ability to conduct innovation to apply it easily in the education process. The government also created the "National Innovation Promotion Services" (India., Planning Commission, 2013). This agency was

used to employ students in local innovation efforts. The government also created 20 different Design Innovation Centers in different central and rural innovation clusters to foster knowledge and product quality in entrepreneurs' products and ideas. The government also created 20 innovation clusters in 20 universities around India. The government encouraged the connectivity between these clusters and industry to encourage innovation in these clusters and the universities curricula (India., Planning Commission, 2013).

The government worked with the plan to enhance education by creating millions of new seats to new students in universities and the higher education system. Also, the government aimed to create world-class universities and pair them with vocational institutions to follow up with the rapidly changing labor market. In these new institutions, the government focused on the autonomy of these educational institutions with the governance control on all interior regulations (India., Planning Commission, 2013).

The government also worked to internationalize faculty and students by encouraging them to engage in international programs with other educational institutions around the world. Furthermore, the government encouraged the creation of clusters in universities and increase the networking between local, regional, central, and global institutions. (India., Planning Commission, 2013).

During the ITWEDP, the government allowed the private sector to create large educational institutions and allow public offering and bonds to finance the creation of these institutions. The government also increase the autonomy of these institutions to allow them to raise funds freely (India., Planning Commission, 2013).

4.1.4.2.11 Conclusion

In early 1950s, there was a lack of high quality educational and research system in India. The government worked on establishing a high technological vocational and educational infrastructure that can deliver high quality education and training at the central and local areas especially in the agricultural fields. During the 1950s and 1960s, the government worked extensively to increase the number of the educational system and control them with a central funding system. It was not until early 1980s when the government started to increase control the spending on the university system using the University Grant Commission as a toll to achieve this objective.

In the early 1990s, the government worked to encourage new technologies such as Information Technology and computer science engineering in all its universities and increased its attention to this sector. In the late 1990s, the government started to increased grants and scholarships for local students to complete their studies abroad in these new fields. This relationship ship with international universities increased in the following years. Furthermore, the government increased the autonomy of the local universities and allowed them to seek funding from national and international organizations.

In the 2000s, the government started to increase the establishment of IT and computer science colleges around India. This effort was accompanied by establishing Innovation clusters in several universities in 2011.

4.1.4.3 Financial institutions

4.1.4.3.1 Overview

This section will investigate the Indian economic development plans to understand the evolution of the financial sector. The study will explore the industrial policies, incentives,

major institutes, and financial focus through the years. These policies and institutes will reveal the role of the financial system in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of indusial firms in building a robust innovation systems had be identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of India. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the financial sector.

The following discussion will develop an understanding of the evolution of the financial sector and its role in developing the connectivity of the innovation systems.

4.1.4.3.2 Reformed the entire banking system and started supporting farmers

- **1951-1959 India First Economic development plan (IFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Increased the lending sources to individuals and local cultivators			→	
	2	Increased government lending			→	
	3	Reformed the Reserve Bank of India and the Indian banking system			→	
	4	Increased banking system reserves and increased money resources			→	

Table23 the Indian First Economic Development Plan (Monetary institutions)

After the independence of Great Britain at the early fifties, the major concern for the Indian government in The First Economic Development Plan (IFEDP) was reforming the complete banking and monetary trading system as shown in (table 23). The government

increased the lending sources for individuals and local cultivators. These lending sources were individuals and private agencies, such as money lenders, landlords, and commercial banks. Also, the government by itself played a major role in lending to individuals through “public, semi-public agencies, State, and co-operative societies” (INDIA Republic of India., Planning Commission, 1953).

During the IFEDP, the government started to reform the Reserve Bank of India as a nationwide institution that would help to reform the entire Indian banking system in central and rural areas. The reserve bank reform helped the banking loans and credit system in supporting the small and medium size businesses. Under the Banking Companies Act, the banking system increased its reserves by increasing the money resources. The banking system included the saving from corporations, public savings, public enterprises surpluses, and private individuals saving. The government needed this reform because of the shortage of income. This shortage was a result of failing to gain enough income from land taxation after the corruption of the tax system that occurred after the Second World War (INDIA Republic of India., Planning Commission, 1953). Accordingly, the government financed its lending through taxation and public savings; general budgetary resources from the central and state government; foreign exchange as external resources; mobilizing direct foreign monetary support to poor people by encouraging the lower class to invest the money in government agencies such as the post office bonds; and deficit financing through local banks (INDIA Republic of India., Planning Commission, 1953).

4.1.4.3.3 Nationalized the Imperial Bank of India and created the cooperative credit agencies

- **1956-1961 India Second Economic development plan (ISEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Converted the largest commercial bank in India "The Imperial Bank of India" to a public-owned bank		*		
	2	Created cooperative credit agencies for each industry in the country		→		
	3	Secured funds to its financial system from foreign exchange and borrowing		↔		

Table24 the Indian Second Economic Development Plan (Monetary institutions)

One of the major steps that the government took after reforming the whole banking system in the previous plan was to nationalize the private banks in the whole country. For example, the largest commercial bank in India "The Imperial Bank of India" was transferred to be to a public-owned bank. This step stopped foreign investments in the following years until the government changed its policies in the early 1990s. After the ownership transfer, the role of the bank had increased to include institutionalization of rural credits. Also, the government added more duties for the Indian reserve bank to include the creation of cooperative credit agencies. The task for these new agencies was to provide credits for small businesses with reasonable rates and prices (INDIA Republic of India., Planning Commission, 1956).

Deficit financing defined as "Government spending more than Government receipts in the shape of taxes. Earnings from state enterprises, loans from the public, deposits and funds and other miscellaneous sources". The deficit financing helped the government finance its operations and make credits available for individuals and local farmers and growers (INDIA Republic of India., Planning Commission, 1956). However, many private sector investments came from private individuals and relatives instead of commercial institutions and banks. Also, many entrepreneurs made this choice to avoid

interests and loans costs from banks. This behavior affected the local bank's system adversely and shortened the funds that should be available to the banks. Accordingly, the central government took further steps to secure funds to the financial system. These funds came from allowing withdrawal from foreign exchange and borrowing from international banks and international institutions, such as the "United Nations Technical Assistance Administration, the United Nations Fund for Economic Development, private foreign investment, and loans & grants from friendly foreign governments" (INDIA Republic of India., Planning Commission, 1956).

4.1.4.3.4 Increased foreign financial support to the agricultural sector

- **1961-1966 India Third Economic development plan (ITEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Created a cooperative credit system that considered the village cooperative and panchayat as its unit of financial focus				→
	2	Connected all farms under a cooperative umbrella				→
	3	Funded industries through internal loans, equity capital and international countries				→

Table25 the Indian Third Economic Development Plan (Monetary institutions)

To increase the support to small business and farmer that was initiated in the previous plan, the government created a cooperative credit system in India' Third Economic development plan (ITEDP). The new system considered the village cooperative and panchayat as its unit of financial focus, especially in agricultural activities.

These governmental decisions were made through the National Development Council. The government started to link most of its credit plans to local farmers at the production level. The government started this trend by bringing all farms under a cooperative umbrella to ease and to systematize the rural areas funding. During the ITEDP, the government created several cooperative organizations, such as the farming cooperatives and the industrial cooperative. These cooperatives were responsible for providing loans to

the working capital from governments and central cooperative organizations; providing loans to members of the industrial cooperative society; providing grants to managerial staff to improve tools and workers' capabilities (INDIA Republic of India., Planning Commission, 1961).

The government also funded many industrial programs through internal loans and equity capital and from friendly international countries, especially in "steel works, machine-building, mining equipment and heavy forge projects" (INDIA Republic of India., Planning Commission, 1961).

- **1969-1974 India Fourth Economic development plan (IFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Relied heavily on taxes and foreign support as a major source of revenue	←	—	—	→
	2	Increased the financial support for the Land Development Bank				→

Table26 the Indian Fourth Economic Development Plan (Monetary institutions)

To secure the funds for the India Fourth Economic development plan (IFREDP) especially under the cooperatives credit agencies and farming operation spending, the government relied heavily on taxes and foreign support as a source of revenue to finance. Other revenues came from "tariff, railways, large government enterprises and small savings, and state providence that funds domestic budgetary resources" (INDIA Republic of India., Planning Commission, 1970). Regarding small businesses, the government funded Land Development Bank had handled the long-term credits loans These banks had functioned through a network of more than 1250 branches in the fourth plan. These banks were mainly focused on agricultural and land development throughout the country. Also, the Agricultural Refinance Corporation provided refinance services for the local

agriculture fields during the Plan period (INDIA Republic of India., Planning Commission, 1970).

4.1.4.3.5 Increased financial operations in rural areas

- **1974-1980 India Fifth Economic development plan (IFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Increased financial and institutions systems existence in all the regions			→	

Table 27 the Indian Fifth Economic Development Plan (Monetary institutions)

Due to the increased oil prices at the beginning of the plan, the Indian economy and balance of payments came under increased pressure, which led to a decreased government activity. This was in addition to the Indian and Pakistani war that occurred during these years. However, the government managed to increase the financial institutions existences in many regions and rural areas (India., Planning Commission, 1976).

- **1980-1985 India Sixth Economic development plan (ISIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Gained funds from government system through the new cooperative credit systems			↔	
	2	Increased the support to the Development Banks for Industry and Agriculture			→	
	3	Secured additional taxes, which had reached 20% of the national income			→	
	4	Restrained foreign debt to keep the country's debt under control		↔		

Table 28 the Indian Sixth Economic Development Plan (Monetary institutions)

At the beginning of the Indian Sixth Economic development plan (ISIEDP), the government started to gain funds from its previously initiated cooperative credit systems. This new system helped in funding the country's operations and farming spending.

Examples of cooperative credits organizations were "the Private Cooperative Savings, the Public Cooperative Savings, the Industrial Cooperative Savings, and the Agriculture

Cooperative Savings." There were also the Development Banks for Industry and Agriculture that played a major role in funding activities in the economy. These organizations helped the businesses that did not have any source of financial support during the plan period (India., Planning Commission, 1981).

The government also relied on securing additional taxes, which had reached 20% of the national income. This income was distributed to support all parts of the county to rebuild the infrastructure and businesses. Also, the country followed a policy that restrained foreign debt to keep the country's debt under control (India., Planning Commission, 1981).

The Council of Scientific and Industrial Research was developed in the year 1942. The major scope of the Council was to initiate and finance laboratories and scientific research that were related to all engineering fields. The research carried out by the council had been conducted in its laboratories with the affiliated universities' laboratories in different centers around the country (INDIA Republic of India., Planning Commission, 1956).

By the end of the year 1953, the government of India established the National Research Development Corporation to bridge the gap between the research and development and ensure the maximum result of research conducted by related laboratories, especially in the agricultural fields. The organization had worked on licensing patents and inventions and applying the regulations on new inventions (INDIA Republic of India., Planning Commission, 1956).

Because of the extensive expansion of the laboratories and government research centers, the government took the initiative to apply the metric measurement systems for all parts

of the scientific production throughout the country. This step helped build and connect the scientific industry in the national regional and sectoral areas (table 28) (INDIA Republic of India., Planning Commission, 1956).

4.1.4.3.6 Eased regulations for money to flow into the economic system

- **1992-1997 India Eighth Economic development plan (IEIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
8th	1	Eased regulations to allow foreign investments to flow into the economy	→			
	2	Reconstructed tax measures and relieved imports and money flow from obligations		→		
	3	Opened mutual fund businesses to the private sector		→		
	4	Allowed companies to decide their capital prices based on the market conditions		→		
	5	Allowed automatic authorization for foreign equity participation	→			

Table 29 the Indian Eighth Economic Development Plan (Monetary institutions)

After the government nationalized and restricted foreign investments in the early fifties, In the Eighth Economic development plan (IEIEDP) the government realized that the foreign investments were low in contrast to the investment opportunities and absorptive capacity. Accordingly, the government eased its regulations to allow foreign investments to flow into several branches and areas in the Indian economic systems (table 29). Also, the government had reconstructed its tax measures and relieved many imports including money flow from obligations, monetary burdens, and restrictions. This financial restriction did not only harm the international relations, but it also affected the whole financial Indian system by widening and deepening the banking system to be able to absorb the cash flow. After the financial restructuring in the seventh plan, credits extended and reached several million borrowers in many rural areas and fulfilled the needs in several industrial and agricultural fields. Also, the government opened mutual fund businesses to the private sector that were reserved before for public-sector banks and financial intuitions (India., Planning Commission, 1992).

One major policy that was implemented in the monetary policy reform allowed companies to decide their capital prices based on the market conditions. The pricing of new companies was strictly controlled in the previous plans by the Controller of Capital Issues through formula-based pricing. This previous policy jeopardized the control of the companies' decisions and capital flow. The new policies gave advantages to new and existing companies to extend their range of financial services in "Merchant banks, mutual funds, leasing companies, venture capital companies and factoring companies" (India., Planning Commission, 1992).

On capital flow, the government allowed automatic authorization for foreign technology collaboration and foreign equity participation. Also, the government authorized automatic clearance for imported capital goods without linking it with foreign exchange flow through foreign equity. Another major policy that encouraged foreign companies to relocate to India was allowing them to use their trademarks inside the country (India., Planning Commission, 1992).

- **1997-2002 India Ninth Economic development plan (INEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
9th	1	Revised the funding that was provided by financial institutions to entrepreneurs				→

Table 30 the Indian Ninth Economic Development Plan (Monetary institutions)

In the Indian Ninth Economic Development Plan (INEDP) the government started to do an occasional revise to the funds that was provided by the government lending agencies to entrepreneurs (table 30). The government spending was gradually decreased over

different period od times to increase self-reliance for the new businesses (India., Planning Commission, 1999).

4.1.4.3.7 Allowed venture capitalist and encouraged long term lending

- **2002-2007 India Tenth Economic development plan (ITEEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
10th	1	Decreased direct financial interventions in all economic activities in the country		→		
	2	Increased private intermediation institutions and ventured capitalist role in the economy		→		
	3	Increased lending services to local entrepreneurs and small industries		→		
	4	Encouraged commercial banks to provide long-term loans to large enterprises		→		

Table 31 the Indian Tenth Economic Development Plan (Monetary institutions)

After the government decreased its intervention in the financial market in the previous and Tenth Economic development plan (ITEEDP), the government allowed foreign and domestic venture capitalists and intermediation institutions to enter the financial market. Also, the government realized the importance of the credit systems and loaning services in the public-sector bank. Accordingly, the government decided to increase the operations of the public-sector banks to increase the lending services to local entrepreneurs and small industries only. The government found that the best way to lead customers to group lending that can be able to hold new investments together (India., Planning Commission, 2002).

To encourage commercial banks to provide long-term loans to large enterprises instead of directly by government, the government started to provide tax incentives along with various other incentives to private banks to encourage them to invest in large enterprises. These incentives were provided through the Indian Development Financial institutions (DFI) (India., Planning Commission, 2002).

- **2007-2012 India Eleventh Economic development plan (IELEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
11th	1	Encouraged private agencies and institutes to support young entrepreneurs financially			→	
	2	Increased the institutional branches to mobilize their financial resources			→	

Table 32 the Indian Eleventh Economic Development Plan (Monetary institutions)

In India Eleventh Economic development plan (IELEDP) the government continued its policies in supporting young entrepreneurs especially in information technology (table 32). There were several governments and private agencies and institutes that took the burden of supporting young entrepreneurs. These organizations were "The Ministry of Rural Development, banks, and Non-governmental organizations" (India., Planning Commission, 2008). These entrepreneurial supportive institutes were conducting its support through more than 2500 institute in all Indian territories and rural areas (India., Planning Commission, 2008).

4.1.4.3.8 Created an innovation ecosystem that could absorb foreign direct investment

- **2012-2017 India twelfth Economic development plan (ITWEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
12th	1	Funded new innovation projects		↔		
	2	Encouraged the creation of both venture capitalist and angel investors			→	
	3	Considered foreign direct investment as the major source of capital			→	
	4	Created several programs that would support the Indian technology infrastructure			→	

Table33 the Indian Twelfth Economic Development Plan (Monetary institutions)

The government in the Indian twelfth Economic development plan (ITWEDP) encouraged the creation of both venture capitalists and angel investors to support innovation activities (India., Planning Commission, 2013). The government considered foreign direct investment as the major source of capital. The foreign capital from foreign markets

helped to link the domestic markets and products with the international ones. The government accordingly allowed all investments to flow freely into the Indian economy to serve all innovative activities.

During the ITWEDP, the government created several programs that would support the Indian technology infrastructure. These programs were as follows:

1- "The Small Industry Business Research Initiatives
2- The Technology Development Board
3- The Biotechnology Industry Partnership program
4- The Biotechnology Industry Research Assistance Program" (India., Planning Commission, 2013).

These programs helped the technological sector to innovate in the early stages through the financial sectors and public-private partnership.

4.1.4.3.9 Conclusion

During the fifties, the India had a weak banking and financial system that was limited and located in central cities and regional areas. Accordingly, the major decision that the government took was to reform the entire banking system. the major decision that the government took to support the financial system was to nationalize the Imperial Bank of India and created the cooperative credit agencies. Using these institutions and foreign investment support to the poorest areas in India, the government started to subsidize local agricultural farmers and small related business. However, local areas were still suffering lack of banking and financial services during the 1950s and 1960s.

Local financial operations started to increase in the late 1970s and early 1980s. The government started to obligate local banks to increase their branches and services to rural

areas. To accelerate the expansion process and connect the local areas with the national and international banking system. the government eased the regulations that could retard the expansion process.

In the 2000s, the government allowed venture capitalist operations and encouraged long term lending. These policies increased the relationship between the global, national, regional, and local financial and investment systems. Moreover, these government policies helped supporting the knowledge economy and innovation ecosystem that the government implement to be its priority in the previous years.

4.1.4.4 Government Research and Development institution GRIs

4.1.4.4.1 Overview

This section will investigate the Indian economic development plans to identify the evolution of the Government Research and Development Institution (GRIs). The study will explore the industrial policies, incentives, major institutes, and industrial focus through the years. These policies and institutes will reveal the role of the GRIs in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of GRIs in building a robust innovation systems had been identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of Saudi Arabia. There will be arrows in front of each policy to indicate the

level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the GRIs sector. Figure 8 shows the latest results of the GRI distribution in several regions in India. This GRIs are government funded research institutions and connected under the jurisdiction of the National Technology Council.

The following discussion will develop an understanding of the evolution of the policies and innovation systems connectivity that helped shape these GRIs.

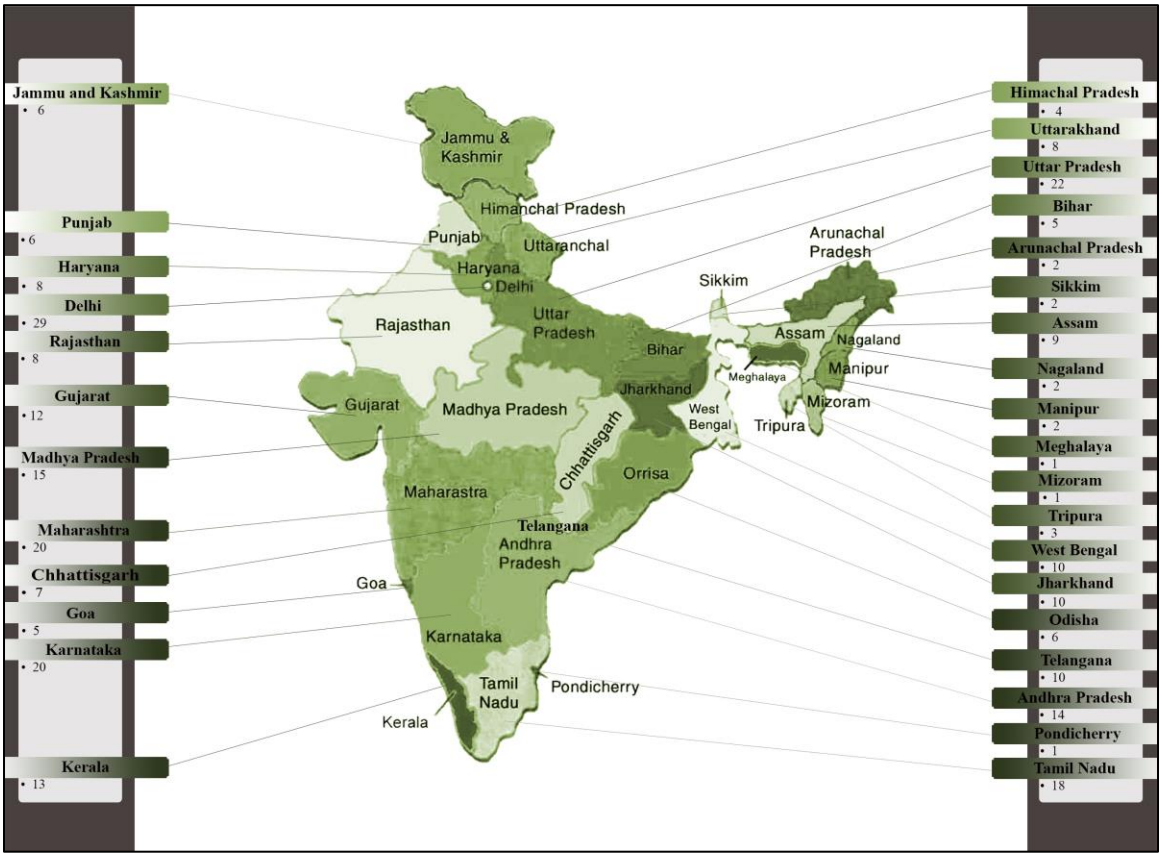

Figure 5 India's GRIs distributions- combined by the researcher

4.1.4.4.2 Building the infrastructure and connecting the existed GRIs

- **1951-1956 India First Economic development plan (IFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Increased the connectivity between already existed agricultural GRIs		⟷		
	2	Created new agricultural related GRIs		⟷		

Table 34 the Indian First Economic Development Plan (GRIs)

After India independence from Great Britain in the early fifties, there were several existed research centers in India. These research centers were developed before and after the Second World-War and before the constitution of India.

The research centers that were focused on agriculture were:

1- "The Indian Council of Agricultural Research

2- The Potato Research Institute

3- The Rice Research Institute" (INDIA Republic of India., Planning Commission, 1953)

There were several branches of these research centers in rural and central areas. The major problem was the lack of connectivity between these research branches and their main centers in central cities. The government of India aimed to increase the connectivity between these centers and promoted development to reach all branches (table 34). For example, the government worked on connecting all food research centers to the Indian Council of Agriculture Research (INDIA Republic of India., Planning Commission, 1953).

After India had gained independence from Great Britain, the central Indian government started to promote many other research activities in different parts of the country especially in agriculture. The government created the following Government Research Institutions:

1. The Central Food Technological Research Institute in Mysore
2. The Central Drug Research Institute in Lucknow" (INDIA Republic of India., Planning Commission, 1953)

- **1956-1961 India Second Economic development plan (ISEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Connected the work of scientists with local industries to solve their actual problems		⟷		
	2	Created more laboratories related to agricultural needs		→		
	3	Supported the work of the Council of Scientific and Industrial Research		→		
	4	Established the National Research Development Corporation		→		
	5	Provided direct funds from the central government to several research institutions		→		
	6	Applied the metric measurement systems for all parts of the scientific and industrial production		→		

Table 35 the Indian Second Economic Development Plan (GRIs)

After developing and initiating many research institutions in the first plan, the government of India started its second five-year plan by connecting the work of scientists in these GRIs with local farms to solve their actual problems (table 35). After founding the importance of this connectivity, the government implemented the second policy and encouraged the connectivity between existed GRIs to find solutions to help local farmers (INDIA Republic of India., Planning Commission, 1956).

Because of the extensive farming activity, the government decided to create more agricultural laboratories in different regions. All these laboratories and R&D centers were actively functioning at the national, regional and local levels. The government put all these laboratories under the Council of Scientific and Industrial Research control. The Council of Scientific and Industrial Research was developed in the year 1942. The major scope of the Council was to initiate and finance laboratories and scientific research that were related to all engineering fields. The research carried out by the council had been

conducted in its laboratories with the affiliated universities' laboratories in different centers around the country (INDIA Republic of India., Planning Commission, 1956). By the end of the year 1953, the government of India established the National Research Development Corporation to bridge the gap between the research and development and ensure the maximum result of research conducted by related laboratories, especially in the agricultural fields. The organization had worked on licensing patents and inventions and applying the regulations on new inventions (INDIA Republic of India., Planning Commission, 1956).

Because of the extensive expansion of the laboratories and government research centers, the government took the initiative to apply the metric measurement systems for all parts of the scientific production throughout the country. This step helped build and connect the scientific industry in the national regional and sectoral areas as shown in (table 37) (INDIA Republic of India., Planning Commission, 1956).

4.1.4.4.3 Expanding the work of government research institutions

- **1961-1966 India Third Economic development plan (ITEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Increased the amount of scientific research			→	
	2	Ensured that all individuals had access to all kinds of knowledge and had equal benefits			→	
	3	Strengthened the existed research institutions and expanded its facilities			→	
	4	Encouraged basic engineering and technology research			→	
	5	Increased training programs and scholarships			→	

Table 36 the Indian Third Economic Development Plan (GRIs)

After initiating a robust agricultural scientific government research institutions(GRIs) related to the agricultural needs. The government aimed in the third plan to increase the amount of scientific research in the whole country and considered them as a cornerstone in the development of the nation (table 36). The second policy was to ensure that all

scientists and farmers had access to all kinds of related technologies or knowledge and had equal benefits to any other individual in any part of the India (INDIA Republic of India., Planning Commission, 1961). Accordingly, the government started to increase farming training programs for farmers and to increase scientific scholarships for scientists. This program was directed to develop the whole country as shown in the fifth policy (table 36).

4.1.4.4.4 Cost efficiency period

- **1974-1980 India Fifth Economic development plan (IFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Control spending on R&D activities			→	

Table37 the Indian Fifth Economic Development Plan (GRIs)

In the IFFEDP, due to the overwhelming spending on research activities the government restricted the S&T plans and research programs to be completed projects with a fixed end-date, fixed costs, and fixed expected benefits. Also, the government increased monitoring the R&D projects to avoid unplanned duplications for the projects in different research facilities (table 37) (India., Planning Commission, 1976).

4.1.4.4.5 Reorganize GRIs and allowed international collaboration

- **1980-1985 India Sixth Economic development plan (ISIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Allowed GRIs independence from political interference			→	
	2	Increased agricultural scientific measurement and standard			→	
	3	Created the State Councils of Science and Technology			→	
	4	Provided incentives to the private entrepreneurs			→	
	5	Linked GRIs with the national and states development agencies to help develop agricultural activates in rural areas			→	
	6	Aligned national and regional S&T centers with international S&T centers		↔	↔	
	7	Encouraged international GRIs scientific collaboration		↔	↔	

Table38 the Indian Sixth Economic Development Plan (GRIs)

By the end of the fifth plan, there were too many specialized agricultural GRIs in all regional districts in the country. The government decided to allow independence for GRIs to encourage them to fulfill their duties freely without any interference from the political level (table 38). The government created the national measurement and standard centers to increase the scientific standards in all operations in research facilities after their autonomy (India., 1981).

To sufficiently reorganize the whole scientific activities in the country after the extensive spending problems in the previous plans, the government created the State Councils of Science and Technology instead of the Council of Scientific and Industrial Research. The major aim of the Council was to conduct the activities of the R&D at the national and regional level. Another aim was to foster development associated with national laboratories and universities in all states. The major element of this development was entrepreneurs and talented young scientists, which could be part of the new research and scientific discovery. Furthermore, the scientists and academics were encouraged to work in close relation with the state S&T councils and state planning boards. These activities had been made accessible, financed, and stimulated under the supervision of the Department of Science and Technology (India., Planning Commission, 1981). These activities had increased the link between the national, regional and sectoral level as shown in the fifth policy (table 40).

The central government provided a bundle of incentives to the private entrepreneurs through finance, tax relief, and central investment subsidy so they could conduct new technological schemes (India., Planning Commission, 1981).

The government also linked agricultural research institutes with the national and states agricultural development agencies to help reconstruct and develop rural areas. The linkage was through special programs that were created to increase the effectiveness of these agencies with rural areas. The government also encouraged the alignment of national and regional S&T centers with international S&T centers to increase scientific content in local farms (India., Planning Commission, 1981).

4.1.4.4.6 Expanded international collaboration

- **1985-1990 India Seventh Economic development plan (ISVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Increased the capabilities of the R&D by increasing the international collaboration	←	→		
	2	Increased the technology transfer to lower the cost of scientific projects		→		
	3	Shared scientific research with other nations	←	→		
	4	Created a central high data processing unit	←	→		
	7	Increased the S&T content in agricultural activities in rural areas			→	

Table 39 the Indian Seventh Economic Development Plan (GRIs)

During the seventh plan, the government increased its support for international collaboration by enhancing the capabilities of the local R&D facilities (table 39). This step was important to be able to absorb foreign technology, which could be transferred to lower the cost of scientific projects. The government also worked on sharing scientific research and scientific capabilities such as training facilities with other nations. This step was very important to increase the local technology content from international countries as shown in the third policy in table 41 (India., Planning Commission, 1985).

To increase the international connectivity with local farms and research facilities the government created a central high data processing unit and linked it with a high-power computer to serve central and regional areas. The government also encouraged industrial firms to acquire knowledge and technology from different GRIs to help themselves in

developing their products and increase their standardization. These research institutions were also encouraged to take part in the development of rural areas. The government encouraged the connectivity of the State S&T Councils and the Regional Research Laboratories (CSIR) and encouraged them to be involved in rural development (India., Planning Commission, 1985).

4.1.4.4.7 Transform the country to an IT international hub

- **1992-1997 India Eighth Economic development plan (IEIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
8th	1	Encouraged research and innovation in all GRIs and accelerated the process of encouraging information and telecommunication technology			→	
	2	Allowed freedom in all operations of GRIs			→	
	3	Encouraged all GRIs to build a close relation with rural areas			→	
	4	Increased collaboration in S&T through GRIs with over 40 countries		↔		
	5	Created entrepreneurship cells in all science/engineering/IITs fields			→	

Table 40 the Indian Eighth Economic Development Plan (GIRs)

In the eighth plan, the government started to choose a different path in its economy by increasing the focus on information and technology in its research centers. The government started to encourage research and innovation in research institutions and accelerated the process of encouraging information and telecommunication technology in many GRIs (table 40) (India., Planning Commission, 1992).

The government allowed freedom in all operations of GRIs to enhance thire capabilities using information technology. The government encouraged all GRIs to build a close relation with rural areas by identifying their problems clearly to solve them using information technology as a tool for solutions (India., Planning Commission, 1992).

During the IEIEDP, the Indian government increased its collaboration in S&T and GRIs activities with over 40 countries and through different international organizations, such as

the Technical Assistance Program (TAP), UNDP, UNESCO, and others (India., Planning Commission, 1992).

To increase the capabilities of the GRIs, the government increased the awareness of entrepreneurship through different organizations, especially through educational facilities and GRIs. The government created entrepreneurship cells in all science/engineering/IITs fields inside research facilities (India., Planning Commission, 1992).

4.1.4.4.8 Expanded IT policies, services, and equipment in India and started collaborating internationally

- **1997-2002 India Ninth Economic development plan (INEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
9th	1	Increased the effort in searching for talented scientist and provided them to local incubators and nurturing facilitates			→	
	2	Eliminated bureaucracy in scientific activities and needs			→	
	3	Marketed all GRIs funding in local and international markets			→	
	4	Guided research funds toward long-term objectives and visions			→	
	5	Signed agreements with 46 countries in the fields of S&T collaboration		↔		
	6	Allowed sharing research facilities in Indian cities with the exchange of scholars		↔		

Table41 the Indian Ninth Economic Development Plan (GRIs)

After creating several supportive entrepreneurial centers inside research facilities in the previous plans. The government increased its effort in the ninth plan (table 41) in searching for talented scientist and provided them to local incubators and nurturing facilitates to adopt their intelligence and ideas especially in software engineering and information technology.

To eliminate bureaucracy, the government increased its effort in reorganizing GRIs and control their operations through time tables and fixed budgeting with targets and goals. Also, the government aimed to market all GRIs funding in local and international markets

by linking the GRIs with the industrial facilities and encourage venture capitalist to work with these facilities. The government obligated official and decision makers to work as facilitators to all linked research industries' and venture capitalists' operations (India., Planning Commission, 1999).

During the INEDP, the government started to guide funds toward research activities that had long-term objectives and visions instead of temporary research views. Accordingly, the government created labs and centers of excellence in engineering at pioneering universities that conduct appropriate networking through various research institutions. This support came from various agencies toward specific universities, such as the National Board for Higher Mathematics (NBHM), which helped in creating several regional centers to improve S&T (India., Planning Commission, 1999).

Many government agencies helped in controlling these activities and guided them through the course of development. One of these agencies was the National Accreditation Board for Laboratories (NABL). These agencies helped to guide and to govern the process of such collaboration through the government needs (India., Planning Commission, 1999).

During the INEDP, the Indian government had signed agreements with 46 countries in the fields of S&T collaborations. The cooperation was mainly conducted with countries that had a culture of scientific research, such as "China, Hungary, Israel, Italy, Poland, Russian Federation and Ukraine." Also, the government signed several agreements with international organizations under several umbrellas, such as "the Indo-French Centre for the Promotion of Advanced Research (IFCPAR) and the Indo-Uzbek Centre," in addition

to the UN Centre for Space Science and Technology Education for Asia-Pacific Region that was established in Dehradun (India., Planning Commission, 1999).

The government also established several branches of joint research facilities in Indian cities with the exchange of scholars, such as "UNESCO - Nehru Science Chair at Jawaharlal Nehru Centre for Advanced Scientific Research in Bangalore and S&T projects with UNDP assistance sponsored by the DST in the areas of Natural Resource Data Management System" (India., Planning Commission, 1999).

4.1.4.4.9 Continued IT expanding Nationally and internationally

- **2002-2007 India Tenth Economic development plan (ITEEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
10th	1	Encouraged the scientists' mobilization between GRIs			→	
	2	Increased the establishments of the international scientific centers	↔			
	3	Encouraged the creation of excellence scientific centers nationally and internationally	↔			
	4	Offered scholarships for scientists to complete their education in its facilities through (CSIR) laboratories	↔			
	5	Initiated 14 new task in 14 laboratories through the CSIR			→	
	6	Increased R&D activities in "information technology, microelectronics, GPS hardware, Photonic, and other technological fields."			→	
	7	Accepted the help of major international cooperation as with Microsoft and Intel	↔			

Table 42 the Indian Tenth Economic Development Plan (GRIs)

After creating a robust infrastructure of research facilities and intelligent scantiest in the field of information technology during the previous plans. The government encouraged the scientists' mobilization between the GRIs and industrial R&D facilities to widen their experiences (India., Planning Commission, 2002).

The government also increased the establishments of international scientific centers with the participation of international scientists (table 42). Furthermore, the government encouraged the creation of excellence scientific centers nationally and internationally. To

help these centers provide services adequately, Fellowships were offered by GRIs for Indians and international students during the plan (India., Planning Commission, 2002). These scholarships were provided by the CSIR laboratories for scientists to complete their education in the CSIR facilities. To achieve this goal, the CSIR started to adopt several colleges and schools' programs under its direct supervision in each field of CSIR interest. The CSIR initiated 14 new tasks in 14 laboratories; that included: "Information technology, food processing, and other" (India., 2002).

The government also aimed to increase R&D activities in "information technology, microelectronics, GPS hardware, Photonic, and other technological fields" (India., Planning Commission, 2002). These developments had reached the national, regional, and sectoral level of the Indian economic at different locations. The government aimed to fund these activities using the private sector investments rather than relying only on the government as a major source of funding. Accordingly, the government accepted the help of major international cooperation, such as Microsoft, Intel, and General Electric to invest in the technological sector in India and open their branches at local innovation clusters (India., Planning Commission, 2002).

4.1.4.4.10 Strengthening the scientific base

- **2007-2012 India Eleventh Economic development plan (IELEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
	3	Shortened the waiting time that projects usually need to get funds			→	
	4	Increased interlaboratory networking			↔	

Table 43 the Indian Eleventh Economic Development Plan (GRIs)

The government aimed through the Department of Science and Technology to shorten the waiting time that projects usually needs to get funds from 18 months to 4 months. This

step was important to speed up the process of operations in GRIs (table 43) (India., 2008). The government also aimed to increase interlaboratory networking between GRIs and other industrial laboratories in industrial and new innovative clusters that created in several universities (India., Planning Commission, 2008).

4.1.4.4.11 Created an innovative connectivity system

- **2012-2017 India twelfth Economic development plan (ITWEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
12th	1	Increased the R&D expenditure to reach 2% of the country's GDP		→		
	2	Secured 1% of its total GDP in attracting corporate to spend more on R&D		→		
	3	Increased the number of researchers		→		
	4	Enhanced young scientists' mobility between institutions		↔		
	5	Encouraged large Indian enterprises to establish world-class R&D centers		↔		
	6	Enhanced international and local partnership		↔		

Table 44 the Indian Twelfth Economic Development Plan (GRIs)

In the India twelfth Economic development plan (ITWEDP), the government managed to create an innovative holistic system that linked the global, national, regional, and cluster level. The government increased the R&D expenditure to reach 2% of the country's GDP. The government also aimed to spend 1% of its total GDP in attracting corporate companies to spend more on R&D by public-private partnerships as shown in table 46. The government also worked on increasing the number of researchers from 154,000 at the beginning of the plan to reach 250,000 researchers by the end of the plan (table 44) (India., Planning Commission, 2013).

The government aimed to encouraged large Indian enterprises to establish world-class R&D centers and to be able to support their products innovative capabilities adequately. Through these R&D center the government encouraged the GRIs partnership with international scientific megaprojects that had an added value for Indian companies (India., Planning Commission, 2013).

To enhance international and local partnership, the government supported the new intellectual property regulations. For example, the government encouraged GRIs to create intellectual properties with industries. The government also created a database center for intellectual property that served national and international industries (India., Planning Commission, 2013).

4.1.4.4.12 Conclusion

In the early fifties, the main concern and focus of the government of India were to support the existed agricultural research facilities and connect them with each other. These research facilities were under complete administrative and financial government control. However, these institutions were operating individually without any connectivity or systematic management between them. The government continued the development and establishment of new agricultural institutions during the fifties, sixties, and seventies. In the late eighties, the government started to change its major concern from agriculture to information technology and computer software & hardware and transform India to be the world global information technology hub. The government increased its effort in establishing new research facilities and upgraded the existed ones to stimulate the new government trends. In the past two decades, the government increased its international relations in R&D with international countries, organizations, companies, and research facilities to be the new innovative hub in the 21st century.

4.1.4.5 Industrial (Large, Medium, and small businesses)

4.1.4.5.1 Overview

This section will investigate the Indian economic development plans to understand the evolution of the industrial sector. The study will explore the industrial policies,

incentives, major institutes, and industrial focus through the years. These policies and institutes will reveal the role of the industrial firms in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of indusial firms in building a robust innovation systems had be identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of India. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the industrial sector.

Figure 6 shows the distributions of the India Regional Innovation Systems that was implemented in 2011. This figure will help the reader in creating an understanding of the evolution process the industrial system in India

Figure 6 India's Regional Innovation Systems

The following discussion will develop an understanding of the evolution of the industrial sector and its role in developing the connectivity of the innovation systems.

4.1.4.5.2 Nationalization of all large private enterprises and expand smaller private agricultural industries

- **1951-1956 India First Economic development plan (IFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Prohibited Free private enterprises from the Indian industrial system		→		
	2	Increased agricultural productivity		→		
	3	Established a development council		→		
	4	Encouraged industries to increase their R&D activities		→		
	5	Decentralized industrial activities		→		
	6	Allowed new industrial operations without the approval of the central government		→		
	7	Registered all existed industries		→		
	8	Supported the rural industries to increase the employment rate in the village		→		
	9	Established the Khadi and Villages Industrial Development Board		→		

Table 45 the Indian First Economic Development Plan (Industrial Policies)

After India gained independence of Great Britain and transformed to a republic country, the government started to nationalize all large enterprises and transformed them to publicly owned. Free private enterprises were forbidden from the Indian industrial system during the first plan. According to the government, each enterprise should be related to a public enterprise or should serve a public need and under the supervision of the states or central government as (table 45) (INDIA Republic of India., Planning Commission, 1953).

In the first plan, the government realized that there was an overwhelming number of individuals working on agricultural activities and that they are concentrated in specific agricultural fields and areas. Thus, the government worked on redistribute the working force during the plan (table 45). Although the overwhelming number of agricultural workers was a concern for the Indian government, increasing agricultural productivity was a major objective and concern for economic development in the first plan. In the agricultural sector, the government focused on industrial productions, such as “sugar,

fertilizers, and other agricultural productions" (INDIA Republic of India., Planning Commission, 1953).

During the IFEDP, the Indian government announced the Development and Regulation Act and established a development council accordingly. The council was responsible for monitoring the industrial production quality and monitored connectivity between industries to achieve maximum cost benefits and minimize waste. Furthermore, the government started to encourage industries to increase their R&D activities, especially in the agricultural facilities (INDIA Republic of India., Planning Commission, 1953).

One of the major aims of the government during the IFEDP was to decentralize industrial activities and promote training to the local workers in new rural industrial locations. However, no new industry could establish its operations without the approval of the central government. All existed industries were obligated to be registered in the central government system. All industries that failed to register during the first five-year plan were forced to be transferred under government management and control

During the IFEDP, the government aimed to support the rural industries to increase the employment rate in villages. The small industries relied mainly on the processing of local agriculture and other raw materials, such as "leather, coir, matches hand-made paper and other." Accordingly, the government established the Khadi and Villages Industrial Development Board to engage in organizing the local villages production processing and their industries. The major concern of the organization was on, "state policy, finance, raw materials, research, technical guidance, the supply of equipment, and marketing for village industry" (INDIA Republic of India., Planning Commission, 1953).

4.1.4.5.3 Developed rural and small agricultural businesses

- **1956-1961 India Second Economic development plan (ISEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Supported the industrial base by increasing the existed production		→		
	2	Increased the efficiency and capacity of the village and small industries		→		
	3	Avoided implementing high technological machines		→		
	4	Encouraged local farmers and handicrafts to develop new production techniques		→		
	5	Created the State Finance Corporations and the Central Small Industries Corporation		→		

Table 46 the Indian Second Economic Development Plan (Industrial Policies)

After controlling the large enterprises in the first economic development plan, the government worked on allowing farmers and small investors to develop their businesses in the Second Economic development plan (ISEDP). The government aimed to increase the existing production base in iron, agriculture, cement, aluminum, chemical pulp, drugs, fertilizers, and machine building industry. The government also aimed to decentralize many industries and upgrade the factories with new technological machines (table 46). These factories and fields were mainly government led firms (INDIA Republic of India., Planning Commission, 1956).

The Indian government worked on increasing the efficiency and capacity of the village and small industries as one of its major objectives in the industrial sector. This objective was motivated by the need to raise income, increase the work opportunity, and develop the rural economic environment. However, unlike many other countries, India avoided implementing high technological machines that could increase unemployment among the Indian workers, which would lead to unprecedented social problems. Instead of adopting the use of high technological machines the government encouraged local farmers and handicrafts to develop new techniques in industrial production, which could help them in developing their products (INDIA Republic of India., Planning Commission, 1956).

These policies were important for traditional village industries whose immediate prospects depended upon the way broad policies were carried into effect. To assist small businesses, the government created the State Finance Corporations and the Central Small Industries Corporation. These corporations were meant to provide nucleus financial services in products that were willing to enter the market through the agencies system (INDIA Republic of India., Planning Commission, 1956).

- **1961-1966 India Third Economic development plan (ITEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Reduced production costs by increasing training activities to local workers		→		
	2	Accelerated growth in rural areas by providing loans to local businesses		→		
	3	Promoted small industries to the larger industries as an ancillary in their production		→		
	4	Continued to help small industries through the National Small Industries Corporation		→		
	5	Enforced the reliance on local machine building facilities and workers		→		
	6	Increased the worker capabilities and knowledge by increasing technical training		→		
	7	Allowed private investments in large enterprises outside of the government businesses		→		

Table 47 the Indian Third Economic Development Plan (Industrial Policies)

India's Third Economic development plan (ITEDP), the Indian government increased its support to the agriculture and village industries by considering the following steps:
The first step was to increase the worker productivity and reduce production costs by increasing training activities and provide new assistance to the local workers on how to use new techniques (table 47). The second step was to accelerate growth in rural areas by providing loans to local businesses and by providing managerial help. The third step was to promote small industries to the larger industries as an ancillary in their production by providing raw materials and parts to the larger industries (INDIA Republic of India., Planning Commission, 1961).
During the ITEDP, the availability of credit agencies was a need for all small and village industries. To be able to secure funds to the small and villages industries the government

decided to provide help from outside of the small industries system. The help came from the Reserve Bank of India. This step was important to meet the requirement of the long and medium-term capital (INDIA Republic of India., Planning Commission, 1961).

During the ITEDP, the Indian government created the National Small Industries Corporation to continue helping the small industries by providing loans and managerial services. This organization worked on ensuring that all small industries were under the government supervision and had access to state aid (INDIA Republic of India., Planning Commission, 1961).

In large industries, the government aimed to achieve a self-sustained machine building by relying on local machine buildings facilities and workers to fulfill their needs. To achieve this goal, the government focused on increasing the worker capabilities and knowledge by increasing technical training programs. The government also concentrated on the basic capital goods industries that were required to build a sufficient economy and become self-sustained and independent in "aluminum, mineral oils, dissolving pulp, basic organic and inorganic chemicals" (INDIA Republic of India., Planning Commission, 1961).

4.1.4.5.4 Increased institutional support to agricultural businesses

- **1969-1974 India Fourth Economic development plan (IFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Strengthened the Small-Scale Industries Development Organization			→	
	2	Initiated the Unit Trust of India as a high-risk financial organization			→	
	3	Created the Industrial Development Bank that was set up in 1964			→	
	4	Implemented new measurements to speed up the industrial licensing		←	→	
	5	implemented new industries in areas that had specific local capabilities			→	
	6	Increased the decentralization and disparity of small businesses			→	
	7	Increased the quality of local agricultural goods			→	

Table 48 the Indian Third Economic Development Plan (Industrial Policies)

In India's Fourth Economic development plan (IFREDP), the government worked on strengthening its support to the Small-Scale Industries Development Organization with product testing equipment and other facilities that were required for developing the field. The government initiated The Unit Trust of India as a high-risk financial organization for financing individuals and small businesses (table 48). To provide larger assistance for major organizations, the government created the Industrial Development Bank that was set up in 1964 (INDIA Republic of India., Planning Commission, 1970).

Also, the government implemented new measurements to speed up "the industrial licensing, the importing of raw materials & capital goods, issuing of capital and approval of foreign collaboration agreements" (INDIA Republic of India., Planning Commission, 1970).

During the IFREDP, the government aimed to decrease the imbalance of industrial development in all areas. To do so, the government increased its investigation to implement new industries in areas that had specific local capabilities in handicrafts or other industries by strengthening their technological and technical capabilities. The government also increased the decentralization and disparity of its small businesses through the implementation of incentive and disincentive policies to increase the development in all regions. These policies were made to move firms away from central regions to other outer areas.

During the IFREDP, the government worked on increasing the quality of local goods by implementing new measures for small businesses and agricultural production processes (INDIA Republic of India., Planning Commission, 1970).

4.1.4.5.5 Increased the quality of agricultural production

- **1974-1980 India Fifth Economic development plan (IFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Established regional testing centers to increase and test the quality of the new products			→	

Table 49 the Indian Fifth Economic Development Plan (Industrial Policies)

In the Fifth Economic development plan (IFFEDP), the government started to increase its attention on the small and village industries quality control and extended its services to this sector. Thus, established regional testing centers to increase and test the quality of the new products (table 49). The support was from the financial institutions that were established in many regions (India., Planning Commission, 1976).

4.1.4.5.6 Opened foreign technologies and investments into local agricultural industries

- **1980-1985 India Sixth Economic development plan (ISIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Encouraged entrepreneurs to relocate in rural areas			→	
	2	Allowed technological manufacturing machines to be imported			→	
	3	Allowed foreign investment in domestic agricultural technologies			→	
	4	Allowed selective importation of raw materials that would increase the products' quality			→	

Table50 the Indian Sixth Economic Development Plan (Industrial Policies)

To increase local and rural support in the Sixth Economic development plan (ISIEDP), the government encouraged entrepreneurs to relocate in rural areas through increased incentives and loans (India., 1981). Furthermore, the government supported the creation of the new businesses in local areas by allowing technological manufacturing machines to be imported (table 50). The government also allowed foreign finance from international organizations to be invested in domestic technological infrastructure. To support this international collaboration, the government allowed selective importation of raw

materials that would increase the products' quality and would increase the exports significantly (India., Planning Commission, 1981).

- **1985-1990 India Seventh Economic development plan (ISVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Increased decentralizing of agricultural industrial firms and operations			→	
	2	Provided equipment to local industries through the State Small Industries Development Corporations			→	

Table 51 the Indian Seventh Economic Development Plan (Industrial Policies)

After focusing on small agricultural businesses in the previous plan, the government in the Seventh Economic development plan (ISVEDP) increased technology transfer to the small agricultural businesses (India., Planning Commission, 1985).

The government also increased the utilization of the District Industries Centers that were launched in 1978 to provide services and support in all industrial districts in rural areas. Also, the government obligated the State Small Industries Development Corporations to play a major role in providing equipment to local industries (table 51). The "sunrise industries played a major role in developing the rural industrial cluster in knowledge-based industries, such as electronics, information technology, and advanced machine tools." A sunrise industry is "A colloquial term for a sector or business that is in its infancy but is growing at a rapid pace. A sunrise industry is typically characterized by high growth rates, numerous start-ups and an abundance of venture capital funding" (India., Planning Commission, 1985).

4.1.4.5.7 Increased scientific base into local agricultural products and reconstruct large enterprises

- **1992-1997 India Eighth Economic development plan (IEIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
8th	1	Developed the agricultural industry by creating an industrial scientific base in firms		→		
	2	Transferred nonproductive public enterprises to the Board of Industrial and Financial Reconstruction (BIFR)		→		
	3	Increased public participation in the reconstruction process of public enterprises		→		
	4	Encouraged industrial cooperatives to established in-house R&D institutions		→		
	5	Obligated industries to increase their products technological content		→		
	6	Obligated the NSIC to increase the scientific base in local products		→		

Table 52 the Indian Eighth Economic Development Plan (Industrial Policies)

At the beginning of the Eighth Economic development plan (IEIEDP), the government succeeded in developing the agricultural industry and create an industrial scientific base in many industrial firms (India., Planning Commission, 1992).

During the IEIEDP, the government decided to transfer nonproductive public enterprises to the Board of Industrial and Financial Reconstruction (BIFR) to recover its productive capability or sell it in the market. After the revival, the government worked on increasing the autonomy of all public enterprises and free them from direct government control (table 52) (India., Planning Commission, 1992).

During the IEIEDP, many industrial firms have established in-house R&D institutions, such as “the Indian Petrochemicals Corporation Ltd, Hindustan Organic Chemicals Ltd, Hindustan Machine Tools and other” (India., Planning Commission, 1992). This step had helped these industries in developing their scientific basis and increase their production quality.

In small businesses, the government increased industrial obligations to increase products technological content especially in the field of information technology. The government

had obligated the NSIC to handle the function of "creating testing centers, conducting studies, implementing technological guidelines, providing information, monitored quality, marketing, and import of samples" to help small businesses to grow promptly (India., Planning Commission, 1992).

4.1.4.5.8 Transformed the country into IT industrial hub

- **1997-2002 India Ninth Economic development plan (INEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
9th	1	Liberalized policies to decrease the control of central government in rural industries		→		
	2	Eliminated main industrial licensing bureaucratic conditions		→		
	3	Reduced the number of services fields that were reserved for public enterprises		→		
	4	Increased the information technology infrastructure		→		
	5	Considered India to be the global hub and super technological power	←	→		
	6	Conducted IT Action Plan on the Development and Export of Software and Data		→		
	7	Increased software products to reach $50 billion by the year 2008		→		
	8	Increased the Indian workforce works in information technology to 25%		→		
	9	Transformed more than 5000 small and medium sized businesses to knowledge-based		→		
	10	Liberalized foreign investments and opened the local economic	←	→		

Table 53 the Indian Ninth Economic Development Plan (Industrial Policies)

In the Ninth Economic development plan (INEDP), the government started to change its major development goal to computer science and information technology instead of agriculture. The government started to conduct liberalized policies to decrease the control of central government over the rural industrial sector. The government eliminated main industrial licensing bureaucratic conditions on industrial firms and small businesses (table 53). The government also reduced the number of services fields that were reserved for public enterprises to give a chance for private enterprises and businesses to invest in it (India., Planning Commission, 1999).

During the INEDP, the government started to increase the information technology infrastructure as a new major technological and network base in the country. Also, the government decided that India should be the global hub and super technological power

and networking industry in the world. To achieve this goal, in 1998 the government conducted its IT Action Plan on the Development and Export of Software and Data. In this plan, the government aimed to increase its software products to reach $50 billion by the year 2008. The country had initiated special advertisement programs to universalize the notion that India will be the future of the IT-based education and industry. The government also conducted the industries to increase their ability to absorb more than one million graduates each year. The government aimed to increase the workforce works in information technology to 25% of the entire Indian labor force (India., Planning Commission, 1999).

At the beginning of the plan, there were more than 5000 small and medium sized businesses transformed to knowledge-based enterprises. To support these industries financially, the government liberalized foreign investments and opened the local economic to foreign venture capitalists to invest in the local knowledge-based industries (India., Planning Commission, 1999).

At the beginning of the ninth plan, the number of in-house industrial research facilities had reached 1600 R&D units. This huge number of research facilities played a major role in increasing the competitiveness of the Indian products in the world market in many technological fields (India., Planning Commission, 1999).

4.1.4.5.9 Supported local S&T infrastructure and opened the economy for international companies to relocate in India

- **2002-2007 India Tenth Economic development plan (ITEEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
10th	1	Treated all small and medium sized enterprises along with handicrafts business as large enterprises		→		
	2	Increased incentives to industries that recruits more citizens		→		
	3	Reduced the tariff for the imported products from 90% to 34%		→		
	4	Supported all small-scale industries and non-farm activities		→		
	5	Liberalized small-scale industrial activities from direct government control		→		
	6	Allowed more than 500 international enterprises to enter the Indian market	←	→		
	7	Upgraded the infrastructure of S&T in the country and created several economic zones		→		
	8	Initiated several research centers for small businesses under Khadi and Village agency		→		
	10	Created 12 more clusters		→		

Table 54 the Indian Tenth Economic Development Plan (Industrial Policies)

During the Tenth Economic Development Plan (ITEEDP), the government decided to treat all small and medium sized enterprises along with handicrafts business as large enterprises in all activities, such as transport, trade, and financial services. The government also linked all incentives, such as credit, sales tax, technology development and marketing support with employment generating. So, the industry that recruited more citizens would gain the most from the incentive system (India., Planning Commission, 2002).

In 2001, the government reduced the tariff for the imported products from 90% to 34%, which was still high in contrast to the common level in East Asia. The government also supported all small-scale industries and non-farm activities as one of the major sources of employment in the country. The government aimed to liberalize the control on small-scale industrial activities and make sure that credits were available for them to conduct their entrepreneurial activity. To achieve this objective, the government worked on encouraging the private sector banks to provide credits to these businesses.

Simultaneously, the government obligated the public-sector banks to ease the approval of cash flow to private banks and small-scale businesses to ease their duties (India., Planning Commission, 2002).

As a result, more than 500 international enterprises have entered the Indian market, such as "ABB, GM, FORD, HP, SHARP, FIAT, CUMMINS, EMERSON ELECTRIC, GE, TOYOTA, and KODAK." The government worked on upgrading the infrastructure of S&T in the country and created several economic zones that can encompass the companies. After signing an agreement to be part of Trade Related Intellectual Property Rights, the government reformed its patent regulations in 2005. The government implemented new laws and policies that controlled the legal, credits and bankruptcy laws. All these regulations had created a positive investment climate in whole India (India., Planning commission, 2002).

At the beginning of the ITEEDP, the government initiated several research centers for small businesses under the supervision of the Khadi and Village government agency. The Khadi and Villages also aimed to create rural communities that connects the industry with research centers and venture capitalists. The Khadi and Village helped local industries to market their products in different parts nationally and internationally. Accordingly, there were 50 clusters identified under the supervision of Khadi and Villages, 12 more clusters were established during the years 1999- 2000 (India., Planning Commission, 2002).

There was another agency that aimed to support small businesses, and it was under the Ministry of Small Scale Industries supervision and called the Small Industries Development Organization. This organization played a crucial role in assessing the small-

scale industry by providing marketing services, technological assistance, infrastructural help, and training and support along with the Small Industries Development Bank of India and other commercial banks to make funds available for small businesses. While the Small Industries Development Organization helped in providing technical and monetary help, The National Small Industries Corporation provided help in other logistical issues. For example, "providing raw material to the business, integrated marketing support, exports, and exhibition, technology transfer, and software setting up help." The international help provided by this organization were through the Asia-Pacific Center for Transfer of Technology (India., Planning Commission, 2002).

To enhance the linkage between small and medium size enterprises and Large size enterprises, the government created several technological agencies that motivated the communication between these industries and the GRIs, such as the Manufactories Association of Information Technology and the National Association of Software and Services Companies. These institutions not only worked to increase local connectivity but to increase the relation between the National and international institutions, labs, and industries (India., Planning Commission, 2002).

4.1.4.5.10 Adopted the innovation model, supported entrepreneurs

- **2007-2012 India Eleventh Economic development plan (IELEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
11th	1	Increased the IT experts in all industrial fields especially in rural areas			→	
	2	Created an IT institutional infrastructure to provide all services to the rural areas			→	
	3	Reduced indirect tax rates on large enterprises to 30%			→	
	4	Created and entrepreneurship development initiatives programs			→	
	5	Trained more than one hundred thousand entrepreneurs each year			→	
	6	Adopted the paradigm of innovations in its operations and product contents			→	
	7	Commercialized and absorbed innovations nationally and internationally			→	
	8	Created an agency that was responsible for delivering technologies for rural areas			→	
	9	Helped linking all small but sincere entrepreneurs to create new businesses			↔	
	10	Encouraged industrial firms to innovate and support their innovative employee			→	

Table 55 the Indian Eleventh Economic Development Plan (Industrial Policies)

During the Eleventh Economic Development Plan (IELEDP), there were several major industrial fields in the country. These fields were "Automotive, Food Products, Chemical Products, Basic Materials, Non-Metals Mineral Products, Plastic and Plastic Processing Industry, Leather, Rubber and Rubber Products, Wood and Bamboo Products, Germs and Jewelry, Handicrafts, Handlooms, and Khadi and Village Industries" (India., Planning Commission, 2008). The government aimed to increase the IT experts in all these industrial fields especially in rural areas (table 55). Accordingly, the government created an IT institutional infrastructure to provide all services to the rural areas.

Tax policies were still a major tool for attracting new industries. The government aimed to reduce indirect tax effect on business by providing long lasting incentives. Also, the government worked on decreasing tax rates on large enterprises to 30% (India., Planning Commission, 2008).

During the IELEDP, the government conducted several initiatives to support the small and medium business sector. The government conducted an entrepreneurship development initiatives programs to encourage entrepreneurship in the country. The

Ministry of Micro, Small, and Medium Enterprises took the initiative to train more than one hundred thousand entrepreneurs on entrepreneurship initiative each year (India., Planning Commission, 2008).

To increase the industrial productivity, the government adopted the paradigm of innovations in its operations and product contents. The government amid to search for ways to create, commercialize, and absorb innovation nationally and internationally as shown in table 57. The government identified several institutions in different sectors that could be brought together to increase the country's productivity; these sectors were as follow:

1- "Government agencies that could fund basic research
2- Research institutions owned by private enterprises
3- Universities and related institutions to provide related skills and knowledge
4- Connecting intermediaries' institutions, such as "technology cents," "technology brokers," and business innovation centers" these institutions came all together to narrow the gap in technological innovation in the country
5- Venture capitalist, federal laboratories, and training organization" (India., Planning Commission, 2008).

All these were very important actors in creating an innovative ecosystem in the eleventh plan. Furthermore, the government realized that technology transfer was still weak and needs more improvements. Accordingly, the government created an agency they were responsible for delivering technologies for rural areas. The agency was called The Council for Advancement of People's Action and Rural Technology. This organization along with the voluntary support organization helped to link together all small but sincere

prospect business or group of entrepreneurs. These agencies helped to team up these groups of intelligent entrepreneurs not only through the national level; it exceeded up this to search for partnership internationally to speed up the process of businesses development. These organization started to search for talented Indian emigrants from all the world and convinced them to come back and create research centers and schools to leverage developments and partnerships between rural, regional, national, and international S&T groups and research centers (India., Planning Commission, 2008). The government also worked on fostering innovation in all industrial sectors. To achieve this goal the government worked on encouraging industrial firms to innovate and support their innovative employee. The National Knowledge Commission had worked with local industries to foster innovation and increase productivity (India., Planning Commission, 2008).

4.1.4.5.11 Enhanced innovation capabilities in the industrial companies

- **2012-2017 India twelfth Economic development plan (ITWEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
12th	1	Encouraged innovation using inexpensive tools and techniques		→		
	2	Adopted efficient techniques in applying new R&D models		→		
	3	Created an innovation "ecosystems of enterprises."		→		
	4	Enhanced skill productivity to ensure competitiveness in technological enterprises		→		
	5	Encouraged all low-cost industries to have a value addition to its manufacturing base		→		
	6	Encouraged small industries to be more specialized		→		
	7	Encouraged innovation and foster the establishment of small innovative businesses		→		
	8	created an environment that could absorb and consume technology between enterprises		↔		
	9	Mitigated the risk of conducting a high technology investment		→		
	10	Encouraged the creation of brand names and images to fulfill the needs of marketing		→		
	11	Used tax credits as an innovation development tool instead of tax incentives		→		
	12	Announced the National Investments and Manufacturing Zone in the year 2011		→		
	13	Encouraged international collaboration to develop rural areas	←	→		

Table 56 the Indian Twelfth Economic Development Plan (Industrial Policies)

During the twelfth Economic Development Plan (ITWEDP), the government of India encouraged innovation using inexpensive tools and techniques to foster innovation in

new businesses in central and rural areas (table 56). The focus was on seeking efficiencies in applying new R&D models, which could benefit the whole country especially the poor. To achieve this goal, the government created an innovative "ecosystems of enterprises" that focuses on bringing together "entrepreneurs, researchers, finance providers, businesses enterprises, and policy makers" (India., Planning Commission, 2013). The government encouraged the collaborations of all these elements in an innovative and productive environment.

To ensure the efficiency of the new policies, the government started to enhance skill productivity to ensure competitiveness in micro, small, and medium enterprises, which encompass 40% of employment in India. The government also aimed to increase multinational cooperation research centers to establish facilities and research centers in India and foster the innovation ecosystem. The major aim of this step was to increase the Indian company's competitiveness in the global market (India., Planning Commission, 2013).

In new products, the government encouraged all low-cost industries to have an added value to its manufacturing base to be able to compete with foreign products. The added value would help the local products to compete even if the foreign prices were lowered. The government encouraged small industries to specialize in specific areas to be the backbone for larger enterprises. To encourage innovation and foster the establishment of small innovative businesses the government supported its business laws. This support was by allowing "early stages risk capital, incubators, and quick exit bankruptcy" (India., 2013).

To improve technology for domestic enterprises, the government enhanced an environment that could absorb and consume technology within domestic enterprises. Also, the government mitigated the risk of conducting a high technology investment with domestic enterprises. The government also implemented extra standards that control the quality of imported materials to help protect the consumers and local products from unfair competitiveness with low-quality products. The government also worked on creating a brand name and image to fulfill the needs of marketing the Indian products (India., Planning Commission, 2013).

To increase small, medium, and large enterprises' innovation capability, the government provided easy access to high-risk capital. The government also set standards and measures for all kinds of businesses with preferable treatment when requiring services or purchasing equipment. To help develop all enterprises with adequate technological infrastructure the government aimed to create clusters that can gather all industries, academia, and GRIs together and provide a skillful workforce that could deal easily with new technologies. The government provided technology funds for companies and institutions that moved into new clusters. The government also used tax credits as an innovation development tool instead of tax incentives. In other words, "equivalent benefits of weighted deduction on R&D spend should be treated as tax credits and be allowed to be set off against tax" (India., Planning Commission, 2013). To avoid affecting enterprises that do not operate in economic zones, the government provided tax incentives for all companies that operate in high technological fields instead of special places.

The National Investments and Manufacturing Zone was announced in the year 2011 to make sure that all technological businesses had the appropriate infrastructures to operate in it. These infrastructures included "rails, roads, ports, airports, and telecommunications." The government through its institutions provided quality and productivity services through specific centers in these zones. The government also took the responsibility of promoting all kinds of investments in the National Investments and Manufacturing Zones nationally and internationally (India., Planning Commission, 2013). During the ITWEDP, the government encouraged all companies that had relations with international companies to search for and locate to areas that lack technological capabilities. The government supported these areas using "FDI (investments by foreign companies in Indian venture) and Joint Ventures of Indian investors" (India., Planning Commission, 2013). The help would be by providing all technological needs and infrastructure to these areas.

4.1.4.5.12 Conclusion

In early 1950s, the major government focus was to increase the central government economic base by nationalizing all large private enterprises and expand smaller private agricultural industries. After achieving this step, the government started to transfer the private sector effort in developing the rural areas especially on smaller agricultural activities.

In late 1960s, the government started to institutionalize the support to local farmers under cooperative agencies and reforming the rural administrative level. During the 50s and 60s, the government fought against new foreign technologies and machines and wasn't

until early 80s when the government allowed foreign technology transfer to the local farming industries.

In early 90s, the government started to reconstruct large enterprises and allow local and international investments in these enterprises. These new investments were accompanied by technology transfer that increased the scientific base of many products. The government also decided to be the world IT industrial hub, which obligated many industries to change their major focus to IT instead of agriculture.

In late 2000s, the government increased its opened economy policy and increased international connectivity with other countries and industries and encouraged the industries to relocate in their industrial facilities in India. This step increased the connectivity the connectivity between the global, national, regional, and local level because the new industrial facilities were in different central and local areas.

After this step, the government started to support the innovation and knowledge economy extensively in different areas. In 2011, started to create special clusters for IT and computer industries in regional and local areas to fulfill their goal to be the global IT hub.

4.1.5 Horizontal institutional connectivity (university, finance, GRI, and industry)

4.1.5.1 Overview

This section will explore the horizontal institutional and industrial connectivity in India innovation system. This investigation will include the connectivity of the four major elements for any successful innovation system that indicated by scholars, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. These elements are the universities (UNV),

monetary institutions (MON), government research institutions (GRI), and industries (IND). The search will include the major policies, incentives, organizations and the role of government in enhancing the connectivity between these institutions to develop an innovation system. In each plan, there will be a table that indicates the policies that influenced the institutional connectivity. Beside each policy there will be stars to explain the connectivity between institutions. Each plan will be headed by a categorization to explain the major vision and objective of the plan. However, some plans will not have a specific category because it continued the previous plan objective and vision. The following discussion will develop an understanding of the evolution of the institutional connectivity and its role in developing the innovation systems.

4.1.5.2 Building the infrastructure

- **1951-1956 India First Economic development plan (IFEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
1st	1	Increased the vocational and technical training in the whole country	*			*
	2	Decentralized industrial activities and promoted training to the local workers	*			*
	3	Created credit guaranty funds for farmers		*		*
	4	Encouraged industries to increase their R&D activities			*	*
	5	Provided scholarships to students to complete their education in developed countries	*	*		

Table 57 India First Economic Development institutional connectivity

In the Indian First Economic development plan (IFEDP), the government increased the connectivity between the educational and industrial system by increasing the vocational and technical training in the whole country in all economic fields, such as agriculture, mining, fishery, and other industrial activities. The major government aim was to decentralize the industrial activities and promote training to the local workers in the new

rural industrial locations (table 57) (INDIA Republic of India., Planning Commission, 1953).

The government promoted connectivity between the financial system and industrial system through the establishment of the credit guaranty funds for farmers. This program provided seeds and fertilizers for local farmers and freed them from the control of the private lenders and traders.

The government encouraged the industrial sector to increase their R&D activities, especially in the agricultural facilities. This step was accompanied by an increased connectivity between the industrial and GRIs especially in the agricultural fields.

The government increased the relation between the financial system and educational system by providing scholarships to students to complete their education in developed countries (INDIA Republic of India., Planning Commission, 1953).

4.1.5.3 Increased agricultural support

- **1956-1961 India Second Economic development plan (ISEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
2nd	1	Encouraged the connectivity between universities and GRIs	*		*	
	2	Created laboratories in 33 universities, 88 R&D centers, and 54 associations	*	*	*	
	3	Provided direct funds from the central government for several GRIs		*	*	
	4	Linked the educational curricula and financial support for engineering institutes with dominant industry in each district and local area	*	*		*
	5	Provided programs to educate local workers	*			*
	6	Provided technical and financial assistance to local agricultural producers		*		*
	7	Created cooperative credit agencies for each industry		*		*

Table 58 India Second Economic Development institutional connectivity

In the Second Economic Development Plan (ISEDP), the government implemented new policies to connect the educational system with the GRIs system. The government

encouraged the connectivity between universities and GRIs in investigations and research applications. To increase this connectivity the government through the Council of Scientific and Industrial Research Department created new laboratories in 33 universities, 88 R&D centers, and 54 associations that conducted scientific and technological research (INDIA Republic of India., Planning Commission, 1956).To ensure that all GRIs conducted its obligation significantly. The government provided directed funds from the central government to several research institutions.

To increase the connectivity between the financial, educational and GRIs systems. The government linked the educational curricula and financial support for engineering institutes and public schools by the dominant industry in each district and local area (table 58).

The government increased the monetary and educational link through special programs to educate local workers by teaching new techniques and methods in local industries. The government also provided scholarships for international students to study in India (INDIA Republic of India., Planning Commission, 1956).

To increase the industrial support and development, the government increased the financial support to the industrial system. The government allowed smaller companies to invest in smaller businesses that does not involve public services and infrastructure buildings under its primary tasks because it's a government enterprises duty. The government provided technical and financial assistance to local agricultural producers, community projects, and village & small industries. To support this general government trend toward the industrial system, the government created cooperative credit agencies to

support these businesses as shown in table 60 (INDIA Republic of India., Planning Commission, 1956).

- **1961-1966 India Third Economic development plan (ITEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
7th	1	Reduced production costs by increasing training activities	*	*		*
	2	Created the National Small Industries Corporation to provide loans to small industries		*		*
	3	Connected all rural farms under a cooperative umbrella		*		*
	4	Funded industrial programs through internal loans, equity capital and friendly international countries		*		*
	5	Coordinated research work through GRIs, universities, and technical institutions	*	*	*	
	6	Provided scholarships through the University Grants Commission	*	*		

Table 59 India Third Economic Development institutional connectivity

In the India Third Economic development plan (ITEDP), the government reduced the production costs by increasing training activities and provided assistance to the local workers on agricultural and local artisan activities (table 59). This step helped the creation of a supportive ecosystem between the educational, financial and industrial systems (INDIA Republic of India., Planning Commission, 1961).

Table 69 shows how did the government created a relationship between the financial and industrial system through the following activities. First, the government accelerated the growth in rural areas by providing loans to local businesses and by providing managerial help. Second, the government created the National Small Industries Corporation to continue helping the small industries by providing loans and managerial services. Third, the government increased the worker capabilities and knowledge by increasing technical training programs. Fourth, the government allowed private enterprises to invest in other production outside of the major government businesses the was mentioned in the first plan. Fifth, the government brought bringing all farms under a cooperative umbrella to ease and to systematize the rural areas funding. Sixth, the government funded many

industrial programs through internal loans and equity capital and from friendly international countries (INDIA Republic of India., Planning Commission, 1961).

The government increased the financial and industrial connectivity by adding the educational system to this linkage. Accordingly, the government coordinated research work through national laboratories, universities, technical institutions, laboratories of scientific associations, and research departments in government agencies. To increase individual efficiency, the government provided scholarships through the University Grants Commission (INDIA Republic of India., Planning Commission, 1961).

4.1.5.4 Institutionalized the financial system to support farming and industrial activity

- **1969-1974 India Fourth Economic development plan (IFREDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
4th	1	Initiated the Unit Trust of India as a high-risk financial organization for businesses		*		*
	2	Created the Industrial Development Bank that was set up in 1964		*		*
	3	Supported the Land Development Bank that handled the long-term farmers credits loans		*		*
	4	Nationalized the banking system and increased the credit availability to all the economy		*		*
	5	Provided special finance to selected products		*		*

Table 60 India Fourth Economic Development institutional connectivity

During the India Fourth Economic development plan (IFREDP), the government initiated several policies to the increased the connectivity between the financial and industrial systems. These policies were as follows. First, the government initiated The Unit Trust of India as a high-risk financial organization for financing individuals and small businesses (table 60) (INDIA Republic of India., Planning Commission, 1970).

Second, provided larger assistance for more major organizations the government created the Industrial Development Bank that was set up in 1964.Third, the government obligated the Land Development Bank to provide the long-term credits loans. These banks had

functioned through a network of more than 1250 branch. Fourth, the government nationalized the banking system and increased the credit availability to all economic sectors, especially the agricultural sector (INDIA Republic of India., Planning Commission, 1970).

4.1.5.5 Strengthened the scientific base

- **1980-1985 India Sixth Economic development plan (ISIEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
6th	1	Provided a bundle of incentives to the private entrepreneurs		*		*
	2	Increased the scientific standards through the national measurement and standard center			*	*
	3	Increased the number of research institutes to interact with higher educational institutes	*		*	
	4	Encouraged scholarly visits between scientists in educational facilities and GRIs	*		*	
	5	Provided financial support through the University Grants Commission	*	*		
	6	Increased the link between education and industry to develop employment opportunities	*		*	*
	7	Created the Development Banks for Industry and Agriculture activates		*		*

Table **61** India Sixth Economic Development institutional connectivity

During the India Sixth Economic development plan (ISIEDP), the government worked on strengthening the scientific base especially in the agricultural and farming activities. The government allowed foreign finance in international organizations to invest in domestic technologies in GRIs and industrial facilities (table 61).

The government also increased the connectivity between the financial and industrial system by providing a bundle of incentives to the private entrepreneurs through finance, tax relief, and central investment subsidies so they could conduct new technological schemes. To ensure the quality of the new industries and GRIs, the government created the national measurement and standard centers to increase the scientific standards in all operations in research facilities (India., Planning Commission, 1981).

The government also encouraged the connectivity between the educational and GRIs through the following policies. First, Scientists and academics were encouraged to work

in close relation with the state S&T councils and state planning boards. Second, increased the number of research institutes to interact with higher educational institutes. Third, the government also encouraged the scientists in educational facilities and S&T institutions to visit and share knowledge with each other. Also, the government did the same with private and public industrial institutions (India., 1981). These policies were achieved through the help of the University Grants Commission had provided financial support to universities to update their computer facilities and instruments for advanced studies in science (India., Planning Commission, 1981).

To increase the validity of the new policies, the government encouraged the universities to build a network between each other and industries in the fields of R&D. These linkages were conducted through students, faculty members, and scientists with neighboring areas and institutions. These peoples resolved social and economic problems through scientific and social development (India., 1981). One of the major finance sources to these activities was the Development Banks for Industry and Agriculture that played a major role in funding activities in the economy (India., Planning Commission, 1981).

- **1985-1990 India Seventh Economic development plan (ISVEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
7th	1	Utilized the entire government system to support small businesses	*	*	*	*
	2	Encouraged industrial firms to acquire knowledge and technology from different GRIs			*	*
	3	Increased the S&T in rural areas through GRIs, universities, and scientific individuals	*		*	
	4	Trained the workforce on information systems and technologies through education	*			*
	5	Encouraged the connectivity between industry and job training in new educational	*			*

Table 62 India Seventh Economic Development institutional connectivity

In the Seventh Economic Development Plan (ISVEDP), the government increased the connectivity between the educational, financial, GRIs, and industrial system. This step was encouraged by utilizing the national laboratories, GRIs, volunteer agencies, the Indian Institute of Technology to take part, venture capitalists and commercial banking institutions to support small businesses (India., Planning Commission, 1985).

The government also encouraged industrial firms to acquire knowledge from different GRIs to help the industries in developing their products and increase their standardization. To achieve this trend, the government obligated the banks and financial institutions to increase the link between the financial intuitions, GRIs, and industries. The government increased the S&T in rural areas by increasing the existence in these areas through Laboratories, agencies, universities, and scientific individuals.

To help the industrial sectore in conducting their activities, the government Continued to support the cooperative institutions and banking systems with the guidance of the Bank of India to fund small business in rural areas (India., Planning Commission, 1985).
The government also increased the support for the educational and industrial system through the creation of Trained workforce on information systems and technologies through educational facilities to assist technical education. Furthermore, the government

encouraged the connectivity between industry and job training in new educational fields and education facilities to strengthen the knowledge of the future workforce (India., Planning Commission, 1985).

4.1.5.6 Increased production quality through institutional connectivity and encouraged IT

- **1992-1997 India Eighth Economic development plan (IEIEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
8th	1	Increased product quality through the connectivity of agricultural universities, GRIs, and industrial laboratories	*		*	*
	2	Transferred all GRIs scientific discoveries to industrial production			*	*
	3	linked public enterprises with universities and GRIs to increase their production quality	*		*	*
	4	Encouraged IT in many GRIs, University, and industries	*		*	*
	5	Allowed freedom of GRIs, and State councils to increase their link to technical academy	*		*	
	6	Increased the S&T training capabilities to accelerate new S&T industries development	*			*
	7	Encouraged industrial firms to support basic research in all educational facilities	*			*
	8	Increased the reliance on domestic resources to finance local investments		*		*
	9	Transferred financial support to develop the technical and industrial infrastructure		*		*

Table 63 India Eighth Economic Development plan institutional connectivity

To increase the products' quality and competitiveness in the Eighth Economic Development Plan (IEIEDP), the government-linked industrial and GRIs system by increasing the connectivity between the agricultural universities, GRIs, and industrial laboratories (table 63). The government had also obligated the NSIC to handle the function of "creating testing centers, conducting studies, implementing technological guidelines, providing information, monitored quality, marketing, and import of samples" to help small businesses to grow promptly. To increase scientific production, the government transferred all applicable GRIs scientific discoveries to industrial production (India., Planning Commission, 1992).

To increase the quality of the products the government increased the link between the universities and GRIs to increase their production quality and managerial capabilities.

During the eighth plan, the government encouraged to research and innovation in all its GRIs and accelerated the process of encouraging information and telecommunication technology in many GRIs, University, and industries. The government also allowed freedom in all operations of GRIs, and State councils and increased the links between them and the technical academic institutions (India., Planning Commission, 1992).

The government also increased the link between the vocational and education in increasing training capabilities for local workers and encouraged the establishment of new S&T industrial firms. The government encouraged industrial firms to support basic research in all educational facilities (India., Planning Commission, 1992).

An increased connectivity was established through policies between the financial and industrial facilities. The government transferred nonproductive public enterprises to the Board of Industrial and Financial Reconstruction (BIFR) to recover its productive capability or sell it in the market. The government increased the reliance on domestic resources to finance local investments. The government also to transferred financial support toward developing the technical capabilities and S&T industrial infrastructure (India., Planning Commission, 1992).

4.1.5.7 Increased institutional connectivity

- **1997-2002 India Ninth Economic development plan (INEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
9th	1	Conducted the industries to absorb more than one million graduates each year	*			*
	2	Aligned the international market trends and local needs with university curricula	*			*
	3	Encouraged faculty movment between universities and in-house industrial R&D	*			*
	4	Marketed all GRIs funding in local and international markets by linking the GRIs with the industrial facilities and encourage venture capitalist to work with these facilities.		*	*	*
	5	Created institutions that linked GRIs, universities, and industries	*		*	*
	6	Encouraged the faculty members to exchange between the universities and industries			*	*
	7	Connected GRIs, Industries in R&D using funds from the (DFIs) and venture capitalists		*	*	*
	8	Supported the researchers and empowered them with their needs	*	*	*	
	9	Encouraged universities research centers to connect researchers with GRIs	*	*	*	
	10	Encouraged the creation of the Regional Sophisticated Instrumentation Centers (RSIC)	*		*	
	11	Liberalized foreign venture capitalists to invest in the local knowledge-based industries		*		*
	12	Increased the support to the emerging fields in S&T, such as IT and Microelectronics		*	*	*
	13	Created the National Assessment and Accreditation Council (NAAC) to assess the new research projects systematically	*	*		

Table 64 India Ninth Economic Development plan institutional connectivity

During the eighth plan, the government increased the connectivity between the educational and industrial system by encouraging the industries to increase their ability to absorb more than one million graduate each year. The government increased the university system connectivity with the global industrial and innovative systems by investigating and aligning the international market trends and local needs with universities curricula. Furthermore, the government encouraged the faculty members exchange between the universities and in-house industrial research facilities. The government also encouraged graduate students to complete their doctorate degrees and follow it by post-doctorate research in foreign countries to be able to cope with new technologies in the international market (India., Planning Commission, 1999).

To increase the connectivity between the financial, educational, and industrial market. The government encouraged all GRIs to link their operation with the international market

needs and industrial facilities and encouraged local and international ventured capitalist to work with these GRIs (India., Planning Commission, 1999).

The government also created special institutions that linked GRIs, universities, and industries like the Technology development missions. The government used funds from the Development Financial Institutions (DFIs) and from venture capitalists to increase this connectivity and support the researchers and empower them with their needs. Also, the government encouraged all universities research centers to help researchers by connecting them GRIs and national bodies to gain extra support logistically and financially, especially young scientists. The government encouraged the creation of the Regional Sophisticated Instrumentation Centers (RSIC) inside universities, in addition to the Advanced Regional Research Centers to help researchers (India., Planning Commission, 1999).

To achieve successful money flow to these researchers and their related industrial fields, the government liberalized foreign investments and opened the local economy to foreign venture capitalists to invest in the local knowledge-based industries.

To absorb all policies adequately, the government decided to increase the financial support and connectivity to the emerging fields in S&T as in Information Technology and Microelectronics. Accordingly, the government created the National Assessment and Accreditation Council (NAAC) to assess the new research projects systematically (India., Planning Commission, 1999).

The government also raised the connectivity between the raise the efficiency of the financial and educational system. To achieve this connectivity, the government conducted three major steps. Firstly, the government conducted several programs that provided scholarships, fellowships, and special assistance through government funded programs to increase the faculty and scholar's capabilities. Secondly, the government increased all university systems' autonomy from direct government control. Thirdly, the University Grant Commission initiated a program that served more than 400,00 students in 31 universities by aligning them with the job market and reconstruct the university courses to be able to cope with the job market (India., Planning Commission, 1999).

4.1.5.8 Increased IT support

- **2002-2007 India Tenth Economic development plan (ITEEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
10th	1	Linked all incentives with employment generating		*		*
	2	Provided incentives to industries that recruited more citizens		*		*
	3	Liberalized the control on small-scale industrial activities		*		*
	4	Increased private intermediation institutions and ventured capitalist		*	*	*
	5	Increased the operations of the public-sector banks in lending services to entrepreneurs		*		*
	6	Encouraged commercial banks to provide long-term loans to large enterprises		*		*
	7	Used information technology and E-Governance as a tool to control all operations		*		*
	8	Created rural communities that connects the industry with research centers and ventures		*	*	*
	9	Encouraged the scientists' mobilization between the GRIs and industrial R&D facilities	*		*	*
	10	Encouraged universities through incentives to design special programs for their scientist to team up with GRIs and industries scientists	*	*	*	*
	11	Offered scholarships for scientists to complete their education in the CSIR labs	*	*	*	
	13	Started to decrease its direct financial interventions in all economic activities	*	*	*	*
	14	Engaged local businesses in forming the syllabus and coursework in universities	*			*
	15	Obligated the vocational institutions to connect with GRIs	*		*	
	16	Provided financial assistances to qualified highly competitive Universities	*	*		

Table 65 India Tenth Economic Development Plan institutional connectivity

The government increased the link between the financial and industrial system during the Tenth Economic Development Plan (ITEEDP) through the following policies: First, the

government linked all incentives, such as credit, sales tax, technology development and marketing support with employment generating. Second, the government decided to provide incentives to the industry that recruits more citizens. Third, the government liberalized the control on small-scale industrial activities and make sure that credits were available for them to conduct their entrepreneurial activity. Fourth, the government allowed the creation of private intermediation institutions and ventured capitalist to play a major role in the economy. Fifth, the government increased the operations of the public-sector banks to increase the lending services to local entrepreneurs and small industries. Sixth, the government increased the connectivity between the financial and industrial institutions using e-governance as a tool to control all operations in all industrial systems including capital flow procedures in the fallowing years (India., Planning Commission, 2002).

The government increased the connectivity between Financial, GRIs and industrial systems using Khadi and Villages agency. The government aimed to create rural communities that connects the industry with research centers and venture capitalists. Accordingly, the government encouraged the scientists' mobilization between the GRIs and industrial R&D facilities to widen their experiences. The government also increased the connectivity by including the educational system development by encouraging local universities through incentives to design special programs for their scientist to team up with GRIs and industries scientists (India., Planning Commission, 2002).

The connectively also enhanced through the CSIR laboratories. The laboratories system offered scholarships for scientists to complete their education in its facilities. The government also created several technological agencies that motivated the

communication between these industries and the GRIs (India., Planning Commission, 2002).

However, the government started to decrease its direct financial interventions in all economic activities in the country and allowed the opportunity to the government to increase their intervention. Thus, local businesses and industries were closely engaged in forming the syllabus and coursework in universities. the government obligated the vocational institutions to connect with GRIs to provide them with newest techniques and technology in the fields. To ensure that qualified educational system was working sufficiently the government increased the role of the University Grant Commission in providing financial assistances to qualified highly competitive Universities in central and state universities (India., Planning Commission, 2002).

4.1.5.9 Continued IT support and related institutional connectivity

- **2007-2012 India Eleventh Economic development plan (IELEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
11th	1	Created an IT institutional infrastructure to provide all services to the rural areas		*		*
	2	Decreased tax rates on large enterprises to 30%		*		*
	3	Increased interlaboratory networking between GRIs and other industrial laboratories			*	*
	4	Increased the autonomy of higher educational and GRIs to mobilize their resources	*		*	
	5	Created 30 new central universities that focused IT and computers hardware	*		*	
	6	Aligned the public privet sectors needs with the universities and vocational outputs	*			*
	7	Aligned the needs of public privet sectors with the universities outputs	*			*
	8	Increased the linkage between India and other developed countries in industrial investments, entrepreneurship, GRIs and other connections grounds		*	*	*

Table 66 India Eleventh Economic Development Plan institutional connectivity

During the eleventh plan, the government increased the connectivity between the financial and industrial systems by creating IT institutional infrastructure to provide all services to the rural areas. The government reduced indirect tax effect on business by providing long lasting incentives and encouraged them to build the IT infrastructures.

The government also worked on decreasing tax rates on large enterprises to 30% (India., Planning Commission, 2008).

The government increased financial policies toward industries by shortening the waiting time that projects usually needs to get funds from 18 months to 4 months.

During the eleventh, the government increased the relation between the industrial and GRIs by increasing interlaboratory networking between GRIs and other industrial laboratory facilities.

The government also increased the connectivity between GRIs and educational system by increasing the S&T base in all universities and established advanced competitive research centers within universities.The government also increased the autonomy of higher educational and GRIs institutions and be free to mobilize their resources. With the help of R&D center, the government started creating 30 new central universities that focused information technology and computers hardware (India., Planning Commission, 2008).

The government increased the connectivity between the educational and industrial system by concentrating and aligning the needs of the public privet sectors with the universities and vocational outputs. Furthermore, the government created a National Vocational Qualification Institute to help the institutions in meeting the needs of industries (India., Planning Commission, 2008).

To ensure that the educational system was functioning according to plans, the government worked on changing the funding system from funding institutes to funding candidates.

The Indian government also increased the linkage between the Indian economy and other developed countries under different categories, such as industrial investments, industrial

development, entrepreneurship, GRIs and other connections grounds (India., Planning Commission, 2008).

4.1.5.10 Increased the creation of innovation clusters

- **2012-2017 India twelfth Economic development plan (ITWEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
12th	1	Created an innovation "ecosystems of enterprises"	*	*	*	*
	2	Increased the R&D expenditure to reach 2% of the country's GDP		*	*	
	3	Attracted corporate to spend more on R&D by a public-private partnership		*	*	*
	4	Enhanced linkage between GRIs, universities, and industries through encouraging young scientists' mobility between these institutions	*		*	*
	5	Created clusters that can gather all industries, academia, and GRIs together	*		*	*
	6	Encouraged large Indian enterprises to establish world-class R&D centers			*	*
	7	Used tax credits as an innovation development tool instead of tax incentives.		*		*
	8	Funded all new innovative projects through government and venture capitalist funds		*		*
	9	Encouraged the creation of both venture capitalist and angel investors		*		*
	10	Considered foreign direct investment as the major source of capital.		*		*
	11	Created 20 Innovation cluster in 20 universities around India	*			*
	12	Encouraged the connectivity between clusters and industry to encourage innovation	*		*	*
	13	Created world-class universities and pair them with vocational institutions	*			*

Table 67 India Twelfth Economic Development Plan institutional connectivity

One of the major steps the Indian government made in the twelfth plan was to create an "ecosystem of enterprises." The creation of innovation "ecosystems of enterprises" was a major focus to bring together "entrepreneurs, researchers, finance providers, businesses enterprises, and policy makers" (table 67) (India., Planning Commission, 2013).

The government took several other steps to increase the relation between the other innovative institutions. The government increased the R&D expenditure to reach 2% of the country's GDP. The government secured 1% of its total GDP in attracting corporate to spend more on R&D by a public-private partnership. Accordingly, the government worked on transforming role from "command and control to a steering end evaluate role." This step took place by increasing the relation between all Universities, GRIs, and R&D related activities (India., Planning Commission, 2013).

The government also enhanced the link between GRIs, universities, and industries through encouraging young scientists' mobility between these institutions. To enhance this connectivity, the government created several clusters that can gather all industries, academia, and GRIs together and provide a skillful workforce that can deal easily with new technologies and research capabilities (India., Planning Commission, 2013). The government increased the connectivity between the industrial and GRIs sectors by encouraging large Indian enterprises to establish world-class R&D centers and be able to support their products innovative capabilities adequately.

The government enhanced the role of financial policies in the industrial system by using tax credits as an innovation development tool instead of tax incentives. The government was also funding policies toward new innovative projects by increasing the acceptance of national and international venture capitalist. Accordingly, the government encouraged the creation of both venture capitalist and angel investors. Furthermore, the government considered foreign direct investment as the major source of capital (India., Planning Commission, 2013).

To enhance innovation, the government increased connectivity using foreign investments and created 20 Innovation clusters in 20 universities around India. The government also aimed to create world-class universities and pair them with vocational institutions to follow up with the rapidly changing labor market (India., Planning Commission, 2013).

4.1.5.11 Conclusion

In the 1950s, there were a lack of connectivity between the different parts of the Indian economy. Accordingly, the major planning focus was to increase the monetary support to build the economic base and infrastructure that could support the economy and the

agricultural activities. This support came directly from the central government and foreign direct support toward the rural and poor communities, especially toward educational and industrial activities. During the fifties and early sixties, the government started to obligate universities and government research institutions to increase their connectivity with local farmers and agricultural producers by providing government incentives and financial support. In the late nineties, the government started to institutionalize the financial system and relied more on private initiatives to support farming and industrial activity.

In early 1980, the government started to focus more on researchers and to increase the scientific base of its local production by encouraging the connectivity and networking between the financial, educational, GRI, and industry. In the early 1990s, the government started to focus more on product quality control to be able to compete globally. Furthermore, the government started to establish institutional connectivity to support information Technology as a new scientific field that needs extra attention. In late 1990s and 2000s, the government decided to be the world hub of IT technology and started to focus its effort and institutional connectivity toward IT activities. This effort conglomerated to create the Regional Innovation Systems and Regional Innovation Clusters that located in different parts of India in the past years.

4.2 South Korea innovation system

4.2.1 Methodology of the Study

In the following section, a process tracing investigation will be conducted to investigate the South Korean innovation system development through the five years' economic development plan. The study will investigate five major subjects in each plan to discover if the government spending and policies can create an innovation model in developing countries. These five major subjects are the plans' major objectives, the financial system development, the educational system, the government research institutions (GRIs), and the industrial sector systems. In each system, the study will investigate the policies and objectives that affected these institutions vertical connectivity between the four major innovation systems: Global innovation system (GIS), National Innovation System (NIS), Regional Innovation System (RIS), and Regional Innovation Cluster (RIC). The study will also investigate how policies affected the horizontal connectivity between the educational, financial, research, and industrial systems and led to create an environment of innovation in each of these chosen developing countries.

The study has been coded to search for major policies that affected the development of the major four systems that led to the connectivity between the institutions. These investigated elements are incentives, taxes, tariffs, institutions, funding sources, international agreements, and government objectives and area of interests.

The country investigation will be organized into six sections, the major objectives, the financial system development, the educational system, the government research institutions (GRIs), and the industrial sector systems and institutional connectivity

policies. Each section will be investigated through the five years' development plans. In each plan, there will be a table describing the policies that affected the GIS, NIS, RIS, and RIC.

4.2.2 South Korea overview

South Korea encountered a devastating war with North Korea in the early 1950s of the past century that destroyed the economy. This incident forced the country to search for a new policy system that can help rebuild the country. The result of the pursuit of the new policy system appeared after several attempts and initiated the five-year economic development plan of South Korea in 1962 (Mahlich, 2007).

In the year 2000, South Korea joined the United Nations, and now it is considered one of the Asian republic countries with a 17 Provinces and metropolitan areas (Figure 1). Since 1962 when the first five-year economic development plan initiated, South Korea's population has grown by roughly 53% from 25,012,374 to reach 50,801,405 in 2016. During this time, the total wealth of the country has grown from $103.75 GDP per capita in 1962 to $37,699 in nominal dollars (OECD, 2016), reaching a total GDP of $1,377 trillion as of 2016.

figure 7 South Korea 17 Provinces and metropolitan areas

South Korea is considered one of the leading countries in economic development in East Asia and the world. Its fast-growing economy has led the international media to label South Korea as one of the four Asian Tigers along with Hong Kong, Taiwan, and Singapore (Government, Department Global Communication, 2016a). Figure 7 shows the Korean Economic Index from the early nineteen seventies to 2016. "*An index is a statistical measure of changes in a representative group of individual data points, such as number of sources, including company performance, prices, productivity, and employment"* (Index investing: What is an index? 2003). Economic indices track economic health from different perspectives. It shows the steady development of the

Korean economy, reflecting the government's aggressive development policies, particularly in the areas of manufacturing and innovation. However, the graph reflects two major economic downturns, one in the late nineties and the second associated with 2008 economic crises. As will be discussed later, these downturns were followed by a shift in governmental policies dealing with innovation. In the process of unfolding major policies that affected the development of innovation systems in South Korea, this investigation will reveal how policies implemented by the Government helped to return the economic back on track. Also, the process tracing of this investigation will reveal how global, national, regional, and cluster innovation system connectivity played a major role.

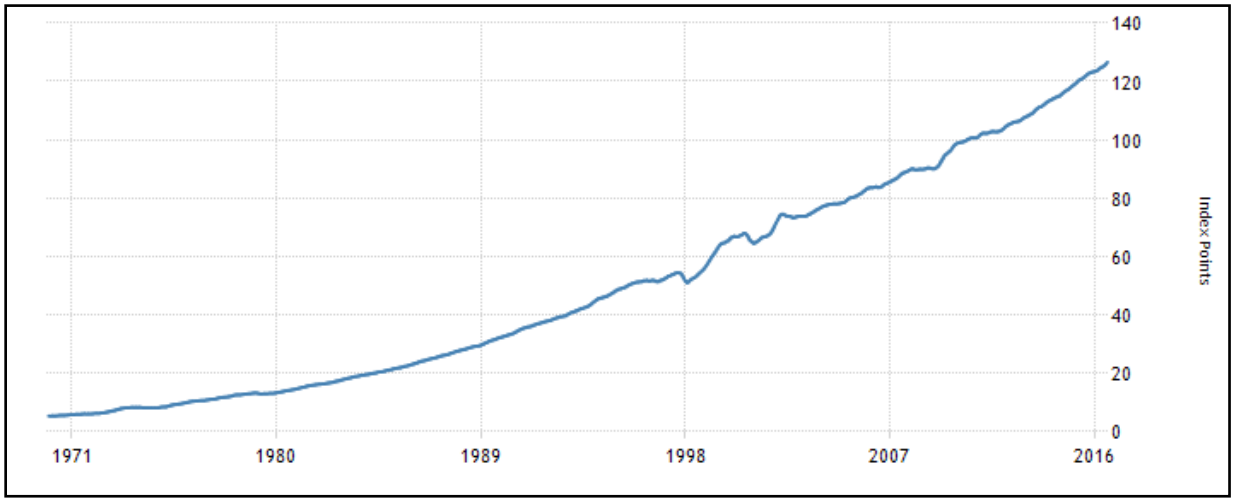

Figure 8 South Korea leading economic index (World economic outlook database.2016)

4.2.3 South Korea Source of Economic and S&T Policies

In 1948, several years after gaining independence from Japan, the government of South Korea established the Ministry of Finance and Economic Planning Board. At its inception, the major role of the Ministry was on implementing tax, monetary, and financial policies. The Ministry's planning board did not play a major role in planning

the economy, until 1961 when it was separated from the ministry of finance and started developing its first five-year economic development plan (K. K. Korea (South)., 1962). The major role for the planning board was: initiating the five-year plan; securing foreign investment for government activities; initiating government policies; and managing the government budget. Under the planning board jurisdiction, the government of South Korea has since initiated seven five-year economic development plans and one five-year plan specifically for Science and Technology (S&T).

During the seventh five-year plan in 1994, the government decided to reunite the planning board with the ministry of finance to form the Ministry of Finance and Economy. By 1997, the Ministry of Finance and Economy joined with the Ministry of S&T to initiate the first five-year development plan of science and technology (1997-2002). However, in 1998 a major economic crisis which affected the country greatly, and led to a major governmental reform. Accordingly, the Korean government canceled the Ministry of Finance and Economy (MOFE) and stopped the initiation of the five-year economic development plans. The concentrated decision making and planning functions of the MOFE were divided among other ministries and government agencies, making each responsible for handling their own the strategic planning and policy setting. The three major budgetary, financial supervision and trade negotiation responsibility of MOFE were transferred to the National budget administration; the Financial Supervisory Commission, and the Ministry of Foreign Affairs and Trade, respectively.

In 1999, the Korean Government established a new Ministry of Planning and Budget through a merger of the Planning and Budget Commission and the National Budget

Administration. One of the major responsibilities of this ministry was to create the 2025 S&T vision. This vision constructed the basis for the new theme of Korea's innovation systems building on the work by scholars as Porter, Lundvall, and Nelson (Lundvall, 2004; Nelson, 1993; Porter, 1998).

One of the major results of this vision was the establishment of the National Science and Technology Council in 1999 as the major coordinator and developer of science and technology policies in the country.

In 2003, South Korea launched the first five-year Basic S&T plan (2003-2007). The plan focused on economic development using S&T as a response to the 2025 S&T vision. In 2008 the Council initiated the 2nd S&T plan (2008-2012) that was called the 577 plan (El Qrarah, Ussenov, Rosca, Zaghdoud, & Bernichi, 2014). The ministry that drew this plan were the Ministry of Education; the Ministry of Science and Technology under the jurisdiction of the National Science and Technology Council. In 2013, the Korean government initiated the third S&T Basic Plan (2013-2017). This plan focused on reinforcing the creative economy policies in South Korea. In conclusion, the Korean government source of S&T policies handed to different agencies and went through different processes. The Korean strategies in developing S&T policies depended on the market circumstances and needs, and they reacted accordingly. The Korean government changed their way of policy initiating from the traditional way of initiation the five-year economic development plan to a more concentrated five-year plan that focuses on S&T to achieve the market needs (Ministry of Science, ICT and Future Planning, 2016).

4.2.4 Vertical connectivity (GIS, NIS, RIS, and RIC)

4.2.4.1 South Korea evolution of its government innovation objectives toward the economy

4.2.4.1.1 Overview

This section will explore the major Korean objectives and policies in the economic development plans from the early 1960s until now. These policies and objectives illustrate the government major principles, priorities, concerns, and new industries that helped shape the economy. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of South Korea. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the university sector. Each plan will have its table that explains the major policies and objectives. Moreover, at each point, there will be an arrow that shows the level of connectivity between the Global Innovation System (GIS), National Innovation system (NIS), Regional Innovation System (RIS), and Regional Innovation Clusters (RIC). These innovation systems existed in the 1980s and 1990s by famous scholar such as (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992). to indicate them at the early economic stages will explain the effect of these early policies in developing the models of innovation systems. Thus, the arrows will explain the effect and relations between the international, national, regional, and rural economy in the country at the early stages.

4.2.4.1.2 Decided to be a guided capitalism country with free enterprises

- **1962–1966 the Korean First Economic development plan (KFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Implemented import substitution as a key development motivation to the economy	→			
	2	Imported technology to update its current industries	→			
	3	Transformed the Korean economy to a "guided capitalism" country		→		
	4	Implemented the principle of free enterprise to the Korean economy		→		

Table 68 the Korean First Economic development plan major objective evolutions

Table 1 shows the main objectives of the Korean First Economic Development Plan of 1962-66 (KFEDP) and how each objective enhanced connectivity between the global, national regional and sectoral innovation systems (rural in some cases).

At the beginning of the 1960s, South Korea relied heavily on import substitution as a key development motivation to its economy. This approach was consistent with the government aim was to stabilize its developing post-war economy and to import technology to its current industries. However, the government did export many products as an exchange for foreign goods; including textile, play wood, footwear, agriculture, cement, oil refining, and fertilizers.

The KFEDP of 1962, reflected a shift in government focus from stabilizing and protecting production for domestic markets, to catching- up with the superior technological capabilities of developed nations and to becoming more competitive on a global stage. The overall goal was to transform the Korean economy to "guided capitalism" where markets are driven by supply and demand as directed by government policies such as trade barriers, taxes, and tariffs, but not direct price controls (K. K. Korea (South)., 1962)

A second major objective of the KFEDP was to apply the principle of free enterprise to the Korean economy. This objective meant that any future policy for enterprises would be implemented according to the private sector needs rather than political forces. Each private enterprise would be monitored and guided directly through government agencies to provide support and services to these industries. Although the KFEDP was aiming to develop the private sector, the major effort went into developing the public enterprises and facilities, and the support for private business only had a "spillover effect." (K. K. Korea (South)., 1964). A spillover effect refers to the impact that seemingly unrelated events on the part of the economy can have on another part of the economy or other nations. (Investopedia, 2016). This objective shaped the relationship between the National, Regional and rural areas during the KFEDP.

4.2.4.1.3 Supported Export and encouraged rural areas to support central areas with raw materials

- **1967–1971 the Korean Second Economic development plan (KSEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Enhanced exports and used the revenue in motivating the industrial infrastructure	↔			
	2	Encouraged farmers and miners to support central cities with raw materials	↔			
	3	Increased the quality of the products to compete domestically and internationally	↔			
	4	Encouraged modernization in the industrial structure to build a self-sustaining economy	→			
	6	Increased exports and imposed imports substitution	↔			
	7	Promoted managerial skills and provided promotions for scientific researchers.			→	

Table 69 the Korean second economic development plan major objective evolutions

Table 69 shows several objectives that the Korean government took in its KSEDP and enhanced connectivity between the four major economic levels. The major objective of the KSEDP was to industrialize the country using export as a motivator for nurturing the industrial infrastructure. Industrializing the country was enforced by encouraging

farmers and miners to increase their production of raw materials to support central cities by goods and raw materials. Accordingly, the fast and massive supply of local raw materials helped Central industries increase their productivity enabling them to fulfill domestic needs as well as export internationally.

The third major objective of KSEDP was to *"promote modernization of the industrial structure and to build the foundation for a self-sustaining economy."* (K. K. Korea (South)., 1966). To achieve this goal, the government of South Korea implemented a 15-year long-term strategic plan with three key elements: capital mobilization, export expansion, and workforce utilization.

Modern computer and electronics industries were not yet part of the Korean economy. Instead, Korea diversified its economy by adding new basic industries such as chemicals, machinery, and iron &steel. These new industries helped to develop the industries in the country internally to be self-sufficient in new machinery technology and raw materials sources.

4.2.4.1.4 Created absorptive capacity by supporting exports of agriculture and heavy industry products

- **1972–1976 the Korean Third Economic development plan (KTEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Balanced the development in the economy to reach all regions			→	
	2	Created an absorptive capacity for Korean products domestically and internationally		↔	↔	
	3	Encouraged local and medium size industries by providing export incentives			→	

Table 70 the Korean third economic development plan (major objective evolutions)

During the Korean Third Economic Development Plan (KTEDP), South Korea intended to achieve a self-sustaining economy by balancing the development of different economic activities to ensure that development reaches every sector of the country

(Table 70). Theses economical activities included mining, fisheries, farming, heavy industries, Oil refineries, agriculture, metal, fertilizers, rubber, textiles, cement, ceramic, food, and electronics (Korea (South), 1971).

During the investigation of the KTEDP, it had been realized that the policy makers had not yet realized the notion of creating innovation clusters. So, the focus during the plan was only on developing rural economy and spreading development through all regions. Another major objective of the KTEDP was to motivate a self-sustaining economic structure. This economic structure obligated officials to search for buyers for local products domestic or international buyers, "creating an absorptive capacity." Thus, the central government urged the private and public enterprises to develop and create heavy and chemical industries that can produce the raw materials. These raw materials can help nurture local and medium size industries by providing export incentives to absorb the remaining products. This step not only helped in the development of the existing industrial atmosphere of the country, but it also helped ensure a favorable balance of payment (Korea (South), 1971).

4.2.4.1.5 Encouraged Free trade, flow of industrial information, and innovation to catch up with developed country

- **1977–1981 the Korean Fourth Economic development plan (KFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Promoted Technological innovation as a priority to catch up with the developing countries	⟷			
	2	Encouraged domestic industries by incentives, substitutions, and policies to innovate		→		
	3	Established an industrial information system	⟷			
	4	Liberalized the imports to increase foreign competition and encourage free trade practice	→			

Table 71 the Korean fourth economic development plan (major objective evolutions)

Technological innovation was a priority in 1977 with the Korean Fourth Economic development plan (KFREDP), with again an eye toward catching-up with the innovative capabilities of developed nations. During the KFREDP South Korea supported its industrial basis by applying the concept of innovation for the first time. Accordingly, the Korean economy targeted its resources and investments toward domestic industries and encouraged these industries by incentives, substitutions, and policies to innovate and produce innovative technological products that can compete domestically and globally. To increase productivity and quality, South Korea aimed to liberalize the import; to increase foreign competition; to encourage free trade practice, and to build an industrial information system. The new system helped authorities and global, national, regional, and local investors to make the right decision in their next industrial and innovative steps (Korea (South), 1976).

4.2.4.1.6 Reduced tariff barrier, joined the GATT, and increased competition

- **1982–1986 the Korean Fifth Economic development plan (KFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Reduced tariff barriers gradually especially on technological import	→			
	2	Increased the market competitiveness by liberalizing the imports	→			
	3	Implemented the GATT code for licensing the imports	→			
	4	Adopted an export-led growth to maintain an open economy	←			
	5	Supported the industrial basis by increasing products quality and competitiveness		→		
	6	Increased competition between industries using market mechanism (supply and demand)		→		
	7	Focused on large-scale projects and encourage private industries initiative to invest in it		→		
	8	Implemented an incentive system to foster innovation		→		

Table 72 the Korean fifth economic development plan (major objective evolutions)

Since 1984, the government started implementing policies to reduce tariff barriers, especially on technological import. To free and liberalize the market the government started a gradual reduction of tariff and increased the market competitiveness. To do so,

the government implemented the foreign trade act and induced transparency to all regulation that promotes liberalization. Also, South Korea implemented the GATT code of licensing the imports to reconstruct the trade regulation and procedures (Korea (South), 1982).

The major objective for Korea was adopting an export-led growth to maintain an open economy in the (KFFEDP). To succeed in this major objective, South Korea worked on increasing the efficiency and quality of its products by increasing future investments in their industrial basis to ensure the products quality and competitiveness. Also, the government promoted competition between industries by allowing the market mechanism (supply and demand) to play its role in deciding the market trends and prices instead of government intervention. To support the competitive environment in South Korea, the government obligated itself to create a limited number of large-scale projects and encouraged private industries to take the initiative to invest in it. The government's intention was to decrease its interference in the market mechanism and replace it with an incentive system to foster innovation. The major condition that the government implemented on new business is to have a comparative advantage and to be in need by the world market (Korea (South), 1982).

4.2.4.1.7 Liberalized the financial market and promoted private initiatives in rural areas

- **1987–1991 the Korean Sixth Economic development plan (KSIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Increased equal distribution of income in different regions and local areas.		→		
	2	Reduced restrictive financial measures in the market and make funds accessible to businesses		→		
	3	Promoted private initiatives in all regions and metropolitan areas		→		
	4	Reformed the tax basis to autonomies and liberalize the financial market		→		

Table 73 the Korean sixth economic development plan major objective evolution

To maintain high economic growth, the (KSIEDP) focused on increasing equal distribution of income in different regions and local areas during its sixth economic development plan. These policies were enforced by reducing the restrictive government measures in the financial market to make funds accessible to each business within the border of the country. The major reason for this objective was to promote private initiatives and to help to build a favorable atmosphere for medium and small size businesses. Promoting private initiatives trend focused on central metropolitan areas including geographical areas that had been neglected from economic development in the past years. Another useful tool that the government used to achieve this objective was to reform the tax bases to meet the new direction in liberalizing the financial market and design the policies to enhance its autonomy (Korea (South), 1986).

4.2.4.1.8 Increased international collaboration and business autonomy in local areas

- **1992–1996 the Korean Seventh Economic development plan (KSVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Increased investment funds to local cities and created regional funds programs			→	
	2	Transferred the control and decision making of licensing the land uses to local authorities			→	
	3	Increased the competence between industries by increasing production qualities			↔	
	4	Increased collaboration between domestic and international industries		↔	↔	
	5	Joined the United Nations in 1991 and OECD in 1996		↔		
	6	Focused on knowledge in the economy instead of material plants in previous plans			→	
	7	Supported innovative entrepreneur			→	

Table 74 the Korean seventh economic development plan major objective evolutions

During the seventh Economic Development Plan (KSVEDP), the central government increased the funds to local cities to creating programs to support the development within these territories. To ease the process of development, the central government transferred the control of licensing the land uses to local government and transfer the full power of decision making to the authorities. To increase the efficacy of local government decision, their autonomy was increased by cooperation between the local and central government through coordination and enlarging local fiscal capability and capacity. Also, the government strengthened the relationship between local government and private industry to strengthen the local economy (Korea (South), 1992).

Another major objective of the KSVEDP was to "increase the efficiencies of the national economy." To achieve this major objective, the Korean board of planning took a different approach than the previous plan by indicating policy issues and drawing strategies and measures to solve and indicate the appropriate decision. The Korean planning board implemented three major strategies that can be concluded in three major steps.

1- Increase the competence between industries by increasing production qualities and managerial capabilities.
2- Promote equity by balancing the development of all regions and geographical areas.
3- Increase the international autonomy collaboration between domestic and international industries.

These goals were facilitated by Korea's entrance to the United Nations in 1991 when North and South Korea signed the agreement of reconciliation.

During this plan, policy makers decided to focus more on knowledge and economy instead of material plans that have been adopted in the past several decades. The importance of innovative entrepreneurship was indicated by the plan. Also, the extra emphasis has been focused on the Korean workforce by educating and training the existing workers. "Koreas industrious workers were one of the most important factors behind the rapid growth of Korean economy in the past 30 years" (Korea (South), 1992).

4.2.4.1.9 Promoted Korea as an international Innovation hub and established the three innovation system models NIS, RIS, and RIC

- **1997-2002 South Korea Science and Technology plan (KS&TP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T	1	Motivated innovation as a key strategy for the S&T plan after economic crises		→		
	2	Announced NIS, RIS, and RIC as models of innovation that must be adopted domestically		↔		
	3	Promoted Korea in the international market as an innovation hub in Asia & the world	↔			
	4	Changed the government oriented S&T system from public to private initiative system		→		
	5	Increased the connectivity between local R&D institutions and international research facilities and consumers.	↔			
	6	Secured new resources to the existing domestic GRIs rather than building new facilities		→		

Table 75 the Korean S&T development plan (major objective evolutions)

By 1997, South Korea and the world faced one of the worst economic crises since the World War II. The world financial crises stopped the flow of foreign direct investments, upon which South Korea was heavily reliant. This triggered deep reform in many administrative and financial institutions that led to an increase in government R&D investment to help stimulate domestic innovation. During that time, the total government budget reached 5% of its total fiscal planning budget in 2002.

In 1999, the government of South Korea launched the 2025 science and technology vision, which lay the basis for future investments in the Korean innovation economy. The long-term vision created a new national avenue for Korea through development initiatives in its national innovation system (S K Gov, 1999). This new path also reflected increasing research into National Innovation System (NIS); Regional Innovation Systems (RIS); and Innovation Clusters (Nelson, Lundvall, Freeman, Porter).

The Korean government undertook several actions to achieve the goals laid out in the 2025 vision:

1- Change the government-oriented S&T system to private initiative system to encourage private companies to draw and initiate policies that affect the economic performance depending on the market orientation rather than government control.

2- Increase the S&T research institution connectivity with other local and international research facilities.

3- Secure new resources to the existing domestic S&T Institute and research centers rather than building new facilities, as a response to the world crises that occurred in the late 1990s.

4- Develop a long-term planning system to achieve long-term goals rather than rely solely on the short-term five-years goal they made before 2025 vision

These policies were under the 21st Century Frontier Science Program that was launched in 1999 as the S&T framework law (S K Gov, 1999).

4.2.4.1.10 Used "Open Innovation" as a model and established international research centers

- **2003-2007 South Korea First Science and Technology plan (KFBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 1st	1	Promoted S&T in all governmental, privatized, and educational institutions		→		
	2	Focused mainly in transforming South Korea to a technological innovation society		→		
	3	Assembly of all GRIs joined under the NSTC under the prime minister control		→		
	4	Invested heavily in S&T.		→		
	5	Connected the Domestic Innovation System to the Global Innovation System		↔		
	6	Increased competition between industries using research and development		→		
	7	Created new fields of S&T and Increased investments in R&D in local governments		→		
	8	Created regional technological innovation centers and connected them with the NIS		←		
	9	Used Open Innovation as a model for innovation in the country		→		

Table 76 the Korean first basic S&T development plan (major objective evolutions)

After South Korea had initiated its 2025 vision, it established its first basic S&T plan in 2003-2008. During this plan, there was an effort to take the countries vision into action by implementing an administrative system and promoting S&T in all governmental, privatized, and educational institutions (Table 76). The implementation of S&T focused mainly in transforming South Korea to a technological innovation society (J. Mahlich & Pascha, 2012).

To increase the validity of the new government policies toward S&T, an assembly of government funded research institutions joined under the umbrella of the Science and Engineering Research Society. These research institutions had been promoted to be

directly guided by the National Science and Technology Council under the prime minister's direct control.

To support this new initiative, the government implemented new policies to develop the Korean innovation system during the first basic S&T plan. These policies include:

1- Invest heavily in S&T.

2- Connect the Domestic Innovation System to the Global Innovation System to get the advantage of technology transfer and cope with all newly available technologies and create an absorptive capacity for new Korean products. This step had been achieved by establishing a regional center for technological and inserted all innovation activities in the region to connect them with central innovation centers to ease the flow of information.

3- Increase research and development activities and apply it to the market and increase competition between industries.

4- Increase investment in R&D in local governments and create a culture of the S&T environment within different local communities.

5- Create new fields of S&T that includes The Biotechnology Development Program, The Nanotechnology development program, and Space and Aeronautics Programs (J. Mahlich & Pascha, 2012).

South Korea had adopted a collaborative researches policy linking Universities, Industries, and Government Researched institutes. To successfully achieve this trend South Korea adopted the open innovation notion that was promoted by Henry Chesbrough in 2003. *"Open innovation can be defined as the use of purposive inflows*

and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively" (Chesbrough, 2006).

4.2.4.1.11 Supported all innovation activities in all government and private institutions

- **2008-2012 South Korea Second Basic Science and Technology plan(KSBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 2nd	1	Expanded R&D investments from 3.2 % of GDP in 2006 to5%	⟷			
	2	Increased R&D investments in 7 fields	⟷			
	3	Created 7 sectors that included "world-class human resources; basic & fundamental research; SMEs' innovation; S&T globalization; regional innovation; S&T infrastructure; and S&T culture.	⟷			

Table 77 the Korean second basic S&T development plan (major objective evolutions)

The Korea Second Basic Science and Technology plan (KSBSTP), also known as the 577 initiatives, was conducted in the years 2008- 2012. The term of 577 in the plan stands for expanding the R&D investment from 3.2 % of GDP in 2006 to 5% of GDP in 2012 (Table 77). These investments were directed to seven fields that included "key industrial technologies; emerging industrial technologies; knowledge-based service technologies; state-led technologies; national issues related technologies; global issues related technologies; and Basic & convergent technologies" (El Qrarah, Ussenov, Rosca, Zaghdoud, & Bernichi, 2014). The result of these investments in these fields served seven sectors that included "world-class human resources; basic & fundamental research; SMEs' innovation; S&T globalization; regional innovation; S&T infrastructure; and S&T culture." (El Qrarah, Ussenov, Rosca, Zaghdoud, & Bernichi, 2014). The goal of this initiative was transformed South Korea into one of the seven most affluent countries in S&T by the end of 2025. During this plan, the National Science and Technology Council was responsible for implementing the policies in the

economics and development environment (El Qrarah, Ussenov, Rosca, Zaghdoud, & Bernichi, 2014). These objectives were implemented by the government and affected the four major levels of the innovation system. All policies were supported invested in by national and international organizations in addition to the government effort and spending toward the implementation of these objectives.

4.2.4.1.12 Transformed the country to a Creative Economy

- **2013-2017 South Korea Third Basic Science and Technology plan (KTBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 3rd	1	Transformed the country to a Creative Economy		→		
	2	Reinforced the national R&D and innovation.		→		
	3	Increased the international corporation regarding R&D and innovation.	↔	↔		
	4	Increased the use of ICT		→		
	5	Transformed creative ideas to commercialized products by intelligent entrepreneurs	↔	↔		
	6	Utilized ICT and S&T in creating new jobs and increased S&T industries		→		
	7	Increased the connectivity between research institutes and universities	↔	↔		
	8	supported the startups, research centers, research universities and creative local industries		→		

Table 78 the Korean third basic S&T development plan (major objective evolutions)

Some of these objectives in the table were destined to influence the relation and connectivity toward regional and industrial innovation systems; others were meant to increase the connectivity between the whole innovation system.

In the third Basic plan, the president of South Korea announced a desire to transform the country into more of a Creative Economy. He defined the creative economy as:

"*... the convergence of science and technology with industry, the fusion of culture with industry, and the blossoming of creativity in the very borders that were once permeated by barriers. It is about going beyond the rudimentary expansion of existing markets and creating new markets and new jobs by building on the bedrock of convergence. At the very heart of a creative economy lie science technology and the IT industry, areas that I*

have earmarked as key priorities."5 Park Geun-Hye first defined this term as a presidential candidate in the 2012 publication of Creative Economy (Ministry of Science, ICT and Future Planning, 2016).

During the KSBSTP**,** the Korean government laid several major objectives to nurture the Korean innovative economic. These strategies include increasing the S&T jobs to reach 650,000. This amount of job creation was meant to serve the initiative of creating a creative economic ecosystem. To achieve the goal of creating a creative economy, the Korean policy makers implemented several strategies as follows:

1- Reinforce the national R&D and innovation.

2- Increase the international corporation regarding R&D and innovation.

3- Increase the use of ICT.

4- Transform creative ideas to commercialized products by intelligent entrepreneurs.

5- Utilize ICT and S&T in creating new jobs and increase the industries that are using these themes.

6- Increase the connectivity between the research institute and universities.

7- Increase the support of startups, industries' research centers, university research communities, and creative local industries (Ministry of Science, ICT and Future Planning, 2016).

4.2.4.1.13 Conclusion

In the first and second plans, the major government aim was to build the economy and import technology to the existing Physical and knowledge infrastructure. During these plans, the government started to decide the major government characteristics and how it

would function economically. In the third plan, the government realized the need to balance the development between the regions. In the fourth plan, the government started to encourage the private sector to build their technology instead of relying only on foreign technology. The new government took place by encouraging technology transfer from GIS to NIS, RIS, and RIC. In the fifth plan, the government started to encourage the connectivity between the innovation systems by increasing the connectivity between businesses and institutions to increase product quality and exports. Also, the government increased the incentive systems to encourage development in NIS, RIS, and RIC. During the sixth plan, the major objective was to influence the local areas income to encourage them to increase their industrial income by increasing spending on their industrial infrastructure. In the seventh plan, the central government increased the autonomy of local government to encourage them to invest heavily and freely per their actual industrial needs. In the late nineties in the S&T plan, the government faced the economic crises by increasing spending on R&D activities and encouraging innovation and technology transfer as a major tool to surpass the financial crisis. In the first and second S&T plans, the government started to increase R&D investment and connectivity in the GIS, NIS, RIS, RIC. The government also adopted new technological fields to invest in innovation and industrial clusters. Finally, the government decided to implement the concept of the creative economy in its model of economic development. The new theme draws the broad lines on how the government would deal with GIS, NIS, RIS, and, RIC in the future.

4.2.4.2 University + Higher educational system

4.2.4.2.1 Overview

This section will investigate the Korean economic development plans to understand the evolution of the university system. The study will explore the University system policies, incentives, major institutes, and educational focus through the years. These policies and institutes will reveal the role of the industrial firms in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of university system in building a robust innovation systems had be identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of South Korea. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the university sector. the Korean government increased its policies to establish new universities in new industrial areas and Economic Zones (Figure 9).

The following discussion will develop an understanding of the evolution of the industrial sector and its role in developing the connectivity of the innovation systems.

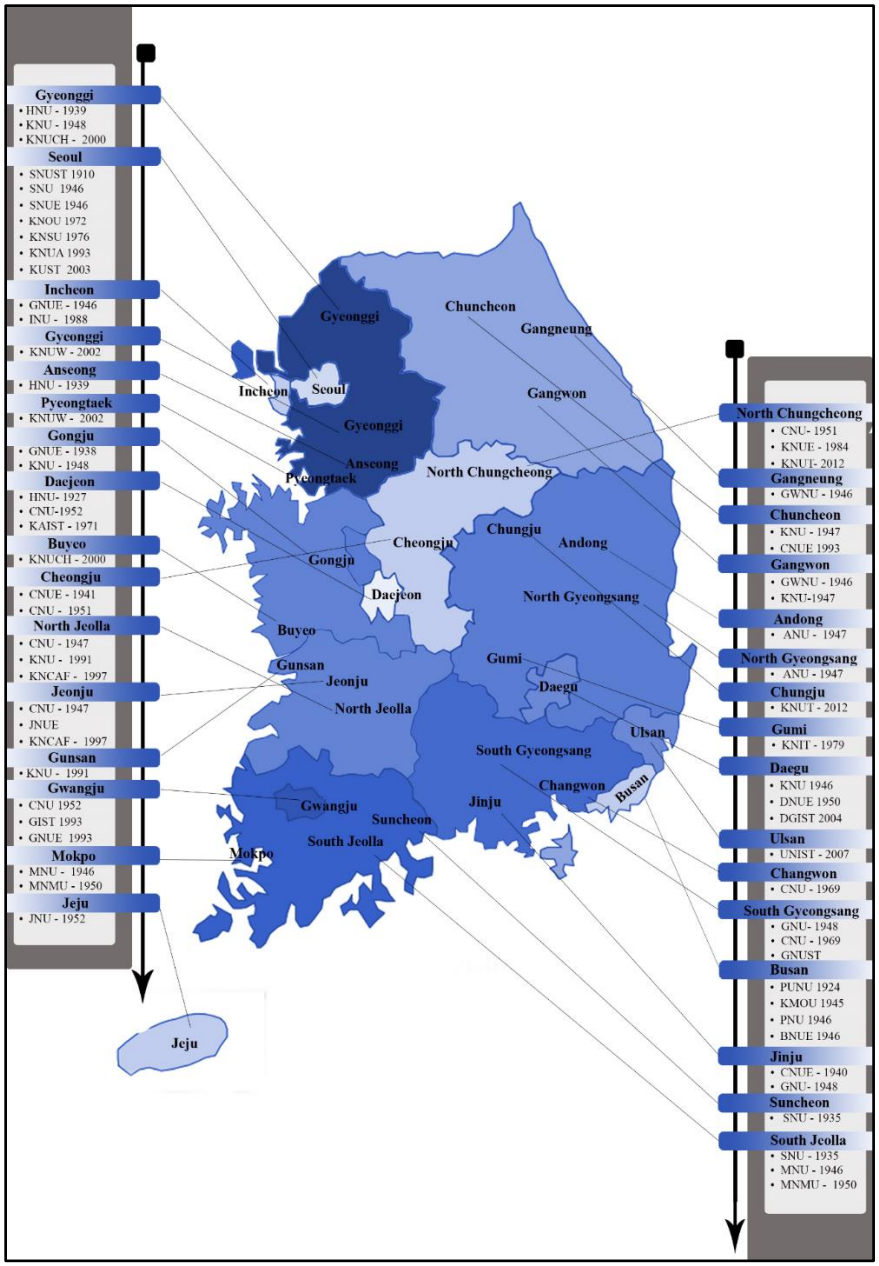

Figure 9 The evolution of South Korea National University and its distribution in Regional and local Areas

4.2.4.2.2 Build an educational infrastructure and the first research-based university

- **1962–1966 + 1967-1971 the Korean First, Second Economic development plan (KFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Created an infrastructure for the higher educational system		→		
2nd	1	Modernized the vocational institutions and trained the existed workforce in S&T		→		
	2	Established the Korean Advance Institute of Science and Technology as an R&D institution		→		

Table 79 the Korean first and second economic development plan (educational system)

The higher education system during the KFEDP was weak and needed a lot of improvement to be able to compete and produce high-quality research scientists and an even workforce. Thus, the major objective of the first five-year economic development plan was to create an infrastructure for the higher educational system in South Korea. (K. K. Korea (South)., 1962)

The government of South Korea realized the importance of educating and training the existing workforce to be able to work on new machines and technologies. Accordingly, the government increased the policies in the second five-year plan that modernizes the vocational institutions to increase its capabilities in educating and training the existed workforce. Through vocational institution, the government started to train the workforce for new technologies in the field of machinery, metal forging, chemical engineering, textile, processed foods, and fishery industries. These industries took the main attention because they already existed in the local economy and the country depended on it heavily in securing its general economic development. (K. K. Korea (South)., 1966). During the first and second five-year plans, Korea was urged to develop its educational system and expand its capacity to reach all parts of the society and regions. The major

focus was not on R&D; however, the focus was on developing an educational system that can transform and educate the society towards a new industrial culture. In 1969, a reform reached all parts of the educational system for a long-term comprehensive plan. The major objective of this plan was to implement S&T in its institutions by installing computers and labs to all parts of the countries lower and higher education facilities. In 1971, the Korean government established the Korean Advances Institute of Science and Technology (KAIST). KAIST was the first attempt by the Government of South Korea in creating a research and engineering-based educational institute with the help of the American government. By counseling the Korean government and providing research policies, the Korean government established its first research university (K. K. Korea (South)., 1966).

4.2.4.2.3 Expand Higher educational facilities into rural area

- **1972–1976 the Korean Third Economic development plan (KTEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Helped expanding development into rural industries and communities through the vocational and technical training centers.			→	
	2	Educated and trained faculty to meet the industries S&T requirements			→	

Table 80 the Korean third economic development plan (educational system)

In the KTEDP, the central government motivated uneducated individuals to apply in vocational and technical training centers. The main aim for these centers was to help expand development into rural industries and communities. Also, the central government provided financial incentives to the unemployed individuals especially in fisheries and agrarian industries to support these individuals in their businesses by knowledge and technical capabilities. Accordingly, the government helped these

businesses to develop their programs to educate and train their employees to meet the industries' specific requirements (Korea (South), 1971).

4.2.4.2.4 Increased the university connectivity with vocational institutions and created special agencies to fund universities activities

- **1977–1981 the Korean Fourth Economic development plan (KFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Enforced the vocational system by the universities to increase its capabilities		→		
	2	Decentralized the vocational system		→		
	3	Created vocational facilities within large industries in different regions		→		
	4	Established KOSEF organization to fund the universities research activities and provide consultation		→		

Table 81the Korean fourth economic development plan (educational system)

During the Korean Fourth Economic development plan **(**KFREDP), there was an increased awareness of the importance of vocational training through the university system. The vocational system was enforced by the universities to increase the capabilities of the teachers to train and educate individuals to be skillful and capable of handling the new industrial and technological machines. For the government to increase the validity of vocational facilities, the government decided to decentralize the vocational system and encourage private industries to create their training and vocational facilities. Creating a vocational facility within large industries in different regions helped the industries in determining their requirements and fulfill them.

The main government goal toward the university system in the fourth plan was to help promote the basic science such as physics and mathematics within the Korean universities by establishing the Korea Science and Engineering Foundation (KOSEF). KOSEF main aim was to fund the universities research activities and provide engineering consultation to companies and industrial facilities. In 1981, the Korean

government established The Korea Research Foundation (KRF) which also supported the research and development field in universities and elsewhere (NRF, 2012).

4.2.4.2.5 Increased R&D activities with international universities

- **1982–1986 the Korean Fifth Economic development plan (KFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Obligated (KAIST) to develop programs with foreign universities in S&T	←	→		
	2	Initiated relationships with foreign institutions by exchanging scholars	←	→		
	3	Expanded the vocational institutions to reach 90 centers in different regions		→		
	4	Provided tax incentives to any facility that would increase its responsibilities in training its employees		→		

Table 82 the Korean fifth economic development plan (educational system)

During the KFFEDP, the government obligated the Korean Advance Institute of Science and Technology (KAIST) to develop programs with foreign universities and research institutions in the field of S&T. These programs helped the universities in initiating relationships with foreign institutions by exchanging scholars between the university and other foreign institutions. Exchanging scholars helped in increasing the connectivity between institutions and assisted in gaining the appropriate knowledge from foreign institutions and increase the country's S&T economic base (Korea (South), 1982).

In vocational institutions, the government decided to expand vocational institutions to reach 90 centers around the country in different regions and metropolitan areas. This policy had been encouraged by providing tax incentives to any facilities that increase its responsibilities in training its employees in innovation and industrial activities (Korea (South), 1982).

4.2.4.2.6 Offred scholarships and established new universities in industrial territories

- **1987–1991 the Korean Sixth Economic development plan (KSIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Offered scholarships to universities, colleges, and vocational training institutions		→		
	2	Dedicated vocational training towards S&T to prepare the future generation in innovation		→		
	3	Implemented a policy that aims to develop the laboratories and science equipment		→		
	4	Secured jobs as a requirement for each graduate from the vocational institutions		→		
	5	Established new regional colleges and universities, especially in industrial territories.		→		

Table 83 the Korean sixth economic development plan (educational system)

During the Korean Sixth Economic development plan KSIEDP, the government offered scholarships in universities and colleges and free vocational training to qualified individuals. Also, the vocational training had been offered for poor students with a livable wage provided to them.

The vocational training has been dedicated toward science and technology to prepare the future generation to be involved in the innovation process that had been spread in the developing world. To allow South Korea to be part of the global innovation system, the government implemented a long-term development policy that aims to increase the development of the laboratories and science equipment. This governmental inclination accompanied by developing the curriculum of the courses to match the developed innovative society of Japan. The new government direction in developing vocational training implemented a mandatory job requirement for industrial jobs for each graduate from the vocational institution (Korea (South), 1986).

During the sixth plan, the government acknowledged the existence of unbalanced educational facilities throughout regions in South Korea. Thus, the government aimed to ensure evenly distributed universities by upgrading and establishing new regional

colleges and universities, especially in industrial territories. Accordingly, the major policy that had been implemented in 1991 was connecting regional colleges with neighboring industrial complexes (Korea (South), 1986).

4.2.4.2.7 Increased university services in industrial vocational facilities and replaced Humanities with S&T

- **1992–1996 the Korean Seventh Economic development plan (KSVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Enforced universities to be part of the industrial vocational facilities		→		
	2	Promoted S&T to the educational system instead of Humanities		→		

Table 84 the Korean seventh economic development plan (educational system)

The continuous increase in industrial technology needs to be led to a continuous need for qualified graduates. To fulfill the needs of new industries, South Korea started to create new four-year technical institutions, colleges, and universities. The new colleges have been spread across the regional and industrial clusters. The curriculum and programs have been made according to the industrial facilities needs and requirements. Even at that time, the major role of universities was not R&D. The major universities role was to reinforce the industries with technicians and workforce. Accordingly, the University strengthens the ties with vocational institutions to fulfill the needs of the technological industries (Korea (South), 1992).

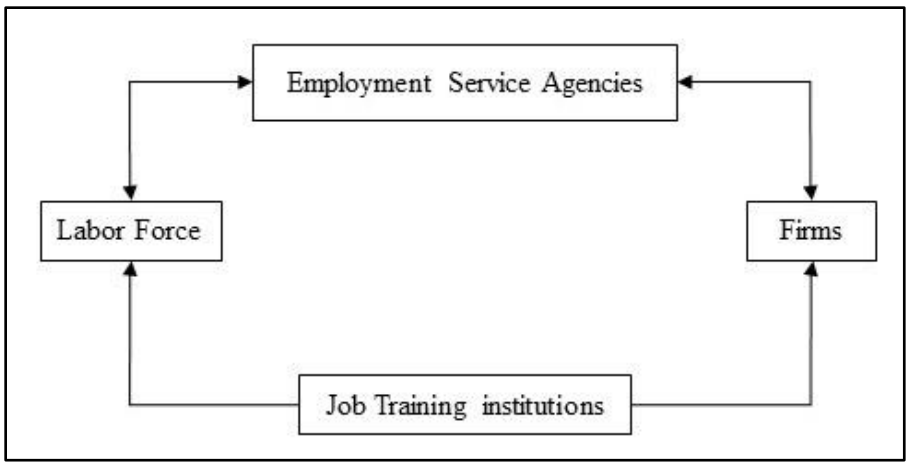

Figure 10 Relation chain between Vocational institutions and firms

During this plan, the Korean government was promoting science and technology to all parts of the educational system and place science and technology to all parts of the educational facilities. Also, the government linked the high school vocational system with the university and education vocational system (Korea (South), 1992).

4.2.4.2.8 Established agencies to fund universities research activities nationally and internationally

- **2003-2007 South Korea First Science and Technology plan (KFBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 1st	1	Established KICOS to finance research between Korean universities and international universities	←	—	—	→
	2	Established (NRF) as a research funding system to fund research in Academic disciplines				→

Table 85 the Korean first S&T development plan (educational system)

Realizing the importance of international cooperation, in 2004 the government established The Korea Foundation for International Cooperation of Science and Technology (KICOS). This foundation helped support and finance research between Korean Universities and universities and laboratories around the world. In 2009, as part of the 2025 vision and second S&T basic plan the Korean government promoted KICOS to be the National Research Foundation of Korea (NRF). The new Foundation

purpose is to develop knowledge by using a research funding system to fund research in Academic disciplines. The NRF is responsible for the planning for all research related to academia and to promote all kind of research in the academic fields. Thus, the major goals of this foundation are to:

1- Subsidize R&D in academic fields and implement it in the overall research fields.

2- Support international cooperation in academic R&D and facilitate the implementation of the research in R&D organizations

3- Draw policies and provide funds for Future R&D activities.(NRF, 2012)

4.2.4.2.9 Focused attention on world-class universities

- **2008-2012 South Korea Second Basic Science and Technology plan (KSBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 2nd	1	Increased financial support for the world-class national research universities		→		
	2	Supported the relation between education, human resources, and S&T.		→		

Table 86 the Korean second S&T development plan (educational system)

During this plan or so called the 577 plan, the government realized the importance of the world-class research universities, and it started to increase its support to postgraduate students in S&T. Also, the government increased the support to the human resources system through merging the education ministry with the human resources and the Ministry of Science and Technology to support the relationship between education, human resources, and S&T. The plan was focusing on increasing and supporting the culture of Science and technology to all parts of the economy (El Qrarah, Ussenov, Rosca, Zaghdoud, & Bernichi, 2014).

- **2013-2017 South Korea Third Basic Science and Technology plan (KTBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 3rd	1	Increased incentives to all universities in research and S&T that are in the world-class ranking	⟷			

Table 87 the Korean third S&T development plan (educational system)

The government started to increase the incentives to all universities that are in the world-class ranking of the top research S&T institutions. The ranking that the government relied on to decide which university deserve the funds was in Shanghai and U.S News rankings. The support has been provided to the universities to increase its capabilities to compete in the world economy. The government also increased its policies towards government funded research institutions to increase their relation to universities and industrial research facilities (Ministry of Science, ICT and Future Planning, 2016).

4.2.4.2.10 Conclusion

In the sixties, the South Korean government spent most of its effort on developing the universities and the educational system in all regions and territories. The government realized that for its policies to succeed in motivating the economy and the industrial infrastructure it needed to focus on two major areas in the educational system, which were vocational institutions and R&D universities. Accordingly, the government started to increase its policies to support and establish new R&D universities and vocational institutions around the country. The government established the Korean Advance Institute of Science and Technology as the first university that focused on R&D. The government initiated a special R&D budget that aims to funds Universities R&D activities (table 88).

Years	1965	1970	1975	1980	1985	1990	1995	2000	2003	2005
Amount	NA	1.3	4.5	39.2	133.5	341.0	999.0	1,382.2	1,621.9	2,573.7

Table 88 South Korea University R&D expenditure In Million Dollars
(Ministry of Science, ICT and Future Planning, 2016)

The budget started with $1.3 million in 1965 and increased until it reached $341 million in 1990. After 1995, the amount of spending rose until it reached $2,573.7 million in 2005.

To help fund educational institutions fairly, the government created several financial institutions that could help fund the activities of these educational institutions, such as KIATE, NRF, and KICOS.

4.2.4.3 Financial institutions

4.2.4.3.1 Overview

This section will investigate the Korean economic development plans to understand the evolution of the financial sector. The study will explore the industrial policies, incentives, major institutes, and financial focus through the years. These policies and institutes will reveal the role of the financial system in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of indusial firms in building a robust innovation systems had be identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of South Korea. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the financial sector.

The following discussion will develop an understanding of the evolution of the financial sector and its role in developing the connectivity of the innovation systems.

4.2.4.3.2 Supported incoming investment to local infrastructure and allowed banks to increase local savings

- **1962–1966 the Korean First Economic development plan (KFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Guided foreign investments to domestic infrastructure and enterprises	→			
	2	Allowed the banks to absorb funds as saving deposits from individuals and institutions		↔		

Table 89 the Korean first economic development plan (financial institutions)

During Korea's First Economic development plan **(**KFEDP), the major assistant to the Korean economy came from Foreign direct investment. The fund reinforcements came as a relief to close the deficit gap between the domestic saving and investment. Thus, the South Korean government launched several major infrastructure projects to support the Korean economic development that includes roads, amenities, and educational facilities. These investments and support to the Korean Economy came mainly from the International Development Associations, the United Nations Development Program, the World Bank, the Asian Development Bank, and bilateral agencies such as the United States Agency for International Development and the Overseas Economic Cooperation Fund of Japan (KOICA, 2008). The budget that was provided by the foreign agencies was controlled by the Korean government to reconstruct many parts of underdeveloped regions that were affected badly during the Korean war and after gaining independence from Japan.

At the national level, there was a lack of systematic banking services, low official monetary exchange rate and insufficient management of the state-operated enterprise.

The central government implemented a policy that allows the banking system to absorb funds as saving deposits from individuals and private institutions into the banking institutions. These financial resources helped the government in funding the existing and the new industrial activities at the same time. Also, the central government implemented a long-term interest system to encourage companies to invest in businesses (K. K. Korea (South)., 1962).

4.2.4.3.3 Encouraged banking activities in the rural markets and developed the stock market

- **1967–1971 the Korean Second Economic development plan (KSEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Increased foreign capital investment that was directed to economic development	→	→	→	→
	2	Encouraged banking institutions to spread their activities and branches in rural markets			→	
	3	Increased public and private savings		→	→	
	6	Sustained self-funding by selling government enterprise assets in the stock market		→	→	

Table 90 the Korean second economic development plan (financial institutions)

During Korea Second Economic development plan KSEDP, the government relied heavily on foreign direct investments to build its infrastructure. These foreign investments were directed towards railways enterprises and other public infrastructures. The Foreign capital investment started to increase toward South Korea to invest heavily on government activities and economic development. Foreign capitals because of the increased need for foreign exchange that surpassed the Korean capabilities to gain by exporting. (K. K. Korea (South)., 1966).

At the national level, the government encouraged bank institutes to absorb all financial activities that occurred outside the financial institutions. The government encouraged these institutions to spread their activities and branches to include rural markets to

prevent them from trading outside the banking system. Furthermore, the government motivated commercial banks

(K. K. Korea (South)., 1966).

The major concentration of own government investment was towards major infrastructure in agriculture and basic industries where the financial needs were too large for individual investors and local entrepreneurs. Private investments, in contrast, have been seen in other parts of the economy as in manufacturing and private activities where government intervention was limited, and its control was only on credit access, import licensing and export supporting.

To ensure South Korea sustainable self-funding, the government took the decision to sell its enterprises assets in the stoke market to increase the transparency toward the public and diversify funds source rather than rely totally on foreign direct investments. The new policy affected mainly the railway's enterprises, the shipbuilding industries, and other public projects (K. K. Korea (South)., 1966).

4.2.4.3.4 Encouraged local loans and banks overseas operations

- **1977–1981 the Korean Fourth Economic development plan (KFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Promoted competition between institutions by diversifying the banking loaning services			→	
	2	Increased the competition between banks by allowing bank expansion			↔	
	3	Encouraged banks to operate overseas and serve local and international industries	↔			
	4	Allowed banks to provide domestic and foreign capital to businesses with tolerated loans	↔			

Table 91 the Korean fourth economic development plan (financial institutions)

During the Korean Fourth Economic development (KFREDP), there were several improvements in the banking system in South Korea. One of the major improvement in the banking system was the expansion of the banking system to hold overseas

transaction to improve the industrial activities and ease local industries export and import transaction and activities. Also, the government promoted competition between institutions by diversifying the function of banks to include direct loans and savings. The local banks increased their duties to ease the relation and transactions between local and international banking institutions by increasing its provision to handle such transactions (Korea (South), 1976).

There were other major improvements made in the banking system during the fourth plan. These improvements as follows:

1- Increasing the competition between banks by allowing bank expansion and improve their managerial capabilities.
2- Allowing and encouraging banks to do overseas operations and transactions to serve local and international industries.
3- Allowing merchant banks to provide domestic and foreign capital to business firms. Also, there has been a development of a long-term equipment financing with a tolerated loan terms (Korea (South), 1976).

- **1987–1991 the Korean Fifth Economic development plan (KFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Decreased direct spending and maximized incentives toward private industries			→	
	2	Increased policies to encourage R&D spending in private industries.			→	

Table 92 the Korean fifth economic development plan (financial institutions)

During the Korean Fifth Economic development plan KFFEDP, the government started to decrease its direct spending and maximize incentives toward private industrial infrastructure and R&D activities. On the other hand, the government increased its policies to encourage spending of the private industries (Korea (South), 1982).

4.2.4.3.5 Encouraged private initiatives in the financial market

- **1987–1991 The Korean Sixth Economic development plan (KSIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Liberalized the financial market and reduced the financial restriction		→		
	2	Encouraged private initiative to play a major role in the financial market		→		
	3	Established KOICA as a government grant agency to S&T businesses		→		

Table 93 the Korean sixth economic development plan (financial institutions)

In the Korean Sixth Economic development plan (KSIEDP), the Korean government took steps toward liberalizing the financial market. This governmental tendency led to the reduction of the financial restriction and government control over the monetary market. Accordingly, the government started to encourage private initiative to play a major role in the financial market. This initiative was caused by the increased world pressure on the Korean government to free the market. Another reason for market liberalization was to control the inflation rate that started to increase because of the trade surplus. Also, the government wanted to focus more on balancing its investments in the global, national, regional and sectoral areas especially on small and medium businesses (Korea (South), 1986).

As a response to the government movement of investing in different businesses and different areas, the Korean government created the Korea International Cooperation Agency KOICA that was founded in 1991 as a government financial agency. The major role of this agency was to increase the efficiency of Korea's grant aid programs by implementing governmental grants into businesses that use S&T in their production programs around the world (KOICA, 2008).

4.2.4.3.6 Allowed technological venture capitalist, provided support to local and international investors

- **1992–1996 the Korean Seventh Economic development plan (KSVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Reduced the link of mutual loans between large corporation		←	→	
	2	Increased the spending on R&D			→	
	3	Established the Korea Technology Promotion Bank as high-risk venture capitalist agency			→	
	4	Established the National Science Foundation to provide incentives and financing to international, national, and regional qualified scientists and engineers	←	—	→	
	5	Encouraged foreign direct investment by promoting technology transfer		—	→	
	6	Provided land as an incentive to new foreign investors	←	—	→	
	7	Increased the autonomy of financial system from government and large corporation control			→	
	8	Provided direct loans to fit new businesses and entrepreneurs' need			→	

Table 94 the Korean seventh economic development plan (financial institutions)

In the Korean Seventh Economic development plan (KSVEDP), the government of South Korea reduced the link of mutual loans between large corporation such as SAMSUNG, LG, HYUNDAI, and others expect for loans of new technologies. These loans were guaranteed by the corporation instead of the official financial management system, which the government decided to establish the seventh plan. The step helped in increasing the fair trade of financial incentives between small and large firms rather than concentrating the funds between large corporations. Also, the Korean government continued its policy trends toward liberalizing the financial market (Korea (South), 1992).

Additionally, the Korean government started to increase the spending on R&D by encouraging the public institutions to increase the spending on R&D. This goal was achieved by obligating public firms to spend an amount of their income on R&D.

To encourage the public and private cooperation to invest in R&D, the Korean government expanded “The Korea Technology Development Corporation” activities and renamed it as “The Korea Technology Promotion Bank.” The role of the Bank was mainly conducted to finance high-risk venture capitalist companies.

The government also increased spending on R&D activities by increasing funds to S&T University equipment. These incentives and financing were directed to the international, national and regional the R&D institutions. These funds were provided throw “The National Science Foundation” to qualified scientists and engineers. On the other hand, Foreign direct investment was encouraged by promoting technology transfer and providing tax incentives to any new high technology industry established by foreign countries. The new incentive exceeded tax relief incentives to provide land to new foreign investors (Korea (South), 1992).

The government increased the autonomy of its financial system away from government and large corporation control. The liberalizing of the financial system accompanied with reforming the loan system to fit the new businesses and entrepreneurs needs. The government also reformed the tax system and financial competition policies by allowing public offering for large conglomerated companies to be offered in the stock market such as Samsung and other large corporations (Korea (South), 1992).

4.2.4.3.7 provided funds for technological exports

- **1997-2002 South Korea Five Year Science and Technology plan (KS&TP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T	1	Increased funds for R&D, patents & publications, and high-technology exports	⟷			

Table 95 the Korean S&T development plan (financial institutions)

The Five-Year Science and Technology plan (KS&TP) was developed in the late 1990s and early 2000s with the aim of improving the capacity and funding for R&D and S&T workforce. The policy aimed to increase funds for R&D, patents & publications, and high-technology exports. The result of these policies led in transforming Korea from a fast follower to a leadership position in S&T capabilities.

4.2.4.3.8 Diversified the monetary source for technological activities through taxes and special organizations

- **2003-2007 South Korea First Basic S&T plan (KFBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 1st	1	Diversified the source of R&D financial investments in innovation Zones		→		
	2	Established the "Daedeok Special Zone Fund" to fund small and medium size businesses		→		
	3	Provided tax incentives to local businesses to encourage them to innovate		→		

Table 96 the Korean first basic S&T development plan (financial institutions)

During South Korea's First Basic S&T plan (KFBSTP), the government aimed to diversify the R&D source of financial investments within the new economic and Innovation Zones. The government established the "Daedeok Special Zone Fund" to fund small and medium size businesses within the boundary of the economic zone of Daedeok. Accordingly, the government increased the investments towards basic research in these economic zones. Also, the government continued its tax incentives to local businesses to encourage them to innovate and increase their activities (J. Mahlich & Pascha, 2012).

- **2008-2012 South Korea Second Basic Science and Technology plan (KSBSTP) or 577 plan**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 2nd	1	Enforced NSTC to coordinate the government R&D budget toward GRIs		→		

Table 97 the Korean second basic S&T development plan (financial institutions)

During the 577-basic plan of S&T, the government strengthened the role of the National Science and Technology Council NSTC to coordinate the government R&D budget. Moreover, the government increased the Government Research institution funds through the NSTC (El Qrarah, Ussenov, Rosca, Zaghdoud, & Bernichi, 2014).

4.2.4.3.9 Direct government monetary support was directed toward Research activities

- **2013-2017 South Korea Third Basic S&T plan (KTBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 3rd	1	Restricted funds on a highly competitive basis between GRIs		↔		
	2	Provided direct funds to new technological fields through GRIs	↔			

Table 98 the Korean third basic S&T development plan (financial institutions)

During the third S&T basic plan, the total amount of funds oriented toward R&D program and organizational planning and expenditure were provided by the Ministry of Strategy and Finance MOSF. The government investments started to be restricted on a highly competitive basis. Furthermore, the government started to be more concise and distributed the budget toward specific projects that were selected through competitive basis between research groups, universities, and industries. Also, new funding was directed toward new technological fields through the S&T related ministries (Ministry of Science, ICT and Future Planning, 2016).

4.2.4.3.10 Conclusion

In the first plan, the government relied heavily on foreign investments and money flow to support its local economy. These investments helped in connecting the local economy with international trends and needs, which helped the economic growth in the later years.

In the second plan, the government worked on increasing banking services to rural areas. The government also worked on sustaining the domestic financial institution by increasing savings and selling government enterprise in the stock market.

In the third and fourth plan, the government started expanding the banking services and branches to cover overseas operations. This expansion helped local banks to increase its activities in overseas markets.

In the fifth plan, the government aimed to decrease direct spending on R&D and increase incentives to motivate industrial and research activities

In the sixth and seventh plan, the government aimed to increase the sources of financial incentives from international direct investments and new domestic banking and venture capital institutions. To increase the local market spending, the government aimed to liberalize the financial market and free the system from direct government intervention. The government also worked on creating new venture capitalist that can help in funding the R&D activity at different innovative levels.

In the S&T plan, the government started to Increased funds for R&D, patents & publications, and high-technology exports

In the 1st Basic S&T plan, the government started to increase the funds for Science and technology activities through creating semi-government organizations in industrial and economic zones to support GRIS and businesses.

In the 2nd Basic S&T plan, the government started to coordinate government funds towards GRIs through the National Science and Technology Council. However, the government allowed other sources of financial support through other non-government or semi-government institutions.

In the 3rd Basic S&T plan, the government started to guide and restrict funds through the different innovation systems on a highly competitive basis.

4.2.4.4 Government Research and Development institution (GRIs)

4.2.4.4.1 Overview

This section will investigate the Korean economic development plans to identify the evolution of the Government Research and Development Institution (GRIs). The study will explore the industrial policies, incentives, major institutes, and industrial focus through the years. These policies and institutes will reveal the role of the GRIs in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of GRIs in building a robust innovation systems had be identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of South Korea. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the GRIs sector. Figure 11 shows the latest results of the GRI distribution in several regions in South Korea and the dates of their establishment. This GRIs are government funded research institutions and connected under the jurisdiction of the "National Science and Technology Council (NSTC)."

The following discussion will develop an understanding of the evolution of the policies and innovation systems connectivity that helped shape these GRIs.

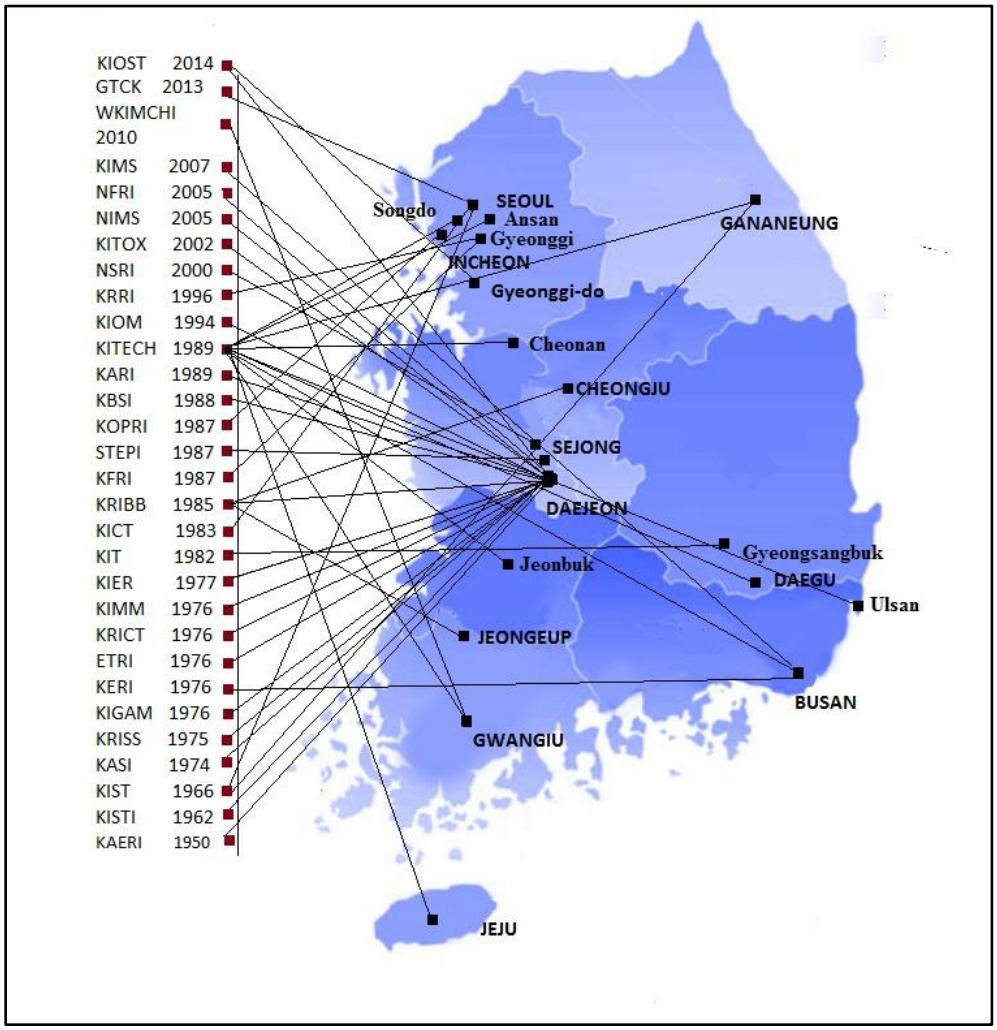

Figure 11 Evolution and distribution of South Korea GRIs in NIS, RIS, and RIC

4.2.4.4.2 Established KIST and KISTI as the base for government research activities

- **1962–1972 the Korean First and Second Economic development plan (KFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Established KIST and KISTI as the base for government research activities	←	—	—	→
	2	Established KOTRA to facilitate Exporting and provide information to local GRIs and industry	←	—	—	→

Table 99 Evolution of South Korea Major GRIs Policies (First Economic Development Plan)

During the first five-year plan (KFEDP), South Korea increased its international connectivity the United States government established the Korean Institute of Science and Technology KIST as a government research center (GRI). The government also created the Korean Institute of Technology information KISTI as an information center for R&D for GRI (table 99). The main objective of KIST was to motivate and conduct research activity in Korea that enhances S&T based (K. K. Korea (South)., 1962).

In 1967, the government of South Korea implemented the "Technology Promotion Act and the Science Education Act" this act gave the legal base for S&T policies that affected KIST as the new major national research center in the country. In 1968, the government created the Ministry of Science and Technology (MOST), the Ministry was the hub responsible for Promoting S&T activities including KIST (Ministry of Science, ICT and Future Planning, 2016).

During the KFEDP, the Korean government established the Korea Trade Promotion Agency KOTRA in 1962. KOTRA main job was to facilitate Koreas Exporting activities to the world market and enhance export of Korean products. The organization also helped in promoting the activities of oversea markets and provide information to

local industries and Research facilities to ease the duties of foreign direct investments in Korea.

In 1995, the Ministry of Trade, Industry, and Energy (MOTIE) renamed KOTRA to be the Korea Trade-Investment Promotion Agency. As a state-funded organization operated by the Government of South Korea, KOTRA added the technological and industrial cooperation promotion projects under its jurisdiction. KOTRA existed in 85 countries with 126 overseas locations and ten regional branches to promote trade-related information, and R&D activities (KOTRA, 2012). This information and activities were mainly focused on attracting foreign investments to local industries and research institutions and share this information with other organizations around the world. Also, KOTRA was considered as an agency that facilitates technology transfer between institutions locally and internationally. Also, KOTRA worked on increasing the numbers of Korean companies that can export their products by linking domestic customers with the overseas corporation through foreign and local investments. (K. K. Korea (South)., 1962).

4.2.4.4.3 Increased GRIs international relations

- **1972–1976 the Korean Third Economic development plan (KTEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Established "the overall Science and Technology Review Council" to review S&T policies			→	
	2	Increased GRIs technology transfer through KIST	←		→	

Table 100 Evolution of South Korea Major GRIs Policies (Third Economic Development Plan)

During the third economic development plan KTEDP, the government of South Korea established "the overall Science and Technology Review Council." The major purpose

of this council was to review and coordinate the S&T policies implemented by the Planning Board; this council (Korea (South), 1971).

In 1970, the government established several GRIs to help support and implement new technologies in industries and to build a culture of R&D in the country. Korea's managed to add new technological products to its exports these products include Ships, semi-conductors. Radios and TV sets.

Between 1972–1976, KIST major duties were to strengthen the ties between technological projects in South Korea and international organization to improve the project efficiency and research development programs (Korea (South), 1971).

KIST did not reach the expectation of policy makers in the central government due to several reasons. These reasons include the small-scale basis of the projects conducted by KIST and the lack of collaboration between GRIs in general and universities. The third five-year plan had solved this problem by adopting a variety of technical standard that aims to increase the competition between local industries by encouraging them to adopt new technologies by the help of GRIs including KIST (Korea (South), 1971).

4.2.4.4.4 Increased the rural GRIs with the national and international GRIs

- **1977–1981 the Korean Fourth Economic development plan (KFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Transferred the current national registration tax to finance rural GRIs		→		
	2	linked Rural GRIs with central cities projects		↔		
	3	Enforced the role of GRI as a major connector with international R&D institute	↔	↔	↔	
	4	Added new GRIs under KIST supervision		↔		

Table 101 Evolution of South Korea Major GRIs Policies (Fourth Economic Development Plan)

The government of South Korea realized the importance of GRIs during the fourth economic development plan (KFREDP). The government exempted from tax payment

all research related activities. This governmental support has been institutionalized and provided through public firms and private firms when collaborated with GRIs. The relationship between agencies took the form of engineering consultancy to promote the industrial firm's products and make it acceptable in the global market.

To prepare the industrial firm's products to the global market, KIST established a technology transfer center to acquire, assess, gather, and make recommendations to domestic firms and overseas technological information (Korea (South), 1976).

The government used the GRI as a major connector and enhancer for R&D by increasing their involvement and connectivity with international companies to compete with the local ones. After the direct intervention by the government, the government reduced its market involvement by giving the opportunity to the market to play its role in developing the economy (Korea (South), 1976).

The government also started to spread all R&D development projects to different R&D institutions under the supervision of KIST. The major aim for this new trend is to create an innovative industrial technology in mechanical engineering, metallurgical engineering, semiconductor engineering, chemical engineering, and resource utilization technology (Korea (South), 1976).

The second institute was the Korea Institute of Electronics Technology that was established in Chilgog semiconductor and computer industrial estates, the major role for the new R&D is to be responsible for technology transfer and information in the industrial firms.

The third institute was the Korea Research Institute of Shipbuilding and oceanography that was established in the Daedeog Research Park. The major role of this institution

was to develop innovation capabilities in the shipbuilding industries (Korea (South), 1976).

The fourth institution was the chemistry Research Institute that was constructed in the Daedeog Research Park. The final institution is the Electrical Missionary Research Institute. This institute was established to support the Korean electric industrial facilities and undertake the quality control of the marketable products. The electrical missionary research institute worked side by side with the Korea Standards Research Institute that was in Daedeog Research Park; its major role was to set up measures for measuring standards within the country (Korea (South), 1976).

- **1982–1986 the Korean Fifth Economic development plan (KFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Updated GRIs with an innovative management and information systems		→		
	2	Increased the distributing of GRIs in rural cities		→		

Table 102 Evolution of South Korea Major GRIs Policies (Fifth Economic Development Plan)

During the KFFEDP, the public enterprises and GRIs that were managed by government institutions have been supported by newly educated management teams and information systems that can implement innovation in their system. (The Republic of Korea, 2016). Because of the burdens that were caused by high population in major cities such as Seoul, Pusan, and Daegu, the central government took the decision of distributing the GRIs accordingly (The Republic of Korea, 2016).

4.2.4.4.5 Increased regulations through special agencies to control GRIs

- **1987–1991 the Korean Sixth Economic development plan (KSIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Provided equal treatment and procedures to deliver permits and Finances to GRIs		→		
	2	Established the CSTP in 1987 by KIST to draw policies for GRIs		→		
	3	Established STEPI in 1993 by the government to support GRIs activities and planning		→		
	4	Maintained all grants to GRIs that cooperates with small and medium size businesses		→		
	5	Localized technological products by using GRIs in R&D		→		

Table 103 Evolution of South Korea Major GRIs Policies (Sixth Economic Development Plan)

In 1987, KIST created the Center for S&T Policy(CSTP), the major aim of this organization was to draw specific policies to GRIs. In 1993, CSTP felt under the Science and Technology Policy Institute (STEPI) that was created by the Korean government to support GRIs activities and held them with planning issues.

In the KSIEDP, the government realized that it was virtually involved in every sector of the Korean economy. While the country moves toward internationalizing the economy, the government intervention has embedded rather than guiding the economic development in South Korea.

In the 1990s, KIST was the only Korean GRIs that opened a branch outside the Korean Peninsula in Germany. The collaboration between KIST Europe and South Korea was focused on several other matters besides R&D. These matters included Education, S&T policies, Technology transfer commercialization, and innovation problem-solving.

In 1991, the government laid down the innovation master plan for South Korea that led the Korean economy in the fallowing years by localizing many technological products and many other parts of mechanical and machinery products (Korea (South), 1986).

One of the major policies that the government of South Korea urged to be active in was to provide equal opportunities to GRIs. This policy was made by providing equal

treatment and procedures to deliver permits and Finances that creates an orderly market economy. The equal opportunity provided fair competition among business and GRIs that helped in developing the economy. While all tax deductions or exemptions were reduced or abolished the government reformed the tax privileges by maintaining all granted taxes to GRIs that cooperates with small and medium size businesses (Korea (South), 1986).

4.2.4.4.6 Increased Korean GRIs existences in international and local industrial clusters

- **1992–1996 the Korean Seventh Economic development plan (KSVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Established the Ministry of S&T in 1996 to increase the importance of S&T policies		→		
	2	Increased the financial support for S&T related activity in GRI		→		
	3	Increased the research funds based on research capabilities of Faculty and students		→		
	4	Increased the support to research institute that collaborates with research institute globally	↔	↔		
	5	Increased the support to foreign scientist to join fellowship and the post-doctoral programs	↔	↔		
	6	Encouraged foreign technology transfer and international joint R&D	↔	↔		
	7	Established KIST Europe in Germany in 1996 by KIST Korea	↔	↔		

Table 104 Evolution of South Korea Major GRIs Policies (Seventh Economic Development Plan)

In the year 1996, KIST signed an agreement with the Germany government to initiate the foundation of KIST Europe. The major aim of this agreement was to establish a joint activity between Europe and Korea in the field of S&T and increase the network and collaboration between South Korea and Europe (KIST, 2016).

The new agreement had another objective of increasing the support for the Korean industrial infrastructure by using technology transfer towards the Korean industries. During the KSVEDP, the government increased the financial support for S&T related activity in GRI and Universities Systems. The Research funds were increased by the

research capabilities of the Faculty members and students. The support was directed to faculty members and facilities within GRI and universities. Increased support to research institute within the border of the country and increased joint venture activity with another research institute globally. Also, any university that had a strong Science and technology capabilities were encouraged to increase their research focus to post-graduate educational programs (Korea (South), 1992).

Under the support of the National Science Foundation, the government increased the support and encouragement to foreign scientist to increase their fellowship in the post-doctoral programs. During the KSVEDP the government started to increase the support to the university industry and GRI by encouraging them to work actively with each other. The government started to encourage the private firm to invest in industrial technology and work closely to develop it with the GRI. Also, the government started to prompt an exchange of personnel and joint use of research facilities between the GRI and the industry. The government also started building research complexes along with the industry to increase the technological and innovative production. On the international basis, the government encouraged foreign technology transfer and international joint research and development activities, Such as the Korean and United State technological cooperation treaty in 1992 and the OECD group of technological advancement countries in 1996 (Korea (South), 1992).

4.2.4.4.7 Organize the S&T relations using KISTEP

- **1997-2002 South Korea Science and Technology plan (KS&TP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T	1	Created KISTEP the Korean Institute of Science and Technology Evaluation and Planning	⟷			

Table 105 South Korea Science and Technology plan (KS&TP)

In 1999, Korea initiated "the Special Act on Innovation in Science and Technology." In response, the government of South Korea created the Korean Institute of Science and Technology Evaluation and Planning (KISTEP). KISTEP was created as a global institute for economic that can contribute to economic growth using S&T strategies and R&D evaluation and planning (Kistep, 2013).

KISTEP is considered a knowledge and network hub that guides the Korean national innovation system relation with international countries and communities including OECD and UNESCO. There are many other national communities in the network of KISTEP; these communities are the "American Association for the Advancement of Science" and the "International Society for Professional Innovation Management." Also, KISTEP supports the local innovation in South Korea by providing technological programs and foresight that other countries and communities need and can be obtained from local businesses.(Kistep, 2013)

- **2003-2007 South Korea First Basic S&T plan (KFBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 1st	1	Increased KIST branches in local innovation clusters	⟷			
	2	Launched the Global Research Laboratory by KICOS in 2006 to solve global S&T issues			⟷	

Table 106 Evolution of South Korea Major GRIs Policies (First Basic S&T Development Plan)

In 2003, KIST opened another major local branch within South Korea; the branch was in one of the promising industrial complexes in Gangneung. The new branch had a major role in promoting Regional S&T and innovation in the region of Gangneung. Also, KIST aim was to increase the innovation culture within the industrial facilities in the region (G. Kist, 2016).

In 2006, the government of South Korea through the Korean Foundation for International Cooperation in Science and Technology (KICOS), launched the Global Research Laboratory. The global laboratories were aiming to solve global S&T issues using international collaboration between Foreign and Korean laboratories in more than 16 fields of study including Nanotechnology, Biotechnology, IT, renewable energy, and medical issues (J. Mahlich & Pascha, 2012).

4.2.4.4.8 Diversified the research activities in South Korea

- **2008-2012 South Korea Second Five-year Basic Science and Technology plan (KSBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T	1	Added new fields in R&D, such as Climate change, Food Safety and other world occurring disease			→	
2nd	2	Established Korea and India KIST and rename it as IKST		↔		

Table 107 Evolution of South Korea Major GRIs Policies (Second Basic S&T Development Plan)

In 2009, Korea and India signed an agreement with KIST Korea to establish IKST to create an Indian and Korean scientific community to come together and collaborate in science and engineering to support the development of next generation in innovation and technology research. The collaboration includes the exchange of doctorate students between countries and conducts technical forums between the two countries (I. KIST, 2016).

Now KIST is considered a Global S&T research institute and a frontrunner among other similar institutes in Korea in promoting innovative international programs and enterprises besides working together with global communities, countries, and partner including U.S, Japan, Germany, and others.

During KSBSTP, the NSTC expanded the Korean government participation in the global innovation system by adding Climate change, Food Safety and other world occurring disease in its Research institution.

In 2009, the government realized the imbalanced development through the regional and local areas in South Korea. Accordingly, the government started to close this gap by increasing S&T through different regional areas as a tool to close this occurring gap. Implemented the S&T to close the gap of regional development started in the first five-year S&T development plan and continued through the second five-year plan. The increased funding and policy implementation the regional innovation within the regions and provisional areas in South Korea. Also, the government implemented a major policy to broaden the scope of S&T by encouraging international R&D centers to open branches in South Korea to increase the Bases of S&T and innovation (El Qrarah, Ussenov, Rosca, Zaghdoud, & Bernichi, 2014).

4.2.4.4.9 Conclusion

In the first plan, the government lacked the information that was needed to encourage R&D activities. Accordingly, the government established KOTRA to facilitate information distribution and exchange between different government institutions. Also, the government initiated the Korea Institute of Science and Technology as the major hub for R&D activities in South Korea. In the fallowing years, the government started

to establish several government research institutions for each new industry. These GRIs were spread in several areas according to the industries need. In the third plan, the government established "the overall Science and Technology Review Council" to review S&T policies and coordinate R&D effort.

In the fourth plan, the government started to reorganize GRIs and increase their connectivity with Universities and industries and connect rural ones with central cities projects. The government also worked on increasing tax incentives for these GRIs to encourage them to collaborate.

In the fifth plan, the government increased training opportunities to GRIs management system and increase the GRIs distributions in rural areas.

In the sixth plan, the government started to increase financial support to all GRIs through new institutions as STEPI. The government started to encourage GRIs to collaborate with other institutions to increase local technologies in industries through R&D.

To increase the importance of S&T, the government created the Ministry of S&T in 1996. The ministry helped to support the GRIs activities and increase the GRIs spending accordingly. This step helped in increasing the R&D collaboration with foreign institutions. KIST, for example, established a joint center in Germany, which increased the collaboration with GRIs, and industries locally and internationally.

In the 1st Basic S&T plan, the government Launched the Global Research Laboratory by KICOS in 2006 to solve global S&T issues using local R&D effort.

In the 2nd and 3rd Basic S&T plan, the government started Adding new fields in R&D, such as Climate change, Food Safety and other world occurring disease. KIST increased

its operations during this plan and opened new branches in the Korea and India KIST and renamed it as IKST

4.2.4.5 Industrial (large, medium, and small businesses)

4.2.4.5.1 Overview

This section will investigate the Korean economic development plans to understand the evolution of the industrial sector. The study will explore the industrial policies, incentives, major institutes, and industrial focus through the years. These policies and institutes will reveal the role of the industrial firms in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of indusial firms in building a robust innovation systems had be identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of South Korea. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the industrial sector.

The following discussion will develop an understanding of the evolution of the industrial sector and its role in developing the connectivity of the innovation systems.

4.2.4.5.2 Established government enterprises that focus on oil refineries and agricultural production

- **1962–1966 the Korean First Economic development plan (KFEDP)**

DP	NUM	Policies & Objectives	GIS	NISS	RISS	RIC
1st	1	Established several new government enterprises		→		
	2	Focused on industries such as oil refineries, cement plants, chemical plants, fertilizer plants, and agriculture products		→		

Table 108 the Korean first economic development plan (large, medium, and small businesses)

During the KFEDP plan, there was a great improvement in the industrial basis of the Korean economy; this was achieved by the establishment of several new government enterprises. These enterprises laid the cornerstone for the future Korean economic and innovation activities. The focus of the new industries at the 1960s was on oil refineries, cement plants, chemical plants, fertilizer plants, ship buildings, synthetic fiber spinning, electric appliances, and manufacturing diesel engines. (K. K. Korea (South)., 1962).

4.2.4.5.3 supported small businesses and provided incentives to export local products

- **1967–1971 the Korean Second Economic development plan (KSEDP)**

DP	NUM	Policies & Objectives	GIS	NISS	RISS	RIC
2nd	1	Established the Korean industrial standards specification to control the quality of exports	↔			
	2	Strengthened the basis of interrelated production needs between domestic industries		→		
	3	Evaluated the validity and advantages that existed industries would gain from new firms		→		
	4	Increased the promotion for industries to expand their activities and increase their export	↔			
	5	Encouraged the small and medium size investments that had a great opportunity to grow		→		
	6	Aided businesses in purchasing and selling raw materials from domestic to international market vis verse	↔			

Table 109 the Korean second economic development plan (large, medium, and small businesses)

In the KSEDP, the Korean government focused their effort on establishing a new industrial production system. The government established the Korean industrial standards specification for quality control of exported goods. The new production system focused on strengthening the basis of interrelated production needs between domestic industries. In other words, local industries were obligated to purchase their

needs from domestic product suppliers. Accordingly, the government started to create an environment where large industries gained production support from new small and medium size businesses and vice versa. The central government started to evaluate each new industrial project regarding its economic validity and the support that existing industries will gain from the new firms (K. K. Korea (South)., 1966).

The central government started to increase the promotion for industries to expand their activities and increase their export. The major products that were supported by the government during the 1960s were agriculture and textile products. Although these products were considered as primary products that didn't have any technological feature, the way that the government treated these industries in connecting local, regional, central, international activities and production together applied to similar innovative products in the future.

At the national level, there has been a transformation from basic materials and machines into new technologies in South Korea's major industrial activities.The new technology helped in creating new heavy industries that grew faster during the KSEDP. These industries were "chemical industry, chemical fertilizers, petroleum & coal, cement, metal industry, machinery industry metal working machinery, automobile, ships buildings, textile machinery communication and transportation equipment." (K. K. Korea (South)., 1966).

The Korean government encouraged the small and medium size investments that they thought had a great opportunity to grow. The government support to these industries was based on increasing their standards and technological capability to let them be capable in competing with foreign products.

These new small and medium sized industries were mainly located in the rural areas in agriculture and fishing villages. The government provided the help in purchasing the raw materials and supported them in selling their products to domestic and international customers (K. K. Korea (South)., 1966).

4.2.4.5.4 connected small businesses with large enterprises and supported rural agricultural production

- **1972–1976 the Korean Third Economic development plan (KTEDP)**

DP	NUM	Policies & Objectives	GIS	NISS	RISS	RIC
3rd	1	Provided direct tax incentives to small and medium-sized enterprises		→		
	2	Supported agriculture and textile business in rural areas		→		
	3	Searched for new markets and new customers locally and internationally	←	→		
	4	Encouraged local producers to increase their product quality by training and incentives		→		
	5	Helped modernize the facilities and developing the management techniques in existing firms		→		
	6	Promoted the alignment of small and medium size businesses with large enterprises		→		
	7	Developed small and medium size business to standardize their goods to meet the needs of large enterprises		→		
	8	Encouraged business mergers especially with companies that engaged in a cutthroat competition to encourage them to export rather than competing		→		
	9	Created the credit guarantee funds for small and medium enterprises		→		

Table 110 the Korean third economic development plan (large, medium, and small businesses)

Taxes in the KTEDP were the most important source of government revenues. In this plan, the government policy was focused on increasing the direct tax and provide tax incentives to small and medium size enterprises.

One of the major attempts to increase the tax base was to support agriculture and textile business in rural areas and support the rural economy accordingly. Although most of the rural areas' businesses in 1968 were on crops and agrarian products, these improved businesses were the core of what later became industrial and innovation clusters.

These businesses faced several difficulties such as technical and financial shortages, substandard facilities, incompetent management, and excessive competition among

industries themselves. The central government solved this problem by searching for new markets and new customers locally and internationally. However, the government faced a serious problem in low-quality products of the local producers. The government encouraged the local producers to increase their product quality by training, incentives, and helping them in exporting their products. Also, the central government helped to modernize the facilities and to develop the management techniques along with providing technical guidelines to these companies. These new policies were conducted by the "National Industrial Research Institute" and through the city and Provincial Cottage Industries Center (Korea (South), 1971).

Another major policy that the government took in the KTEDP was to promote the alignment of small and medium size businesses with large enterprises. This policy means that any small and medium-size business needs to work closely with large enterprises and the business needs to share their products, techniques, markets, and financial resources. The policy created a new clear market and support system for small and medium size businesses that allowed them to nurture and develop by supplying large enterprises with what they need. Also, the policy allowed the small and medium size businesses to standardize and develop their goods to meet the needs of large enterprises, which allowed them to compete with other products when exporting to other countries (Korea (South), 1971).

Another very important policy that encouraged the relationship between small, medium and large size enterprises was the promotion of business mergers. The merging businesses focused on companies that engaged in a cutthroat competition to encourage

them to export rather than compete. The encouragement was by extending the tax relief and extending the financial incentives to reinforce their competitive market.

Another financial incentive was the creation of credit guarantee funds for small and medium enterprises to ensure that all companies in rural and central areas have access to loans whenever needed and that these companies meet the requirements to deserve these funds (Korea (South), 1971).

4.2.4.5.5 Supported technological content products

- **1977–1981 the Korean Fourth Economic development plan (KFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Encouraged technology transfer to local industrial production using R&D	←	→		
	2	Offered tax incentives to local industries to compete with international industries	←	→		
	3	Encouraged the industries to recruit and train the employee on new technologies		→		
	4	Provided managerial training and expanded favorable atmosphere for entrepreneurs		→		
	5	Encouraged the advertisement for technological goods in overseas markets	←	→		
	6	Created S&T industrial fields such as semiconductors, computers, and related fields		→		
	7	Provided financial support to modernize small and medium business equipment		→		
	8	Provided the Highest financial advantage for the highest selling products		→		
	9	Searched for new locations in regional and local areas to relocate the existing plants		→		
	10	Created new industrial locations near ports to ease the process of exporting goods		→		
	11	Increased fair competition and encourage the private sector to adopt innovation model.		→		
	12	Completed the Daedeog research park that focuses on S&T products		→		
	13	Increased the role of R&D facilities in industrial firms		→		

Table 111 the Korean fourth economic development plan (large, medium, and small businesses)

In the KFREDP, the government started to adopt a new trend in supporting the local industries by encouraging technology transfer to adopt new technologies in local industrial production. Also, the government started to encourage R&D in local industries and increase competition between industries. To achieve these new goals the Korean government offered a bundle of new tax incentives to enhance the atmosphere for local industries to compete with international industries. Along with these policies, the government encouraged the industries to recruit and train the employee on new

technologies. To ensure the successful placement of the new workers, the government started to intensify training capabilities to local industries to employ skilled labor in these industries such as missionary, electronics, and shipping building during this plan (Korea (South), 1976).

The support for these industries was aggregated to ensure international competition. Also, the government of Korea searched for new production fields and increased its industrial basis by adding the petrochemical industries to ensure international competition.

During the KFREDP, an overseas sales office was developed, and sales engineers were spread all over the world to promote the Korean products around the world. Also, the government started several programs to promote medium and small business by providing managerial training and expanding a favorable atmosphere for entrepreneurial consultant system.

During the plan, the government started to promote electrical products and considered them as major technological goods that need to be advertised and marketed overseas. These new fields mainly included semiconductors, computers, and other related items that were considered strategically important for these goods. To support this new inclination, the government created a new R&D institution that could help in creating a creative environment for the new related industries, and the government supported it with $60 million in funds to develop its activities (Korea (South), 1976).

To help the new industries, the government created a supportive system to the new electronic and semiconductor industries. This system was based on supporting the

small, medium, and large businesses that could supply the main parts, semi-processed goods, and raw materials to the large industries.

The government produced the financial support for modernizing the small and medium businesses' equipment and provided managerial support to the new businesses. To ensure appropriate regional placement for the new small and medium size businesses, the government started to create new industrial estate agencies that could search and find new locations for regional industries. Also, the government created other R&D institutions that were responsible for quality control for these new industries after they had been placed in the new regional and urban centers.

The government also provided an incentive system to these new industries to help them in improving the marketing of their products. This incentive system was based on increasing exports to create new markets for their new products. In this supportive system, the government supported the industries that managed to market their products the most, and would accordingly gain the highest financial advantage from the government incentive system.

Because of pollution issues, the government of South Korea started to search for new locations for their existing industrial estate by searching in the regional and local areas to relocate the existing plan. Accordingly, the government started to create new industrial locations near ports to ease the process of exporting goods, such as the industrial ports of Pohang, Onsan, Yeocheon, Changwon, and Bugpyeong. In the new locations, the Korean government adopted for the first time the paradigm of innovation instead of solely technology transfer in its industrial structure. To foster innovation, the government started to increase fair competition and encourage the private sector to

adopt the innovation model. This took place by providing incentives and limiting government financial measures to increase the ability of private sector to access all services provided by the government.

The creation of the Korea Institute of Science and Technology (KIST) and the Korea Advanced Institute of Science (KAIS) during the sixties helped to foster innovation during this period. Also, the completion of the Daedeog research park in Dejon had increased the technological and scientific research capabilities in the area.

To enhance the innovation supportive atmosphere, the government increased R&D expenditure by 5% during the plan. Furthermore, the government increased the tax and financial incentives to each organization that adopted a Foreign technology.

- **1982–1986 the Korean Fifth Economic Development Plan (KFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Exempted from tax all R&D activities in intensive technological innovation industries			→	
	2	Allowed the industries to successfully allocate financial resources domestically and globally to their industrial operations		←	→	
	3	Allowed a new line of products to be exported such as ships, machinery, and other heavy industrial products		←	→	
	4	Increased the industries regulations to meet international standards and compete		←	→	
	5	Increased R&D and encouraged the industries to implement foreign technologies		←	→	
	6	continued a program to link all small and medium size companies with large enterprises		↔		
	7	Established new agencies to help develop small and medium size businesses			→	
	8	Provided buyers credit system to increase the demand for domestic products by providing incentives for all buyers		↔		

Table 112 the Korean fifth economic development plan (large, medium, and small businesses)

During KFFEDP, the government started to improve its incentive and industrial system, which developed in the sixties and seventies. The new incentives system was directed to industries that had a competitive advantage. These incentives were provided indirectly, such as special depreciation grants rather than direct tax exemptions. These incentives were provided as follows:

1- The tax exemption was provided to R&D in technological innovation intensive industries and their workforce.
2- The incentive was provided for feasibility studies for large-scale investments that were revised carefully by a board to coordinate industry, trade, and tariff policies.

In the KFFEDP, the government allowed the industries to successfully allocate financial resources domestically and globally to their industrial operations. This step forced the industries to increase the quality of their products to gain comparative advantages in the world market. In other words, the government supported the production quality of the Korean industries and upgraded their capabilities to be able to compete with the international market. The major cause for the shift in the government industrial policies was to allow innovation, technology, and business management to take place in the domestic industrial structure (Korea (South), 1982).

In this plan, the government initiated a new economic goal by allowing a new line of products to be exported, such as ships machinery and other heavy industrial products. This new system included buyers' credit systems to increase the demand for domestic products by providing incentives for all anticipated buyers.

Also, the government started to increase the automotive regulations to meet international standards to be able to compete internationally. This was mainly achieved by importing foreign technology to improve the quality of the domestic car industry.

During this plan, the government urged domestic technological industries to add value to their products by increasing R&D and implementing computers and technologies to their products to exceeds markets expectations. Furthermore, they urged the industries to

absorb foreign technology within their products. The key factors in the new model of development were achieved through research institutions (Korea (South), 1982).

- Small and medium industries:

The small and medium size companies started to gain easy access to new production technology and information. Furthermore, the government increased the financial and bank loans for industries that followed the path of increasing its production quality. The government started a program to link all small and medium size companies with large enterprises in a way that allows large enterprises to absorb all the products that were produced from the small and medium businesses. To fulfill this policy, the government started an equitable tax policy that dealt with large, medium, and small business in an equitable approach. The policy was implemented to give the opportunity to the small and medium size business to improve their quality and standards to meet large and international enterprises standards (Korea (South), 1982).

To do so, the government created "the Small and Medium Industry Promotion Corporation" and "the Korea Production Technology Corporation." The purpose of these two organization was to make sure that the new business was operating effectively and that their managerial capabilities were up to standard by guiding them.

Also, a venture capital system was introduced to the small and medium businesses by "the Technological Development Corporation." The government also intensified tax and banking policies to enlarge the activities of this new business and enlarge the businesses of local governments.

The government adopted a procedure to reduce tariff and liberalize South Korea's market. For the commodities that were produced domestically, the government created a tariff

system to allow the domestic products to gradually increase efficiency and competitiveness until the local producers could compete with foreign products. This policy allowed foreign investors to increase foreign investments and accelerate liberalization substantially (Korea (South), 1982).

4.2.4.5.6 locating new clusters near raw materials and encourage companies to open overseas offices

- **1987–1991 the Korean Sixth Economic development plan (KSIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Generated industrial jobs for rural residents		→		
	2	Encouraged knowledgeable workforce to be part of the industries		→		
	3	Restrained tax exemption and deduction expect for institution that educated the workforce in small and medium size industries in regional and local areas		→		
	4	Searched for companies that had the potential to grow faster and focused on developing them extensively		→		
	6	Encouraged international trade and reduced tariff rates gradually to increase competition	←	→		
	7	Encouraged companies to open overseas offices	←	→		
	8	Created economic zones in central, southwest and other rural areas		→		
	9	Expanded the existing industrial districts and develop new industrial parks		→		
	10	Encouraged the companies to be near the raw materials production facilities		→		

Table 113 the Korean sixth economic development plan (large, medium, and small businesses)

One of the major aims of industrial development in the KSIEDP was to focus more on Argo industries. More than 350 developments in 150 cities and counties were developed in the South Korea. The main objective of was to generate jobs for residents in the country and to spared development to local areas. To do so, the government encouraged the residents to participate in vocational training to create a knowledgeable workforce that can deal with the new technologies implemented in the agro-industry. The central government encouraged locals to participate in such vocational institute by providing living expenses to participated individuals (Korea (South), 1986).

The government restrained tax exemption, and deduction for many industrial institutions expect for institutions that were responsible for educating the workforce in small and medium size industries in regional and local areas.

During the KSIEDP the government followed a special policy that focused on choosing special companies that have a potential to grow faster and started to focus on them extensively. This focus took the shape of increased incentives and financial support. The supported companies started to conglomerate creating large enterprises; they started to dominate many markets inside and outside the Korean country. These companies had been selected from several cities and regions that can help develop the region's industrial bases. Although this policy has created strong enterprises to compete domestically and internationally, the government started to realize that it created un unhealthy environment by concentrating power in these large enterprises. These large enterprises started to rely on banks loans rather than their funds in supporting their activities. This behavior led to uneven distribution of bank loans at the hands of these large enterprises (Korea (South), 1986).

To solve this issue, the government started to increase its regulations on banks to ensure fair trade policies between industries. To eliminate the concentrated power in large enterprises, the government implemented the free market system and enforced untie monopoly regulations

- Incentives

To encourage international trade, the tariff rates had been lowered, and some trade barriers had been diminished to encourage international trade. The government started implementing import liberalization to support the country’s balance of payments.

Also, the government started to encourage companies to open overseas offices to support the relationship with other markets. Furthermore, the government started to encourage banks to funds export-import activities to achieve its major goal. The new activities were not only directed to Korea historical partners such as the United States, Japan, and Europe; it exceeds that to cover other markets in Asia, Africa, and South America.

- Development of local industry:

During KSEDP, the government started to create a favorable atmosphere for provisional areas by creating industrial firms in regional and local areas. To do so, the government created an economic zone in central and southwest regions and other rural areas the local economic zones were established to develop small and medium size cities instead of large metropolitan areas. The central government gave the power for each local government to plan and develop its economic zone. However, the funds will come from the central government through its budgetary and tax returns (Korea (South), 1986).

Furthermore, the government started expanding existing industrial districts. Many agriculture lands had transferred to a more industrialized technological industry. The government started to ease restrictive regulations on building new factories and started promoting a new system to develop industrial parks. The new system included upgrading major infrastructure in rural areas such as major roads, railways, local roads that can contribute to the new development.

The government provided a bundle of incentives to the new industries that includes tax incentives and financial support that was mainly provided for medium and small

business. Also, local banks had been encouraged to increase their capital size to be new firms.

A new policy system was directed to existing firms in large cities to relocate in rural cities by providing a national and local tax exemption for any industry that relocates in rural areas and cooperative industrial parks.

One of the major reasons that led to the government to adopt relocating firm's policy was to encourage the companies to be near the raw materials such as agro products, woods, and other local raw material. Furthermore, the government provides showrooms, outlets, and vocational training to encourage the relocation of the industry. The government also opened new branches of its institutions in these areas to ease governmental needs for these industries.

During the sixth plan, the development of the rural industrial infrastructure expanded including direct and indirect services and infrastructure. This trend was mainly supported by the government to reduce the burden on Seoul metropolitan areas and increase the balance of development between metropolitan, regional and central areas (Korea (South), 1986).

4.2.4.5.7 Transformed many industries to high technological industries

- **1992–1996 the Korean Seventh Economic development plan (KSVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Encouraged factory autonomy and training within businesses.		→		
	2	Promoted more than 5000 businesses during this plan on high technology fields		→		
	3	Increased incentives to any business spends more than 5% of their income R&D		→		
	4	Obligated large enterprises to invest 10% of their income in small and medium business		→		

Table 114 the Korean seventh economic development plan (large, medium, and small businesses)

During the KSVEDP the government increased the support to small and medium size businesses and reinvigorated R&D activities within these enterprises. The government encouraged factory autonomy and encouraged the training within these businesses. One of the major incentives that the government provided to the Small and Medium-sized businesses were ten years' support to any businesses whom their R&D spending exceeds 5% of their income. The government aimed to promote more than 5000 businesses during this plan in the fields of high technology products such as semiconductors and machinery products (Korea (South), 1992).

During KSVEDP, the government realized that the large conglomerated enterprises such as SAMSUNG had entered too many unrelated industrial production fields. The conglomerated companies' activities had weakened their ability to provide smaller parts for their assembled products. Accordingly, the government obligated the large enterprises to invest 10% of their income in small and medium sized businesses in R&D activities. This new government policy aimed to fulfill the large conglomerated businesses needs of small parts rather than importing them (Korea (South), 1992).

4.2.4.5.8 Increase information flow between domestic and international industries

- **1997-2002 South Korea Science and Technology plan (KS&TP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T	1	Supported the base of the NIS by increasing the Industrial Information technology capabilities	↔			↔
	2	Increased the awareness of implementing S&T in all industrial productions fields, Such as automobile, shipbuilding, iron, construction, and other industries.	↔			↔
	3	Allowed the flow of information between the business globally and domestically	↔			↔

Table 115 the Korean S&T development plan (large, medium, and small businesses)

During KS&TP. The government aimed to take advantage of the internet explosion and aimed to support the base of the GIS, NIS, RIS, RIC by increasing the Information

technology capabilities and capacity. The government aimed to increase its relationship with the global world to understand the world market deeply. During this plan, the government started to increase the awareness of the need to implement S&T in all current fields of industrial productions, Such as automobile, shipbuilding, iron, construction, and other products. The main reason for this new policy came because of the government understands the need for the S&T comparative advantage to be able to compete with the international markets and countries. Accordingly, South Korea started to increase its policies and spending toward R&D by driving industries to spend more on their laboratories and research institutions. The priority in the new trend of R&D enhancement was to allow South Korea to be the research hub of the Asia -Pacific regions and compete globally. To achieve this goal the government intended to digitize all its industrial activities to allow the flow of information between different parts of the business environment globally and domestically (S K Gov, 1999).

The government started to enhance its capabilities in core technologies and started to add new fields in its industrial production depending on its industrial and agricultural capabilities, such as food, medicine, and other biotechnology products. This new trend enhanced the capabilities of the Korean industry to compete on different fields globally and domestically (S K Gov, 1999).

4.2.4.5.9 Increased the role of entrepreneurs in industrial innovation activities

- **2003-2007 South Korea First Science and Technology plan (KFBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 1st	1	Increased the number of R&D facilities in small and medium size businesses		→		
	2	Increased the information to entrepreneurs to enhance their innovation capabilities		→		

Table 116 the Korean first S&T development plan (large, medium, and small businesses)

During KFBSTP**,** the enterprises increased the number of their R&D facilities in small and medium sized businesses from 9705 in 2002 into 12218 in 2006. The plan enhanced creativity in training in industrial human resources focused on increasing the innovative capabilities in the workforce. The major innovation focus was to increase all sort of information provided to new entrepreneurs to be able to compete and innovate domestically and globally (J. Mahlich & Pascha, 2012).

4.2.4.5.10 Established several agencies to support innovation in industrial clusters, signed several agreements with other countries to support trading

- **2008-2012 South Korea Second Basic S&T plan (KSBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T 2nd	1	Used tax deduction to motivate industrial facilities to increase their R&D spending		→		
	3	Invested in talented scientists and engineers who could work on emerging S&T fields		→		
	4	Created KIAT to implement policies that motivate innovation in existing industries		→		
	5	Established an industrial technology corporation between local industries	↔	→		
	6	Established KEIT as an R&D management and international corporation in S&T	↔	→		
	7	Upgraded KEIT to play a major role in developing Korea RIS by evaluating all projects and provided assistance and support R&D in clusters		→		
	8	Enforced the United States-Korea Free Trade Agreement	↔	→		
	9	Enforced the Free Trade Agreement with EU	↔	→		

Table 117 the Korean second S&T development plan (large, medium, and small businesses)

In 2008, the government announced a new strategy that changed the industrial system from individual clusters to seven regional innovation hubs in figure 12. Each area has its vision, specialized industry, GRIs, and industrial clusters. These areas were called: Metropolitan as an IT & electronic hub; Chungcheong IT electronic and related industry hub as; Honam as shipbuilding and automobile hub; Jeju as a bioindustry; Kangwon as a medical equipment industry; Daegyeong as electric and Machin industry; and Dongnam mechatronics shipbuilding and automobile industry (KICOX, 2011).

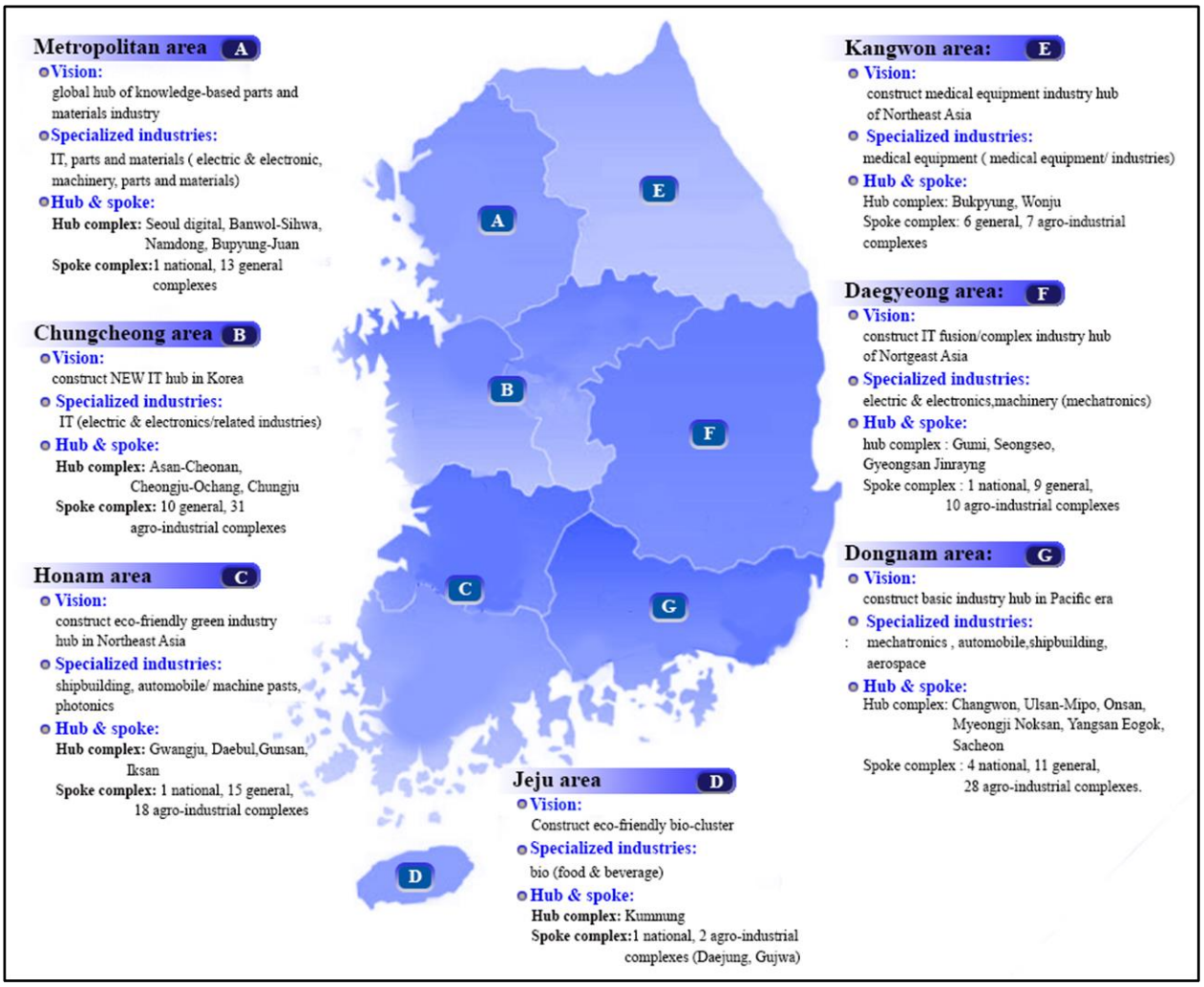

Figure 12 South Korea Major Economic and Regional Clusters (Park & Koo, 2013)

During the KSBSTP, the government of South Korea planned to increase the R&D spending by 5% of GDP in 2008. The government used tax deduction to motivate industrial facilities to increase their R&D the rate of this deduction was between 7and 10 %.

Also, the government increased its investments in strategic and emerging areas in industrial technology and national R&D. The government invested extensively in nurturing talented scientists and engineers who had the capabilities in working in the emerging fields of S&T such as the Nanotechnology. Along with this movement, the

government increases their intervening in supporting innovation by implementing more policies relating to innovation (El Qrarah, Ussenov, Rosca, Zaghdoud, & Bernichi, 2014).

The new laws were focused on developing human resources within the industries to be able to handle the innovation environment. Other laws were focused on developing the government organizational structure and S&T basic research. One of the major R&D government restructurings was on giving the authority and power to the National Science and Technology Council NSTC to coordinate and plan and evaluate science and technology policies and programs. The authority includes the budget distribution to R&D programs; this responsibility had ended in 2008 when it was handed to the Ministry of Strategy and Finance for evaluating national R&D programs and distributing their resource budget. Since 2008, NSTC has been accountable for setting the national R&D priorities, coordinating national R&D programs (NSTC, 2016).

In 2009, the Korean government created the Korea Institute for Advancement of Technology KIAT. The new organization mission was *"to realize a leading nation in innovation and technology through well-established industrial technology policy and infrastructure."*

The major role for the new organization was to implement policies that motivate innovation within existing industries and strengthening the knowledge-based economy within the country. Also, it provides information about innovation opportunities within the existing industrial clusters by being the technology information hub for both consumers and suppliers.

KIAT started drawing policies for the long and short term for its industrial activities. KIAT took the responsibility of linking the Academia along with the industry to help build a relation between the two institutions. KIAT also took the responsibility in building and industrial technology corporation between local industries, domestic research programs, and global R&D programs (KIAT, 2015).

Another institution had been created in the year 2009 as a response for the industrial promotion act was the Korea Evaluation Institute of Industrial Technology (KEIT). KEIT is a government-affiliated organization under the Ministry of Trade, Industry, and Energy. KEIT main aim was R&D management and international corporation in technology assessment. Also, KEIT took the role as a catalyst of technology infrastructure.

To be able to get the role of planning toward enhancing the environment of innovation, KEIT brought together several institutions to provide its services thoroughly. These organizations were Korea Industrial Technology Foundation; Korea Institute of Design Promotion; Korea National Cleaner Production Center; Korea Material & Components Industry Agency; the Institute for Information Technology Advancement; and Korea Institute of Industrial Technology Evaluation and Planning. This merge allowed KEIT to play a major role in developing Korea Regional innovation system; KEIT started its operation by evaluating all projects and provide assistance and support for R&D for individuals and Organizations in industrial and innovation clusters. The program that has been supported by KEIT as regional development initiatives reached 8.7 trillion WON that have been managed by cities and local governments (KEIT, 2013).

In 2012, the government of South Korea enforced “the United States-Korea Free Trade Agreement (KORUS FTA)” that was signed in 2007 to create new markets for Korean products with countless opportunities. On the other hand, the agreement opened the door wide for American companies and products to enter the Korean market (BUREAU OF EAST ASIAN AND PACIFIC AFFAIRS, 2016).

In 2011, The Korean government Signed a Free Trade Agreement with EU. The agreement eliminated the trade barriers between the countries especially on automotive, pharmaceutical, medical and electronic devices. Also, the agreement opened the market between the EU markets and South Korea market with an easy flow and access to all services and industries including venture capitals and banking loans (European Commission, 2016).

4.2.4.5.11 Decentralized industrial projects using small and medium sized businesses as a role for development

- **2013-2017 South Korea Third Five-year Basic Science and Technology plan (KTBSTP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
S&T	1	Increased the support to small and medium-size businesses that employ less the 20 persons in the local areas			→	
3rd	2	relocated government offices in the new developed RIS and RIC			→	
	3	Increased the number of international trade organizations			↔	

Table 118 the Korean third S&T development plan (large, medium, and small businesses)

In the KTBSTP, the government increased its development to the small and medium-size businesses that employ less the 20 persons in the local areas.

The government also increased the decentralized project to decrease the imbalances of payment. Moreover, the government increased the development in the provisional areas

by relocating the plant and government offices in the newly developed regional and local areas.

Now South Korea is a member of the fallowing organizations “South Korea and the United States belong to a number of the same international organizations, including the United Nations, G-20, Organization for Economic Cooperation and Development, Asia-Pacific Economic Cooperation forum, Association of Southeast Asian Nations (ASEAN) Regional Forum, International Monetary Fund, World Bank, and World Trade Organization. South Korea hosts the Green Climate Fund, an international organization associated with the United Nations Framework Convention on Climate Change. South Korea also is a Partner for Cooperation with the Organization for Security and Cooperation in Europe and an observer to the Organization of American States” (Ministry of Science, ICT and Future Planning, 2016).

4.2.4.5.12 Conclusion

In the early sixties, the major government aim was to build the industrial basis of the Korean economy. Although the focus at the beginning was in central cities and metropolitan areas, this focus changed in the early seventies and eighties to be on upgrading the regional and local areas’ industrial infrastructure by connecting all industries together.

The focus at the early stages of the Korean economy was on primary industries, such as agriculture, fertilizers, cement, chemical, and oil refiners. The major government tool for development in the sixties was by encouraging small and medium size businesses to grow, connect, and compete with the global world. The government encouraged these

industries to increase the industrial exports of raw materials to international industries. In the early seventies and nineties, the government started to add new businesses, such as Semiconductors, Electronic, shipbuilding, and automotive industries to the industrial base. The government started to provide incentives to small and medium size business to join and create large enterprises that could handle the new government business trends. These new trends encouraged technology transfer to local industries to compete with international companies with high production standards.

In the nineties, the government increased the regulations to encourage private industries to produce their technologies by encouraging them to increase research and development. The government also encouraged the companies to build relations with international partners and be part of industrial R&D activities in the Korean industries. The new policy played a major role in transforming the economy to a technology-oriented economy.

In 2008, the government implemented the policy of dividing the country into seven major hubs for technology innovation to encourage the industries to be consistent in their industrial R&D activities.

The government moved its areas of focus from one industry to another at the beginning of each plan. This government policy encouraged the same companies to chase funding and add new industries to its production. Accordingly, there were several huge companies in South Korea that specialized in different industries, such as agriculture, construction, shipbuilding, automobile, and other at the same time as HYUNDAI.

4.2.5 Horizontal institutional connectivity (educational, financial, GRIs, and industrial)

4.2.5.1 Overview

This section will explore the horizontal institutional and industrial connectivity in South Korea innovation system. This investigation will include the connectivity of the four major elements for any successful innovation system that indicated by scholars, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. These elements are the universities (UNV), monetary institutions (MON), government research institutions (GRI), and industries (IND). The search will include the major policies, incentives, organizations and the role of government in enhancing the connectivity between these institutions to develop an innovation system. In each plan, there will be a table that indicates the policies that influenced the institutional connectivity. Beside each policy there will be stars to explain the connectivity between institutions. Each plan will be headed by a categorization to explain the major vision and objective of the plan. However, some plans will not have a specific category because it continued the previous plan objective and vision. The following discussion will develop an understanding of the evolution of the institutional connectivity and its role in developing the innovation systems.

4.2.5.2 Established special advertisement informational agencies for local research and products

- **1962–1966 the Korean First Economic development plan (KFEDP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
1st	1	Established KOTRA to facilitate exporting and provide information to local GRIs and industries			*	*

Table 119 South Korea First Economic Development Plan on institutional connectivity

Table 119 shows the major step that South Korea took in the First Economic Development Plan to establish connectivity between GRIs and industrial institutions. To achieve this step, the government established the Korean Trade-Investment Promotion Agency (KOTRA). KOTRA's main aim was to facilitate exportation by providing information to local businesses and GRIs to enhance connectivity and accelerate export to international markets.

4.2.5.3 Increased monetary connection with industries through funding local products and selling public enterprises in local stock market

- **1967–1971 the Korean Second Economic development plan (KSEDP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
2nd	1	Trained the workforce on new technologies in S&T	*		*	*
	2	Enhanced exports and used the revenue to motivate the industrial infrastructure		*		*
	3	Reduced restrictive financial measures in the market and made funds accessible to businesses		*		*
	4	Sustained self-funding by selling government enterprise assets in the stock market		*		*
	5	Used tax deduction to motivate industrial facilities to increase their R&D spending		*		*
	6	Aided businesses in purchasing and selling raw materials from domestic to international market		*		*

Table 120 South Korea second Economic Development Plan on institutional connectivity

Table 120 shows how South Korea in the Second Economic Development Plan established a connectivity between four major components: university, monetary, GRI,

and industry in its early development stages. The following discussion will elaborate the policies' connectivity between each level. The first step was to establish connectivity between the university, GRIS, and industry through training the workforce on new, related technologies and equipment in the job market. The second step was to enhance exports and use the revenue in motivating the industrial infrastructure. The third step was to reduce restrictive financial measures in the market and make funds accessible to businesses. The fourth step was to establish a sustainable, self-funding monetary system by selling government enterprises as assets in the stock market. The fifth step was to use tax deduction to motivate industrial facilities to increase R&D spending. The sixth step was to provide financial support to businesses in purchasing and selling raw materials from domestic to international markets vice versa. These steps increased connectivity between the monetary system with the industrial firms and businesses.

4.2.5.4 Increase connectivity between educational and industrial systems

- **1972–1976 the Korean Third Economic development plan (KTEDP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
3rd	1	Provided direct tax incentives to small and medium size enterprises		*		*
	2	Created credit guarantees for small and medium enterprises		*		*
	3	Created vocational centers to help expand development into rural industries and communities	*			*
	4	Helped modernize the university and industrial facilities and developed their management techniques	*			*
	5	Educated and trained employees to meet the industries S&T requirements	*			*
	6	Encouraged local producers to increase their product quality by training and incentives	*	*		*

Table 121 South Korea Third Economic Development Plan on institutional connectivity

The government provided direct tax incentives and created credit guarantee funds to small and medium-sized businesses. This monetary support and connectivity between

both finance and industry helped create a new generation of businesses in the Korean economy that supported the future of the Korean innovation system.

The aforementioned policies helped create a connection between the university and industrial systems. The first policy was building vocational centers to help expand the skilled workforce into rural industries and communities. The second policy modernized the existing facilities and developed the management techniques for the industrial system using the educational system to upgrade the management system. The third policy was to educate and train employees to meet the industries' general technological requirements. The government also increased the connectivity between education, finance, and industry by encouraging local farmers to increase their product quality by supporting training in educational institutions for themselves and their workers. The government also provided incentives to enhance connectivity and encourage local agricultural producers to connect with the educational systems.

4.2.5.5 Encouraged competition and established new GRI and educational facilities in industrial clusters

- **1977–1981 the Korean Fourth Economic development plan (KFEDP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
4th	1	Created a creative environment for new, related industries using GRIs			*	*
	2	Created GRIs that is responsible for quality control for new industries			*	*
	3	Increased the role of R&D facilities in industrial firms			*	*
	4	Created vocational facilities within large industries in different regions			*	*
	5	Established GRIs in industrial clusters such as the Changwon industrial estate to create an environment of innovation within the industrial cluster			*	*
	6	Increased competition between industries by increasing production quality			*	*
	7	Increased the research funds based on research capabilities of faculty and students	*	*		
	8	Established KOSEF organization to fund the universities' research activities and provide consultation	*	*		
	9	Increased support of foreign scientists to join fellowships and post-doctoral programs	*	*		
	10	Increased support of research institutes to collaborate with research institutions globally		*	*	
	11	Transferred the current national registration tax to finance rural GRIs		*	*	
	12	Provided financial support to modernize small and medium businesses' equipment		*		*
	13	Provided highest financial advantages for the highest selling products		*		*
	14	Allowed banks to provide domestic and foreign capital to businesses with tolerated loans		*		*
	15	Increased the autonomy of financial system away from government and large corporation control and direct loans to fit new businesses and entrepreneurs needs		*		*
	16	Reduced the link between mutual loans and large corporation		*		*
	17	Required universities to be part of the industrial vocational facilities	*			*
	18	Enhanced the competition between local and international industries through liberalizing imports and transferring the GRIs with specific universities and industrial clusters into a free economic zone	*	*	*	*
	19	Established the National Science Foundation to provide incentives and financing to national, regional and international qualified scientists and engineers	*	*	*	*

Table 122 South Korea Fourth Economic Development Plan on institutional connectivity

The first step made by the government was to increase connectivity between GRIs and industry through the following policies. The first policy was to encourage technology transfer to local industrial production using R&D. The second policy was to create a creative environment in the new technological industries using GRIs. The third policy was to create GRIs that is responsible for quality control in new industries. The fourth

policy was to increase the role of R&D facilities in industrial firms. The fifth policy was to create vocational facilities within large industries in different regions. The sixth policy was to link rural GRIs with central cities projects and businesses. The seventh policy was to establish GRIs in industrial clusters such as Changwon industrial estate to create an environment of innovation within the industrial cluster. The eighth policy was to increase the competitiveness of industries by increasing production qualities (Korea (South), 1976).

The second step made by the government was to increase connectivity between education and finance through the following policies. Firstly, increase the research funds based on research capabilities of faculties and students. Secondly, establish the Korea Science and Engineering Foundation (KOSEF) organization to fund the universities research activities and provide consultation. Thirdly, increase the support to foreign scientist to join fellowship and the post-doctoral programs.

The third step made by the government was to increase connectivity between financial institutions and GRIs through the following policies. Firstly, increase the support to research institutes that collaborate with research institutions globally. Secondly, transfer the current national registration tax to finance rural GRIs.

The fourth step made by the government was to increase connectivity between the financial institutions and industry through the following policies. Firstly, provide financial support to modernize small and medium business equipment. Secondly, offer tax incentives to enhance local industries competence with international industries. Thirdly, the highest financial advantage for the highest selling products. Fourthly, allow banks to provide domestic and foreign capital to business with tolerated loans. Fifthly,

increase the autonomy of financial system away from government and large corporation control and direct loans to fit new businesses and entrepreneurs needs. Sixthly, reduce the link of mutual loans between large corporation. Seventhly, establish the Korea Technology Promotion Bank as a high-risk venture capitalist (Korea (South), 1976).

The fifth step made by the government was to increase connectivity between educational institutions and industry by enforcing universities to be part of the industrial vocational facilities.

The sixth step made by the government was to increase connectivity between the educational, financial system, GRIs, and industry through the following policies. Firstly, enhance the competition between local and international industries through liberalizing the imports and transferring the GRI with specific universities and industrial clusters into a free economic Zone. Secondly, establish the National Science Foundation to provide incentives and financing to national, regional and international qualified scientists and engineers (Korea (South), 1976).

4.2.5.6 Encouraged venture capitalist operations to be small and medium sized businesses and used tax incentives rather than direct money support

- **1982–1986 the Korean Fifth Economic development plan (KFFEDP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
5th	1	Provided tax incentives to any facilities that increase its responsibilities in training its employees	*	*		*
	2	Supported the production quality of the industries to compete with international market			*	*
	3	Improved the incentive system and reformed the industrial system that was developed in the 60s and 70s		*		*
	4	Increased the financial and bank loans for industries that increase its production quality		*		*
	5	Decrease direct spending and maximize incentives for private industries and R&D		*		*
	6	Increase policies to encourage R&D spending in private industries.		*		*
	7	Introduced venture capital system to small and medium businesses through the "Technological Development Corporation" and other banking institutions		*		*

Table 123 South Korea Fifth Economic Development Plan on institutional connectivity

The first step made by the government was to increase connectivity between education, financial, and industry by providing tax incentives to any facilities that increase its responsibilities in training its employees.

The second step made by the government was to increase connectivity between GRIs and industry by supporting the production quality of the industries to compete with the international market.

The third step made by the government was to increase connectivity between financial institutions and industry through the fallowing polices. Firstly, improve the incentive system and reformed the industrial system that was developed in the 60s and 70s. Firstly, increase the financial and bank loans for industries that increase its production quality. Secondly, decrease direct spending and maximize incentives for private industries and R&D. Thirdly, increase policies to encourage R&D spending in private industries.

Fourthly, introduce venture capital system to small and medium businesses through the "Technological Development Corporation" and other banking institutions**.**

- **1987–1991 the Korean Sixth Economic development plan (KSEDP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
6th	1	Restrained tax exemption and deduction expect for institution that was educating their workforce in small and medium size industries	*	*		*
	2	Encouraged factory autonomy and training within businesses	*	*		*
	3	Dedicated vocational training towards S&T to prepare the future generation in innovation		*	*	*
	4	Maintained all grants to GRIs that cooperates with small and medium size businesses		*	*	*
	5	Increased banks regulations to ensure fair trade policies between industries		*		*
	6	Secured jobs as a requirement for each graduate from the vocational institution		*		*
	7	Established KOICA as a government grant agency to S&T businesses		*		*
	8	Established new regional colleges and universities, especially in industrial territories	*			*
	9	Localized technological products by using GRIs in R&D			*	*

Table 124 South Korea Sixth Economic Development Plan on institutional connectivity

The first step made by the government was to increase connectivity between educational, financial institutions, and industry through the fallowing polices. Firstly, restrain tax exemption, and deduction expects for an institution that was educating their workforce in small and medium size industries in regional and local areas. Secondly, encourage factory autonomy and training within businesses.

The second step made by the government was to increase connectivity between financial institutions, institutions, GRIs and industry. Firstly, dedicate vocational training towards S&T to prepare the future generation in innovation. Secondly, maintain all grants to GRIs that cooperates with small and medium size businesses.

The third step made by the government was to increase connectivity between financial intuitions and industry through the following policies. Firstly, increase banks regulations to ensure fair trade policies between industries. Secondly, secured jobs as a requirement

for each graduate from the vocational institution. Thirdly, establish KOICA as a government grant agency to S&T businesses.

The fourth step made by the government was to increase connectivity between education and industry by establishing new regional colleges and universities, especially in industrial territories.

The fifth step made by the government was to increase connectivity between GRIs and industry by localizing technological products using GRIs in R&D in technological development.

4.2.5.7 Increased GRIs existences in Industrial Clusters

- **1992–1996 the Korean Seventh Economic development plan (KSVEDP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
7th	1	Established research complexes within industries to increase the technology and innovation			*	*
	2	Increased the competitiveness between industries by increasing production qualities			*	*
	3	Obligated large enterprises to invest 10% of their income in small and medium business		*		*
	4	Increased the autonomy of financial system away from government and large corporation control and direct loans to fit new businesses and entrepreneurs needs		*		*
	5	Reduced the link of mutual loans between large corporation		*		*
	6	Established the Korea Technology Promotion Bank as high-risk venture capitalist		*		*
	7	Enforced universities to be part of the industrial vocational facilities	*			*
	8	Increased the support to research institute that collaborates with research institute globally		*	*	
	9	Increased incentives to any business invest 5% or more on R&D spending		*	*	*
	10	Increased the connectivity between local R&D institutions and international research facilities and consumers.		*	*	*
	11	Increased the research funds based on research capabilities of Faculties and students	*	*	*	
	12	Increased the support to foreign scientist to join fellowship and the post-doctoral	*	*	*	
	13	Established the National Science Foundation to provide incentives and finances to national, regional and international qualified scientists and engineers	*	*	*	*

Table 125 South Korea Seventh Economic Development Plan on institutional connectivity

The first step made by the government was to increase connectivity between GRIs industry. Firstly, establish research complexes within industries to increase the

technology and innovation. Secondly, increase the competitiveness of industries by increasing production qualities

The second step made by the government was to increase connectivity between financial institutions and industry through the following policies. Firstly, obligate large enterprises to invest 10% of their income in small and medium business. Secondly, increase the autonomy of financial system away from government and large corporation control and direct loans to fit new businesses and entrepreneurs needs. Thirdly, reduce the link of mutual loans between large corporation. Fourthly, establish the Korea Technology Promotion Bank as high-risk venture capitalist

The third step made by the government was to increase connectivity between educational system and industry by requiring universities to be part of the industrial vocational facilities.

The fourth step made by the government was to increase connectivity between financial institutions and GRIs by increasing the support to a research institute that collaborates with research institutions globally.

The sixth step made by the government was to increase connectivity between financial institutions, GRIs, and industry through the following policies. Firstly, increase incentives to any business invest 5% or more on R&D spending. Secondly, increase the connectivity between local R&D institutions and international research facilities and consumers.

The seventh step made by the government was to increase connectivity between education, financial institutions, and GRIs through the following policies. Firstly, increase the research funds based on research capabilities of faculty and students.

Secondly, increase the support to foreign scientist to join fellowship and the post-doctoral programs

The eighth step made by the government was to increase connectivity between education, financial, institutions, GRIs, and industry by establishing the National Science Foundation to provide incentives and financing to national, regional and international qualified scientists and engineers.

- **1997-2002 South Korea Five Year Science and Technology plan (KSTP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
	1	Established the center of KIST in Gangneung industrial complexes in 2003	*		*	*
	3	Used government budgets as incentives to tie private enterprises, universities, and GRIs	*	*	*	*
	4	Enforced regional universities to increase the relationship with other industries and GRIs	*	*	*	*

Table 126 South Korea S&T Plan on institutional connectivity

The first step was to establish a branch of the Korean Institute of Science and Technology in Gangneung industrial complexes in 2003. This step helped in increasing the center connectivity with local industries. The second step was to use the government budget to provide incentives to tie private enterprises, universities, and GRIs (figure 13). The government used this policy to support operations and spending in universities to be capable of conducting researches with GRIs to upgrade industrial productions.

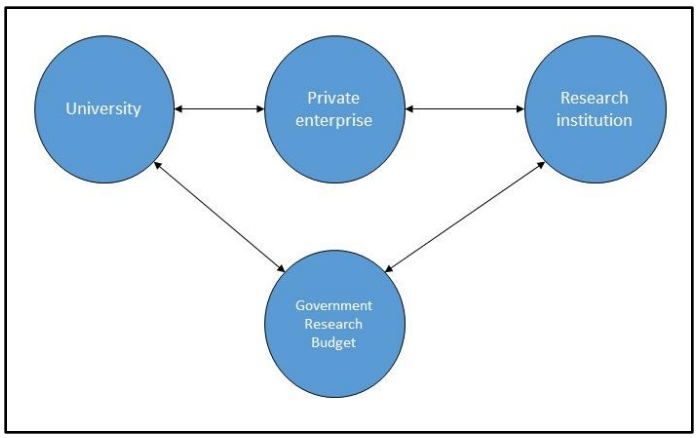

Figure 13 Institutions Budget Connectivity in R&D

4.2.5.8 Increased the connectivity between all institutions to support entrepreneurs and medium and small sized businesses

- **2003-2007 South Korea First Basic S&T plan (KFBSTP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
S&T 1st	1	Increased the number of R&D facilities in small and medium size businesses			*	*
	2	Transformed creative ideas to commercialized products by intelligent entrepreneurs			*	*
	3	Established KICOS to finance research between Korean and international universities	*	*		
	4	Founding (NRF) as a research funding system to fund research in Academic disciplines	*	*		
	5	Provided tax incentives to local businesses and encourage them to innovate		*		*
	6	Established the "Daedeok Special Zone Fund" to fund small and medium size businesses		*		*
	7	Increased the connectivity between the research institute and universities	*		*	
	8	Increased competition between industries using research and development		*	*	*
	9	Diversified the R&D source of financial investments in new economic and Innovation Zones		*	*	*
	10	Promoted S&T in all governmental, privatized, and educational institutions	*		*	*
	11	Supported the startups, research centers, research universities and creative local industries	*	*	*	*

Table 127 South Korea First Basic S&T Plan on institutional connectivity

The first step by increasing the connectivity between the GRIs and industry through two policies. Firstly, increased the number of R&D facilities and laboratories in small and medium size businesses. Secondly, transforming creative ideas into a commercialized product by intelligent entrepreneurs.

The second step was through increasing connectivity between the university and financial system. This step was achieved through two major policies. Firstly, establish the Korea Foundation of international cooperation for Science and Technology (KICOS) to finance research between Korean and international universities. Secondly, the Korean government founded the National Research Foundation of Korea (NRF), a research funding system to fund research in Academic disciplines internationally.

The third step was by establishing a connection by establishing a supportive system between the financial and industrial system through two major policies. Firstly, provide tax incentives to local businesses and encourage them to innovate. Secondly, establish the "Daedeok Special Zone Fund" to fund small and medium size businesses within the Daedeok regional and local areas.

The fourth step in increasing a relation between the educational and GRIs system by increased the connectivity between the research institute and universities in joint research and faculty and students interchange.

The fifth step was through increase the connectivity between the financial, GRIs, and industrial system through several policies. The first policy was to increase competition between industries using research and development. The second Policy was through Diversifying the R&D source of financial investments in new economic and Innovation Zones from domestic and international sources. These sources could be through private organizations, international organizations, banking institutions, or government investment nationally and internationally.

The sixth step was by Promoting S&T in all governmental, privatized, and educational institutions. The final step was by increasing the connectivity between all institutions and support startups, research centers, research universities and creative local industries.

4.2.5.9 Increased Regional connectivity between all four institutions

- **2008-2012 South Korea Second Five-year Basic Science and Technology plan (KSBSTP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
S&T 2nd	1	Increased financial support to the world class National research universities	*	*		
	2	Established an industrial technology corporation between local industries, domestic research programs, and global R&D programs by KIAT		*	*	*
	3	Upgraded KEIT to play a major role in developing Korea RIS by evaluating all projects and aided and support for R&D in clusters		*	*	*
	4	Supported the relation between education, human resources, and S&T	*	*	*	

Table 128 South Korea Second Basic S&T Plan on institutional connectivity

Table number 63 shows how did the South Korean government in the Second Basic S&T improved connectivity between the university and financial system by Increased financial support to the world class National research universities. The following discussion will elaborate the policies' connectivity between each level.

To increase connectivity between the financial system and GRIs the government establish an industrial technology corporation between local industries, domestic research programs, and global R&D programs through the Korea Institute for Advancement of Technology

(KIAT). To reinforce the connectivity the government Upgraded Korea Evaluation Institute of Industrial Technology (KEIT) to play a major role in developing Korea's RIS by evaluating all projects and provide support for R&D in industrial and innovation clusters.

The government also encouraged the relation between education, human resources, and GRIs by providing programs by providing financial support to help educational facilities to modify their programs with GRIs programs.

4.2.5.10 Directed funds to specified purposes

- **2013-2017 South Korea Third Five-year Basic Science and Technology plan (KTBSTP)**

DP	NUM	POLICY	UNV	MON	GRI	IND
S&T 3rd	1	Restricted funds on a highly competitive basis between GRIs		*	*	
	2	Provided direct funds toward new technological fields through GRIs		*	*	*

Table 129 South Korea Third Basic S&T Plan on institutional connectivity

The government increased the financial connectivity to educational institutions by Increasing incentives to all universities that are top in S&T research at the world-class ranking. Also, demonstrated this connectivity by restricting funds on a highly competitive basis between GRIs.

The government also demonstrated connectivity between the financial systems GRIs, by providing funds on a highly competitive basis to institute instead of providing funds for all GRIs in the country.

4.2.5.11 Conclusion

In the first plan, the government worked on creating an information system that could help develop the industrial and educational system. The information provided by this system would help the entire county in deciding its future trends and policies in developing the economy.

In the second plan, the government started its effort in reconstructing the industrial and educational system. The government worked on training employees, securing funds, and

promoting industries. The reconstructing process main aim was on developing the whole institution system together.

In the third plan, the major government aim was to increase training in rural areas and connect the trained workforce with new and existed rural industries to motivate rural development.

In the fourth plan, the government started to increase the network between all industries in rural and central areas with international industries and institutions. This process helped in increasing the technology transfers as one of the major government objectives of the country into South Korea. These policies helped in establishing a network between institutions that played a major role in developing the innovation system later.

In the fifth plan, the government started to review the financial sector and help them develop capabilities to be able of funding new businesses and economic activities.

In the sixth plan, the government focused more on securing financial resources for innovation related institutions. The government implemented extra policies to funds shared innovation related institutions rather than develop each sector alone.

In the seventh plan, the government started to increase the awareness of R&D and obligated all inform major innovative institutions: educational, financial, GRI, and industrial institutions to establish branches in each other's facilities and to collaborate financially. This step was important in creating a holistic approach to motivating innovation.

In the S&T plan, KIST, the major government R&D institution established a new branch in prospected innovation clusters and increased connectivity with universities and industries.

In the 1st Basic S&T plan, the government worked extensively on increasing the support for Small and medium sized businesses. The government increases the number of organizations that supported the R&D development activities in these businesses; the govern also worked on increasing their existence in new innovative and industrial clusters.

In the 2nd Basic S&T plan, the government started to increase the coordination between the educational, financial, GRI, and industry by establishing a special organization that could collaborate the effort between these institutions. The government also implemented new policies that increase the financial support for such collaboration.

In the 3rd Basic S&T plan, the government started to restrict all sort of funds on a highly competitive basis instead of opened budgets to all institutions. These funds also directed to institutions that collaborate with other industries and provides maximum advantage to the economic systems.

4.3 Saudi Arabia innovation system

4.3.1 Methodology of the Study

In the following section, a process tracing investigation will be conducted to investigate the Saudi Arabian innovation system development through the five years' economic development plan. The study will investigate five major subjects in each plan to discover if the government spending and policies can create an innovation model in developing countries. These five major subjects are the plans' major objectives, the financial system development, the educational system, the government research institutions (GRIs), and the industrial sector systems. In each system, the study will investigate the policies and objectives that affected these institutions connectivity vertically between the four major innovation systems: Global innovation system(GIS), National Innovation System(NIS), Regional Innovation System(RIS), and Regional Innovation Cluster(RIC). The study will also investigate how policies affected the connectivity between the educational, financial, research, and industrial system horizontally and led to create an environment of innovation in each of these chosen developing countries.

The study has been coded to search for major policies that affected the development of the major four systems that led to the connectivity between the institutions. These investigated elements are incentives, taxes, tariffs, intuitions, funding sources, international agreements, and government objectives and area of interests.

The country investigation will be organized into six sections each section will be investigating the five-year plan's major objectives, the financial system development, the educational system, the government research institutions (GRIs), add the industrial

sector systems and institutional connectivity policies. Each section will be investigated through the five years' development plans. In each plan, there will be a table describing the policies that affected the GIS, NIS, RIS, and RIC.

4.3.2 Saudi Arabia Overview

Saudi Arabia is considered one of the developing countries in the Middle East. Although, this county had a remarkable location in the path of the world trading between two important seas the red and the Arabian Gulf, lack of resources was a serious problem at the beginning of the twentieth century in its inception.

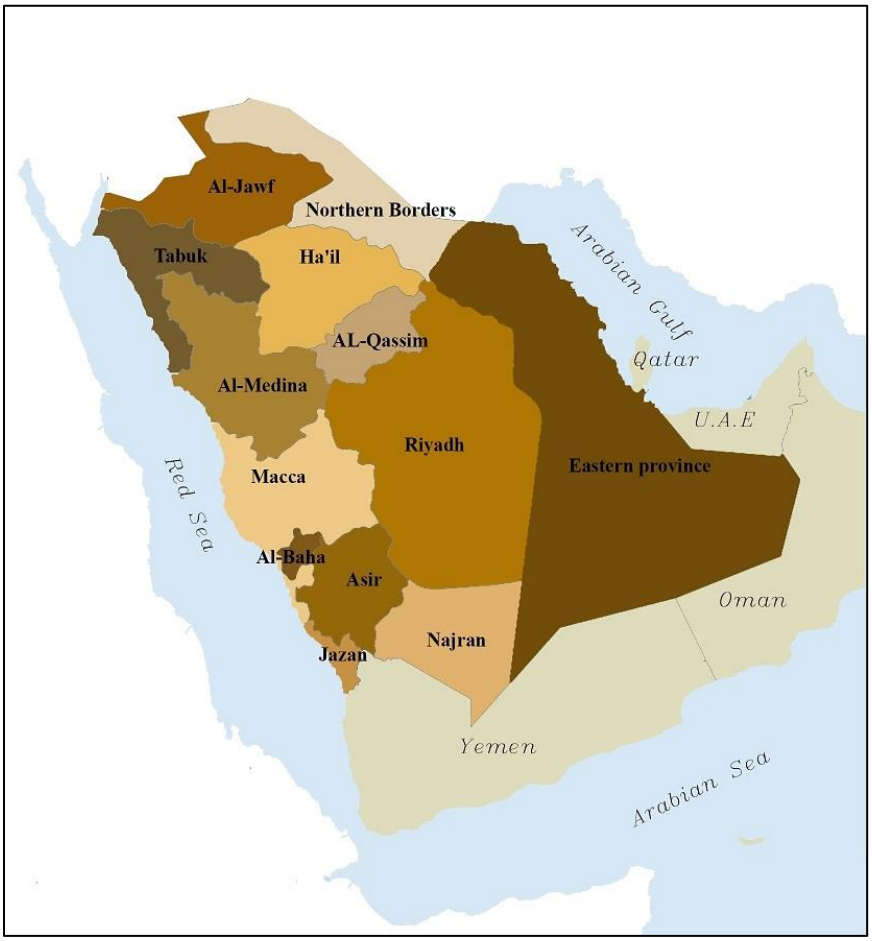

Figure 14 Saudi Arabia (http://countries.bridgat.com/Middle_East.html, 2012

This resource wasn't only food, besides that, there was a lack of money, economic, education, institutions, and basic needs. However, after the discovery of the oil in 1938, the main source of income has been created, and the spark of diversifying the resources has been initiated. The discovery of oil insured the money, and the main resource for any development in the world. In addition to the motivation to create a great economic that supported by education, institution and commercial trends.

Figure 15 shows the rapid increase in Saudi Arabia population. The residents of the country have increased from 2004 to 2011 by around 8 million individuals who are around 30% percent of its population, which calls for a need for new jobs new housing and new thinking out of the box.

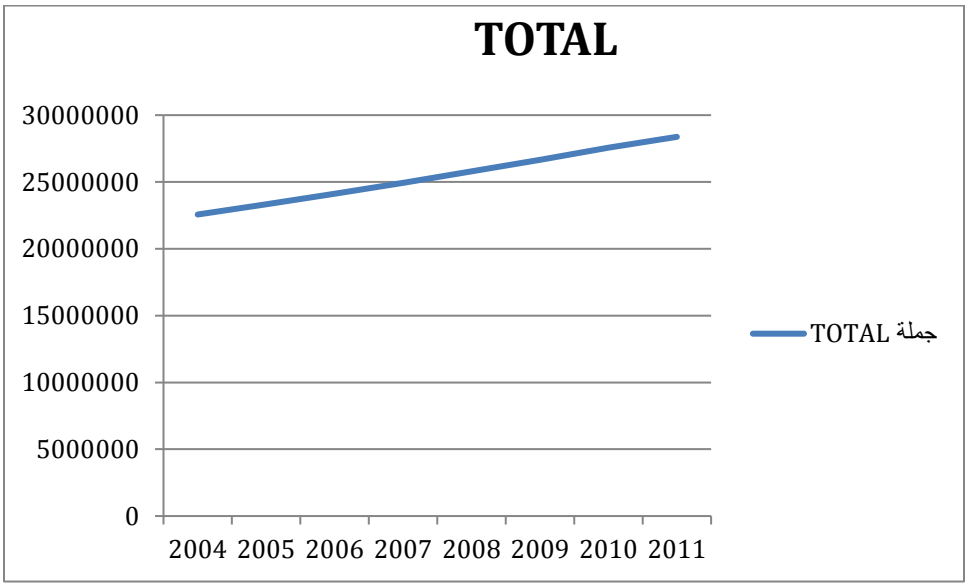

Figure 15 Saudi Arabia Population

- **The country's' Income:**

The main economic concern in Saudi Arabia was that more than 90 % of the exports are oil based. The government couldn't do anything toward solving this problem. Although,

there is the oil which means money; however, this resource is not durable and cannot ensure sustainable development in the country for the future. The fallowing graph shows that more 50 % of Domestic products are crude oil and petrochemical products. Also, many other products are services that are produced for the citizens. Thus, need to diversify the economic base of the country is mandatory.

4.3.3 Saudi Arabia Source of Economic and S&T Policies

In Saudi Arabia, the planning procedure was conducted by collecting all information and statistics from all ministries and government agencies. The information that is provided to the Ministry of Planning coordinate the needs for each ministry and implement policies and needs accordingly to be approved by the government along with its budgeting.

4.3.4 Vertical connectivity investigation between (GIS, NIS, RIS, and RIC)

4.3.4.1 Saudi Arabia evolution of its government innovation objectives toward the economy

4.3.4.1.1 Overview

This section will explore the major Saudi Arabia objectives and policies in the economic development plans from the early 1970s until now. These policies and objectives illustrate the government major principles, priorities, concerns, and new industries that helped shape the economy. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of Saudi Arabia. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models.

Each plan will have its table that explains the major policies and objectives. Moreover, at each point, there will be an arrow that shows the level of connectivity between the Global Innovation System (GIS), National Innovation system (NIS), Regional Innovation System (RIS), and Regional Innovation Clusters (RIC). These innovation systems existed in the 1980s and 1990s by famous scholar such as (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992). to indicate them at the early economic stages will explain the effect of these early policies in developing the models of innovation systems. Thus, the arrows will explain the effect and relations between the international, national, regional, and rural economy in the country at the early stages.

4.3.4.1.2 Systemizing the existed economic activities and develop it accordingly

- **1970–1975 Saudi Arabia First Economic development plan (SAFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Developed the human resources in all fields and regions		→		
	2	Diversified the countries' income instead of relying on oil		→		
	3	Supported the private initiatives to create their industries		→		
	3	Created the Saudi Industrial Bank to fund new industrial projects		→		
	4	Increased the information to industries through the Saudi statistical agencies		↔		
	5	Created a solid educational infrastructure		→		
	6	Increased the number of colleges in engineering, geology, and humanities		→		
	7	Increased the number of vocational institutions		→		
	8	Increased local worker's productivity as in Nomads and Bedouins		→		
	9	Created (Petromeen) a company that was responsible for marketing oil	↔			
	10	Created three industrial clusters		→		
	11	Encouraged private industrial initiative		→		
	12	Created the industrial development Research Center to provide consultation to private and government sector		→		

Table 130 the Saudi First Economic Development Plan (major objectives evolutions)

Before the Saudi First Economic development plan (SAFEDP) there was some moderate development in the in the economy and infrastructure. However, in the SAFEDP the development was more organized and systemized to fulfill certain objectives and goals in

specific fields. During the plan, there was no general objectives or visions. The major goal was to develop the whole economy with specific objectives in each economic sector (table 130).

During the SAFEDP, the government started to lay down the broad lines for the future government economic systemization and trends in economic developments. The major goal was to develop the human resources in all fields and regions to increase their productivity and allow them to be part of developing the countries' industrial infrastructure. The second major goal was to diversify the countries' income instead of relying on oil as the major source of income (Saudi Arabia, Ministry of Planning, 1970). To achieve these goals the government intended to support the private initiatives to create their industries. During the seventies, many people had not got the financial ability to invest heavily in industrial projects. Thus, the government created the Saudi Industrial Bank to fund new industrial projects and give the opportunities to entrepreneurs to create their new industries. These policies were developed to serve local and central areas and connect their input and outcome together. Furthermore, the government decided to increase the information provided to these industries through the Saudi statistical agencies to increase the efficacy of the future industrial projects. The information that was provided to the anticipated industries helped the investors and businessmen to industry to take the decision in developing their industries (Saudi Arabia, Ministry of Planning, 1970).

Education:

During the seventies, the government aimed to build a solid educational infrastructure by increasing the opportunities for individuals to complete their education. The government

decided to increase the number of colleges in several areas such as engineering, geology, and other humanities fields. The new colleges were developed and located in major cities in Saudi Arabia in central, western, and eastern regions. Furthermore, the government decided to increase the In In the first plan, the tendency toward increasing local worker's productivity accompanied by encouraging Nomads and Bedouins to settle in larger cities and villages, which was achieved in later years. These policies were developed to serve local and central areas and connect their input and outcome together.

Industries:

During the plan, the government focused on creating new industries beside agriculture to diversify its income, some of these industries were:

1- "Oil refinery
2- Petrochemical industries
3- And transformative production"

To support these industries the government created a company that was called (Petromeen), this company was responsible for marketing these products in the global market. Petromeen job was between local industries and international market in oil, gas, and other related fields (Saudi Arabia, Ministry of Planning, 1970).

To support the transformative industries the government created three industrial clusters in the three major cities Riyadh in the central region; Jeddah in the Western region; Dammam in the Eastern Region. Within these cities, the government encouraged the private initiative by creating offices to provide consultation to any industries that want to be part of their industrial structure.

In 1966, the government created the industrial development Research Center to provide consultation to private and governmental industrial facilitates regarding the production process and managerial advice (Saudi Arabia, Ministry of Planning, 1970).

4.3.4.1.3 Invested in large projects such as gas and oil, encouraged private initiatives in agriculture and food production, and support the connections with the international market

- **1976–1980 Saudi Arabia Second Economic development plan (SASEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Diversified the economic and income based		→		
	2	Increased the workforce training in each region based on its specific needs		→		
	3	Invested heavily in large projects such as gas and oil and encouraged smaller firms to invest in agriculture, and food		→		
	4	Provided loans and research assistance to investors through national laboratories		→		
	5	Developed the private industry, the government maintained an open economy to import high technological machines from advanced countries	↔	↔		
	6	Signed several cooperation agreements with countries such as the U.S, the UK, Sweden, Turkey, and Finland, to assist the national effort	↔	↔		

Table 131 the Saudi Second Economic Development Plan (major objectives evolutions)

In the second economic development plan the SASEDP, the government continued its plan to diversify its income by relying on natural resources in each region. Accordingly, the government decided to pay extra attention to each region's natural resources and increased the workforce training in each region based on its specific needs. However, the major focus was on gas, minerals and oil production (Saudi Arabia, Ministry of Planning, 1976).

The government aim was to invest heavily in large projects such as gas and oil production and encourage individuals and smaller firms to invest in agriculture, food, and other smaller industries. To help other investors, the government provided loans and research assistance to investors through national laboratories. The laboratories assisted in

agriculture production to allow the country's self-sufficiency in major goods such as grains and wheat.

To help develop the private industry, the government maintained an open economy to import high technological machines from advanced countries. Conversely, other countries accepted local Saudi goods without high taxes or tariffs such as oil and gas. The government signed several cooperation agreements with countries such as the U.S, the UK, Sweden, Turkey, and Finland, to assist the national effort in developing the economy and the self-reliance on its resources (Saudi Arabia, Ministry of Planning, 1976).

- **1981–1985 Saudi Arabia Third Economic development plan (SATEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Split the country into five major regions: north, west, south, east, and center		→		
	2	Continued supporting the free economy and diversified the economic income base		→		
	3	Increased the country's effort in training and educated the workforce to Increase local growth		→		
	4	Increased and upgraded the existed vocational and educational facilities to be capable of coping with new technologies		→		
	5	Focused on regions that had the capability to grow using their natural resources		→		

Table 132 the Saudi Third Economic Development Plan (major objectives evolutions)

To help distribute the government income to all areas and intensify the focus on each region regarding services and economic development. The government split the country into five major regions: north, west, south, east, and center.

During the Saudi Arabia Third Economic development plan SATEDP, the government continued supporting the free economy and diversification of the economic income base. Moreover, decreasing the dependence on oil as a major source of income was still the main government issue during this plan. Accordingly, the government realized that it still needs to increase its effort to train and to educate the workforce to support local growth. To achieve this goal the government increased and upgraded its existing vocational and

educational facilities to be capable of coping with new technologies. The new workforce and facilities that the government supported this plan were directed to support four major fields: oil, agriculture, mining, and hydrocarbon production. The new government policies were directed to the regions that had the capability to grow using their natural resources (Saudi Arabia, Ministry of Planning, 1980).

- **1986–1990 Saudi Arabia Fourth Economic development plan (SAFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Continued to conduct free economic	↔			
	2	Allowed the free importation of goods	→			
	3	Focused on agriculture and industrial production		↔		
	4	Encouraged private companies to build a relationship with the neighboring countries	↔			
	5	Created the product quality measurement agency		↔		
	6	Encouraged the importation of new technologies and technical workforce	→			

Table 133 the Saudi Fourth Economic Development Plan (major objectives evolutions)

During the Saudi Arabia Fourth Economic development plan SAFREDP, the Saudi Arabian government continued to conduct free economic and market policies. The government allowed the free importation of goods without any administrative or tariff barriers to make sure that free trade was a priority. In higher education, the number of students had increased to reach 86194 in 1985. As a result of the previous plan's policies, the agriculture and wheat production had increased to reach 1.3 million tons.one of the major agriculture products are dates. Dates production reached 440,000 tons because of the new technologies and research that were adopted by the government (Saudi Arabia, Ministry of Planning, 1984).

In the SAFEDP, the government emphasized the importance of decreasing the reliance on oil production income and diversifying the economic base. Accordingly, the government

searched for an alternative by focusing on agriculture and industrial production and increased its mineral investigation activities.

The government also started to encourage private companies to build a relationship with the neighboring countries, especially in the Arabian Peninsula to get an advantage of the markets in these countries. To be able to compete with other products around the world, the government worked on increasing the quality of its public and private products through the creation of a product quality measurement agency. Also, the government encouraged the importation of new technologies and technical workforce that were capable of operating and succeeding in the new government objectives (Saudi Arabia, Ministry of Planning, 1984).

- **1991–1995 Saudi Arabia Fifth Economic development plan (SAFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Increased the relationship with international countries regarding trade, industry, and R&D	⟷			
	2	Increased its effort in training the workforce on technical capabilities		⟷		
	3	Supported the technical infrastructure by supporting the technical institutions		→		
	4	Provided equal distribution of income based on the population size		⟷		
	5	Invested heavily in basic equipment and infrastructure in major industrial cities		→		
	6	Transformed the Technology Innovation Council to the King Abdul-Aziz City for Science and Technology (KACST)		*		
	7	Increased the production of supplement products		→		

Table 134 the Saudi Fifth Economic Development Plan (major objectives evolutions)

The major objective in the Saudi Arabia Fifth Economic development plan SAFFEDP was to increase the relationship with international countries regarding trade, industry, and R&D collaboration. To achieve this goal, the government increased its effort in training the workforce on technical capabilities to be able to absorb the new technologies. Thus, the government supported the technical infrastructure by supporting the technical institutions' capabilities and by building more branches in several rural areas.

To increase the international collaboration, the government increased the integration between the country and the Gulf Cooperation Council, which included six neighboring countries: Oman, Kuwait, Qatar, Bahrain, United Arab Emmaites and itself.

The second most important objective was to secure equal opportunities in different parts of the country by providing equal income distribution based on the population size.

The government also aimed to invest heavily in basic equipment and infrastructure in major industrial cities and in agriculture production to fulfill the country's major needs.

During the SAFFEDP, the government paid extreme attention to technical activities by transforming the Technology Innovation Council to the King Abdul-Aziz City for Science and Technology (Saudi Arabia, Ministry of Planning, 1990).

The government also encouraged collaboration between single industries and foreign companies to increase productivity and product quality.

The industrial focus was on the products that required power consumption to be produced, such as petrochemicals and hydrocarbons. Also, the government increased the production of supplement products, such as plastics and aluminum to increase its economic base. To be able to export these products freely the government started to sign several agreements with other countries to eliminate trade barriers and reduce tariffs on competitive products (Saudi Arabia, Ministry of Planning, 1990).

4.3.4.1.4 Increased the growth of the local economy

- **1996–2000 Saudi Arabia Sixth Economic development plan (SASIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Diversified the industrial production felids		→		
	2	Improved the local product share percentage		↔		
	3	Increased non-oil exports	←			
	4	Trained and increased the productivity of the workforce		→		
	5	Ensured equal development and income distribution through all parts and regions of the country		→		
	6	Focused on agriculture and industry in diversifying the country's economy.		→		
	7	Increased mining activities and investments		→		
	8	Increased the capacity of the technical and vocational institutions		→		
	9	Joined the GATT agreement	↔			

Table 135 the Saudi Sixth Economic Development Plan (major objectives evolutions)

By the end of the Saudi Arabia Sixth Economic development plan SASIEDP, there were several improvements in Saudi Arabia's economic base to diversify the industrial production felids. The first improvement was the non-oil production, which increased four times since the first economic development plan. The second improvement was the local product share percentage, which increased from 53 % to 67% by the end of the fifth plan. The third improvement was in increasing non-oil exports from 8% at the beginning of the fifth plan to 21% by the end of the plan. The fourth improvement was the increasing in agriculture production by six times from what it was in the first plan (Saudi Arabia, Ministry of Planning, 1995).

In the SASEDP, there were several major objectives that affected the connectivity between the different government and international institutions and innovation systems. These objectives are as follows:

1- Train and increase the productivity of the workforce to be able to compete and succeed in the job market

2- Ensure equal development and income distribution through all parts and regions of the country
3- Focus on agriculture and industry in diversifying the country's economy
4- Increase mining activities and investments
5- Increase the capacity of the technical and vocational institutions in detailed technical fields.

The government of Saudi Arabia also signed the GATT agreement. The GATT was a consortium of 125 countries that reduced the countries' tariffs to be between %5.5 and %6.5 in 1995 (Saudi Arabia, Ministry of Planning, 1995).

4.3.4.1.5 Encourage technological innovations in industries through incentives

- **2001–2005 Saudi Arabia Seventh Economic development plan (SASVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Freed the trading system from high taxes and high tariff	→			
	2	Encouraged technological innovation as a primary driver in public policy		→		
	3	Encouraged private industries to build their research facilities			→	

Table 136 the Saudi Seventh Economic Development Plan (major objectives evolutions)

During the Saudi Arabia Seventh Economic development plan SASVEDP, the government started to increase its effort to deal with globalization, which started to occur around the world. Globalization is "the process of international integration arising from the interchange of world views, products, ideas, and other aspects of culture." The country was obligated to free its trading system from high taxes and the tariff on industrial, agricultures, and other products (Saudi Arabia, Ministry of Planning, 2000). To be able to compete internationally, the government for the first time started implementing new policies that encourage technological innovation as a primary driver in

public policy, such as financial, industrial, educational, and research institution policies. The government started to encourage private industries to build their research facilities. However, many industries preferred imported technology rather than developing their own. The major problem was the lack of connectivity between central research centers and industries (Saudi Arabia, Ministry of Planning, 2000).

4.3.4.1.6 Changed the economy to a knowledge-based economy

- **2006-2010 Saudi Arabia Eighth Economic development plan (SAEIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
8th	1	Distributed equal development to all regions			→	
	2	Decreased the technology gap	↔			
	3	Provided scholarships to qualified candidates	←		→	
	4	Changed the economy to a knowledge-based economy			→	
	5	Focused on developing products that have a "competitive advantage."			↔	
	6	Focused on agricultural products that do not need much water			→	
	7	Established new clusters to absorb the incoming foreign investments			→	
	8	Developed the managerial capability in GRI's			→	
	9	Encouraged the industrial bank to increase its support to industries			→	
	10	Signed several free trading zones with foreign countries	↔			
	11	Created the Human Resource Development Fund			→	

Table 137 the Saudi Eighth Economic Development Plan (major objectives evolutions)

During the Saudi Arabia Eighth Economic development plan SAEIEDP, the government realized that the importance of the primary materials and natural resources, such as oil was starting to decrease. Furthermore, the government realized that creating a country consortium and free zones were starting to increase worldwide, which led to a very important step in coping with the international change, especially in the technology and innovation field. Accordingly, one of the major goals of the Saudi government was to decrease the technology gap nationally and internationally (Saudi Arabia, 2005). Nationally, they decreased the technology gap by ensuring that all regions and areas have their share of development and all citizens have access to quality education and technical

training. Internationally, they decreased the technology gap by ensuring that the country was up to date in international technological innovation. The government provided scholarships to qualified candidates to complete their education in all fields and ensured the companies and GRI's have access to new technologies.

During this SAEIEDP, the government aimed to change the economy to a knowledge-based economy where it relies on knowledge and technological research to build itself. Accordingly, the government focused on all products and services that have a "competitive advantage," such as information technology and other transformative materials. In the SAEIEDP, the government considered the small and medium size business as a cornerstone in archiving the knowledge-based economy. Also, the government decided to focus more on agricultural products that do not need much water and have a competitive advantage in it (Saudi Arabia, Ministry of Planning, 2005).

During the SAEIEDP, the government decided to establish new spaces to absorb the incoming foreign investments. The government also decided to provide an organizational, law, and policy environment to sort and arrange these investments. Furthermore, the government decided to organize all investment activities within governmental institutions to be capable of handling and managing the new investments. (Saudi Arabia, Ministry of Planning, 2005).

The government aimed to develop the managerial capability in GRIs to develop innovation and technology activities. The government also started to increase the awareness of innovation in the society and provided extra incentive and support to new ideas and talented students (Saudi Arabia, Ministry of Planning, 2005).

The government also encouraged the industrial bank to increase its support to industries that were willing to invest in research and development extensively. The government created The Human Resource Development Fund to fund all organizations that are willing to employ citizens in their facilities.

The government also aimed to sign several free trading zones with the European Union and the Arabian Gulf Countries (Saudi Arabia, Ministry of Planning, 2005).

4.3.4.1.7 Increased small and medium sized businesses support especially in innovation activities

- **2011-2015 Saudi Arabia Ninth Economic development plan (SANEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
9th	1	Ensured equal distribution of development in regions		→		
	2	Increased productivity and knowledge through advanced technical education		→		
	3	Transformed the society to a knowledge-based society		→		
	4	Increased industrial foreign and local investments		→		
	5	Supported the small and medium sized businesses		→		
	6	Increased the role of women in developing the economy		→		
	7	Depend on the relationship between the private and public sector		↔		
	8	Increased the investments in R&D in different fields and areas		→		
	9	Encouraged family enterprises to diversify their business		→		
	10	Invested in technology transfer to develop it locally		↔		
	11	Established clusters of related products		↔		
	12	Increased investments on innovation		→		
	13	increased the competitive advantage of products	↔			
	14	Supported the exports through the Saudi Fund for Development Agency	↔			

Table 138 the Saudi Ninth Economic Development Plan (major objectives evolutions)

The first major objective during the Saudi Arabia Ninth Economic development plan SANEDP was to ensure that there was an equal distribution of development between all territories and areas. The second major objective was to increase the workforce productivity and knowledge through advanced education in all technical and technological fields. The third major objective was to transform the society into a knowledge-based society that applied information technology in all its economic fields.

The fourth major objective was to increase the connectivity between foreign and local private investments in the industrial base and production (Saudi Arabia, Ministry of Planning, 2010). The fifth major objective was to support the small and medium size businesses so they could play a major role in the local economy (Saudi Arabia, Ministry of Planning, 2010).

To achieve these objectives, the government aimed to implement new policies toward the economy and make it more effective in dealing with the new economic trends. The first policy was to decrease the development gap between all regions of the country. The second policy was to increase the role of women in developing the economy by allowing them to take part in leading companies in the country. The third policy was based on deepening the relationship between the private and public sector to increase the economic productivity; Increase the country's effort in diversifying the economic base, and Increase the knowledge economy content in education levels and all regions and economic activity. The fourth policy was to build clusters of related products to increase productivity between cross related industries (Saudi Arabia, Ministry of Planning, 2010). The fifth policy was to increase their investments on innovation as a major part of the economic development, especially through small and medium size businesses. The sixth policy was to increase the investments in R&D in different fields and areas, especially in the areas that would enhance the industrial productivity. The seventh policy was to increase the technological components of the country's exports rather than relying on traditional products without any technological content such as dresses, food, jewelry, metal, plastic, and oil. The eighth policy also aimed to increase the investments in technology transfer to develop it locally in industrial infrastructure and information

technology. The government also encouraged family enterprises to diversify its business and increase their investments by entering the stock market. In its side, the government started to sell parts of enterprises in the stock market (Saudi Arabia, Ministry of Planning, 2010).

In the SANEDP, the government aimed to increase the competitive advantage of products that relied on innovation to be able to compete with foreign products. The government also continued to provide all kinds of support to the exports through the Saudi Fund for Development Agency (Saudi Arabia, Ministry of Planning, 2010).

4.3.4.1.8 Conclusion

The major government focus in the first economic development plan was to systemize the whole government system to be able to deliver adequate services to all the economy. In 1975, the government started to increase its investments in large projects such as gas and oil. The government also encouraged private initiatives in agriculture and food production in rural areas, and supported the connections with the international market. The same government trends and objectives continued in the following years. In 2001, the government started to implement to new objectives that aimed to encourage technological innovations in industries through incentives. In 2006, the government adopted the knowledge based economy model and increased the support for all educational infrastructure and R&D activities. In 2011, the government prioritized the support for small and medium sized businesses especially in innovation activities.

4.3.4.2 University + Higher educational system

4.3.4.2.1 Overview

This section will investigate the Saudi economic development plans to understand the evolution of the university system. The study will explore the University system policies, incentives, major institutes, and educational focus through the years. These policies and institutes will reveal the role of the industrial firms in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of university system in building a robust innovation systems had be identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of Saudi Arabia. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the university sector. The Saudi government increased its policies to establish new universities in rural areas (Figure 16). The following discussion will develop an understanding of the evolution of the industrial sector and its role in developing the connectivity of the innovation systems.

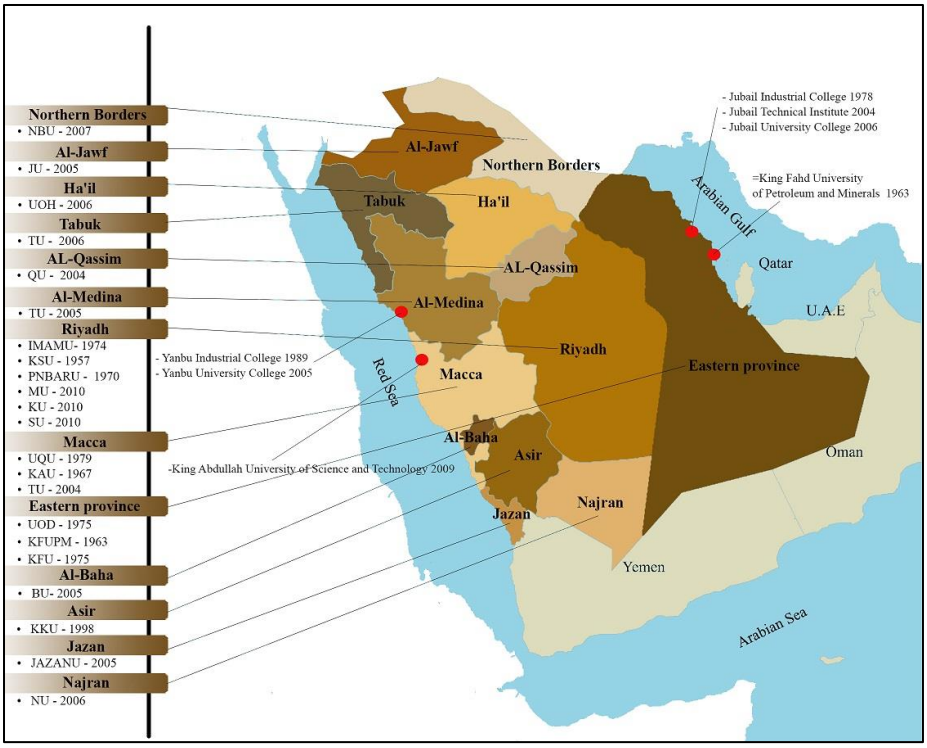

Figure 16 Saudi Arabia's government university distributions- combined by the researcher

4.3.4.2.2 Supported the existing universities with new colleges and increased the number vocational institutions

- **1970–1975 Saudi Arabia First Economic development plan (SAFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Increased the capabilities of local individuals by creating vocational institutions		→		
	2	Increased the number of colleges within existing universities instead of increasing the number of high educational institutions		→		
	3	Increase the productivity and knowledge atmosphere within institutions and put government spending on education under control		→		

Table 139 the Saudi First Economic Development Plan (educational institutions policies)

There were seven existed universities existed before the Saudi first economic development plan SAFEDP was initiated. One of these universities was called the college of petroleum and minerals and was initiated in 1963. The college was important because it was the major source of knowledgeable workforce in oil production, the major

source of the country's revenue. In SAFEDP, the government aimed to increase the capabilities of local individuals by creating vocational institutions using the central government funds. The government started to increase the numbers of industrial vocational institutes in several regions in six additional regions along with the four existing institutions to increase capabilities of the working force in rural areas. During the SAFEDP, the government main intention was to increase the number of colleges within existing universities instead of increasing the number of high educational institutions. The major aim of this policy was to increase the productivity and knowledge atmosphere within institutions and put government spending on education under control (Saudi Arabia, Ministry of Planning, 1970).

4.3.4.2.3 Increased the number of Saudi scholars in international universities

- **1976–1980 Saudi Arabia Second Economic development plan (SASEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Increased the number of buildings and classrooms within existed universities		→		
	2	Increased vocational institutions facilities to be able to accommodate more individuals in its system		→		
	3	Created the Institute of public administration to be able to train public employees on how to deal with managerial, industrial, and financial issues		→		
	4	Sent scholars to foreign countries to learn how to handle advanced technologies	↔			

Table 140 the Saudi Second Economic Development Plan (educational institutions policies)

During the Saudi Arabia Second Economic development plan SASEDP, the major aim of the government was to cope with the increased number of public-school graduates and to fit them in the university system. Accordingly, the government took the burden of increasing the number of buildings and classrooms within existing universities. Furthermore, the government took the same step in increasing vocational institutions facilities to be able to accommodate more individuals in its system.

The government created the institute of public administration to be able to train public employees on how to deal with managerial, industrial, and financial issues. The government now runs six vocational regional branches to train employees in different central and local areas.

For scholars to gain sufficient knowledge and training techniques the government started to send them to advance countries so, the scholars could handle advanced technologies (Saudi Arabia, Ministry of Planning, 1976).

4.3.4.2.4 Increased the number of agricultural colleges

- **1981–1985 Saudi Arabia Third Economic development plan (SATEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Increased the number of vocational institutions from 9 to 26 branches in all regions		→		
	2	Fulfilled the current industrial and agriculture needs with qualified workers		→		

Table 141 the Saudi Third Economic Development Plan (educational institutions policies)

The major concern during the Saudi Arabia Third Economic development plan was to increase the number of individuals attending public schools and vocational institutions. Accordingly, the government increased the number of vocational institutions from 9 to 26 branches in all regions. The focus was to fulfill the current industrial and agriculture needs with qualified workers.

During this time, the government had seven major universities around the country that had a combination of humanities and engineering branches (Saudi Arabia, Ministry of Planning, 1980).

4.3.4.2.5 Increased rural colleges that connects to central universities

- **1986–1990 Saudi Arabia Fourth Economic development plan (SAFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Aligned the educational outcomes with the labor market		⟷		
	2	Provided financial incentives to businessmen who trained new graduates		→		
	3	Increased the number of higher educational institutions in rural areas and connect them with the central universities in the major cities		⟷		
	4	Applied science in hydrocarbons production using universities as one of the R&D tools		→		

Table 142 the Saudi Fourth Economic Development Plan (educational institutions policies)

During the Saudi Arabia Fourth Economic development plan SAFREDP, the government's major concern was how to align the educational outcomes with the labor market. To solve this problem, the government started to produce financial incentives to businessmen in the private sector to provide training programs to new graduates. The new step was aimed to fit the new graduates to the job market through these new training programs. Moreover, the government started to change the vocational and technical curricula to be compatible with the job market.

The private institutions started to train the private sector. However, the public system during this period still relied on the major universities to meet the needs of the knowledgeable job market. The private institutions also relied on the vocational institutions, but they focused more on technical training. Accordingly, the government started to implement policies to increase the number of higher educational institutions in rural areas and connect them to the central universities. The reason for this policy was to get the most from each faculty member by having them teach in rural and central areas instead of building new universities.

Another major policy that was implemented during the plan was the participation of the Saudi universities in R&D in the field of applied science in hydrocarbons production (Saudi Arabia, Ministry of Planning, 1984).

4.3.4.2.6 Established new technical colleges

- **1991–1995 Saudi Arabia Fifth Economic development plan (SAFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Ensured that higher educational service is distributed equally through all university and vocational institutions			→	
	2	Connected high educational, technical institutions with the job market		↔		
	3	Increased the university research productivity		↔		
	4	Created new technical colleges to provide diplomas in technical areas			→	

Table 143 the Saudi Fifth Economic Development Plan (educational institutions policies)

One of the major objectives of the government during the Saudi Arabia Fifth Economic development plan SAFFEDP was to ensure that higher educational service is distributed equally through all university and vocational institutions to ensure the quality of education provided through these intuitions.

The government also aimed to connect all high educational intuitions with the job market especially in technical fields. The government aimed to increase the university research productivity by connecting and allowing government intuitions to collaborate with universities in consultations activities and research. However, research expenditure was still limited and was not the major objective of the decision makers, which hindered the graduate programs' growth in the country.

The government started to create new technical colleges to provide diplomas in specific technical areas such as a computer, electronic, and electrical fields (Saudi Arabia, Ministry of Planning, 1990).

- **1996–2000 Saudi Arabia Sixth Economic development plan (SASIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Reorganized the educational system		→		
	2	Increased the numbers of colleges in the country		→		

Table 144 the Saudi Sixth Economic Development Plan (educational institutions policies)

During the Saudi Arabia Sixth Economic development plan SASIEDP, the government started to focus its effort on teaching and educating policies along with physical educational and vocational institutions. The education system was split into four parts as follows:

1- General education: where public education occurs from kindergarten until high school and colleges that are responsible in graduating public school teachers.
2- Higher education: this part includes universities and other colleges.
3- Training and technical education: This is the part that specializes in training and technical education for both the public and private sector.
4- Science and technology: this is the part that specializes in educating high school graduates in the fields that required detailed workforce in specific high technological branches

During the SASIEDP, the government increased the numbers of colleges that were connected directly to each ministry and distributed them in all regions and territories. For instance, the colleges that were related to the ministry of health reached 41 colleges (Saudi Arabia, Ministry of Planning, 1995).

4.3.4.2.7 Allowed private investments in higher educational institutions

- **2001–2005 Saudi Arabia Seventh Economic development plan (SASVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Allowed private investments to create private higher education institutions		→		
	2	Established the eighth university in the country in the southern region		→		

Table 145 the Saudi Seventh Economic Development Plan (educational institutions policies)

During the Saudi Arabia Seventh Economic development plan SASVEDP, the government allowed for the first-time private investments to create private universities, colleges, and higher education institutions in all regions and territories. The government accompanied this announcement by initiating a special regulation that controlled the industry in the following years. Furthermore, the government began the eighth government-funded university in the country that was in the southern region to serve the territories that had not gotten enough attention in the past years (Saudi Arabia, Ministry of Planning, 2000).

4.3.4.2.8 Created valley parks and incubators in several rural and central universities

- **2006-2010 Saudi Arabia Eighth Economic development plan (SAEIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
8th	1	Created new incubators in universities and increased R&D spending		→		
	2	Encouraged the creation of technology valleys and parks in universities		→		
	3	Increased connectivity of the local vocational institutions with other ones internationally	↔			
	4	Encouraged the private sector to build their technological colleges and vocational institutions		→		

Table 146 the Saudi Eighth Economic Development Plan (Educational institutions policies)

At the beginning of the Saudi Arabia Eighth Economic development plan SAEIEDP, the number of research centers in universities had reached 57 centers in the field of

agriculture, water, environment, engineering, humanities, and health (Saudi Arabia, Ministry of Planning, 2005).

To achieve the knowledge-based economy, the government aimed to create new incubators in universities and increase R&D spending. The governments also encouraged the creation of technological valleys and parks in main regions and encouraged technological transformations to these parks nationally and internationally (Saudi Arabia, Ministry of Planning, 2005).

During the SAEIEDP, the number of technical colleges had reached 24 around the country. The government aimed to increase the number of these technical colleges to 50 in the following years. To achieve this goal, the government urged the educational and training institutions that were responsible for these colleges to increase its connectivity with other vocational institutions around the world.

The government also encouraged the private sector to build their technological colleges and vocational institutions (Saudi Arabia, Ministry of Planning, 2005).

4.3.4.2.9 Created the first R&D based King Abdullah S&T University that focuses on renewable energy

- **2011-2015 Saudi Arabia Ninth Economic development plan (SANEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
9th	1	Increased the number of the public-led universities		→		
	2	Increased the presence of R&D infrastructure in all new universities		→		
	3	Encouraged vocational institutions to accept all high school students		→		
	4	Obligated new universities to provide new technologies to local societies		→		
	5	Increased the number of incubators and technological valleys		→		
	6	Encouraged universities to expand their branches		→		
	7	Increased the higher technology grants and scholarships inside the country		→		
	8	Created new research facilities in the universities that aimed to achieve the general government goals		→		
	9	Increased investment in the higher education sector		→		
	10	Created the R&D based King Abdullah Science and Technology University	↔			
	11	Allowed the exchange of scholars and faculty members to other countries	↔			

Table 147 the Saudi Ninth Economic Development Plan (Educational System Policies)

During the Saudi Arabia ninth economic development plan SANEDP, the government increased the importance and awareness of the knowledge-based economy through several educational facilities. To increase the efficiency of the new economic theme, the central government increased the number of the public-led universities in regional and central cities to reach 28 universities from 8 universities, which they only had for many years. The government increased the presence of R&D infrastructure in all new universities as a primary component of the new universities facilities (Saudi Arabia, Ministry of Planning, 2010).

The government also increased the capacity of the vocational institutions to accept all high school students who wished to complete their future in technical fields, such as computer, electricity, electronics and other higher technology branches. The educational authority represented by the ministry of education obligated the new universities to

connect with local societies to provide them with new technologies and techniques that can help the locals in their daily needs.

The government also aimed to increase the number of incubators and technological valleys (innovative technological startup companies) within the universities and connect them directly with the industries to increase their productivities. The technological valleys were placed in several universities, such as Um al Qura University, and King Saud University. Also, the government encouraged the universities to establish new facilities that focused on the new branches in the fields that could support the knowledge-based economy, such as entrepreneurship, marketing, informational technology, and innovation. The government increased the higher technology grants and scholarships to faculty members to complete their higher education in many technical fields that could support the local economy (Saudi Arabia, Ministry of Planning, 2010).

The government also established new consultation facilities in the universities to provide its services through the government in the fields that needed highly qualified personnel to help government agencies to complete their tasks promptly (Saudi Arabia, Ministry of Planning, 2010).

Also, the government created new research facilities in the universities that aimed to achieve the general government goals, such as the Nanotechnology research facilities and the vitality research facilities.

During the SANEDP, the government increased its incentives to the private sector to increase their investment in the higher education sector and build new colleges and universities in different regions (Saudi Arabia, Ministry of Planning, 2010).

The government aimed to increase the technology transfer through public and private companies, research institutions and universities. To increase technology transfer, the government created the King Abdullah Science and Technology University that focused on the graduate level in high technological fields.

The government also allowed the exchange of scholars and faculty members between Saudi Arabia and other countries to open the economy to foreign knowledge, techniques, and technology (Saudi Arabia, Ministry of Planning, 2010).

4.3.4.3 Financial institutions

4.3.4.3.1 Overview

This section will investigate the Saudi economic development plans to understand the evolution of the financial sector. The study will explore the industrial policies, incentives, major institutes, and financial focus through the years. These policies and institutes will reveal the role of the financial system in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of indusial firms in building a robust innovation systems had be identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of Saudi Arabia. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the financial sector.

The following discussion will develop an understanding of the evolution of the financial sector and its role in developing the connectivity of the innovation systems.

4.3.4.3.2 Encouraged development in the entire financial system

- **1970–1975 Saudi Arabia First Economic development plan (SAFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Increased the productivity of the public financing		→		
	2	Encouraged the private banking system to handle part of the growth financing		→		
	3	Created the industrial bank to fund new large and medium size businesses		→		
	4	Encouraged locals to save their money in banks		→		
	5	Encouraged the open economy with no restriction on money transfer		↔		

Table 148 the Saudi First Economic Development Plan (monetary institutions policies)

During the Saudi Arabia's first economic development plan SAFEDP, the government implemented several policies to increase the productivity of the public financing. From these policies appeared the encouragements of the private banking system to handle part of the growth financing within the border of the countries (Saudi Arabia, Ministry of Planning, 1970).

The government started to create the industrial bank to fund new large and medium size business in general and play a supportive role for small business.

The government encouraged banks to open new branches in rural areas and encourage locals to save their money in banks. Moreover, the government encouraged the open economy with no restriction on money transfer in or out of the country (Saudi Arabia, Ministry of Planning, 1970).

4.3.4.3.3 Increased international investments and support to other countries through directly and through investment banks

- **1976–1980 Saudi Arabia Second Economic development plan (SASEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Supported the creation of the private financial companies			→	
	2	Supported foreign investment and partnership with foreign companies			→	
	3	Increased its partnership with national and international financial institutions by creating the Islamic Bank		←	→	
	4	Funded projects and industries in underdeveloped regions and created an environment of industrial activities locally and internationally			→	

Table 149 the Saudi Second Economic Development Plan (monetary institutions policies)

Due to the increased oil income in the Saudi Arabia's second economic development plan SASEDP, the government decided to continue its policies in supporting the creation of the private financial companies. The government offered several incentives to the private sector and supported foreign investment and partnership with foreign companies especially in petrochemicals and oil production where there is a lack of local experiences and expertise within these fields (Saudi Arabia, Ministry of Planning,1976).

The government increased its partnership with national and international financial institutions by creating the Islamic Bank; the Arab Fund for Economic & Social Development; the Arab Investment Company; the Saudi Fund for Development; and other financial institutions. These institutions were meant to fund industrial projects within several international and local agriculture and industrial projects. Although the government's main aim was not to use innovation in creating new clusters, the government's major aim was to fund projects and industries in underdeveloped regions and create an environment of industrial activities locally and internationally (Saudi Arabia, Ministry of Planning, 1976).

4.3.4.3.4 Eliminated taxes and rely on oil to develop the economy

- **1981–1985 Saudi Arabia Third Economic development plan (SATEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Stopped all tax income and relied heavily on oil income to support the economy	→			
	2	Created a council to increase non-oil product exports and created exhibits in major cities	↔			
	3	Encouraged private commercial banks to take the role of financing new industries		→		
	4	Obligated commercial banks to increase loans and shorten the period of repaying		↔		

Table 150 the Saudi Third Economic Development Plan (monetary institutions policies)

During the Saudi Arabia's third economic development plan SATEDP, the government stopped all tax income and relied heavily on oil income to support their economic development. Furthermore, the government created a council to increase non-oil product exports and created exhibits in major cities such as Riyadh, Jeddah, and Dammam to advertise national products to local markets.

Due to the lack of specialized private financial institutions, the major private commercial banks took the role of financing new industries in addition to the government borrowing agencies (Industrial Bank, Agriculture Bank, Islamic Bank)

During the second plan, the government realized that individual and industrial firms preferred government loans with no interests rather than private loans with high interest and costs. However, the consumer habits obligated commercial banks in the third plan to increase the loans amount and shorten the period of repaying the loans with competitive options (Saudi Arabia, Ministry of Planning, 1980).

4.3.4.3.5 instituted the stock market to absorb local investments

- **1986–1990 Saudi Arabia Fourth Economic development plan (SAFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Increased monetary regulations		→		
	2	Instituted the stock market and implemented new policies to develop it		→		
	3	Connected trading markets in rural areas with the national and international markets	←	→		
	4	Encouraged the creation of new financial institutions through incentives		→		
	5	Increased loans to small businesses that did not get enough attention in the previous plans		→		

Table 151 the Saudi Fourth Economic Development Plan (monetary institutions policies)

During the Saudi Arabia's fourth economic development plan SAFREDP, the government started to increase its monetary regulations by controlling the money and stock market and obligating the commercial banks to play a major role in this new policy. Accordingly, the government initiated an organization that was responsible for controlling the stock market and implemented new policies to develop it. The stock market played a crucial role in helping large enterprises to secure funds in the stock market, such as SABIC, the major government petrochemical enterprise in the country (Saudi Arabia, Ministry of Planning, 1984).

The government also started to increase the number of chambers of commerce in different regions. The chambers of commerce were responsible for controlling the trading markets in rural areas and connecting them with the national and international markets. During the SAFREDP, the government encouraged the creation of new financial intuitions and provided extra incentives to intuitions that provided loans to industrial production industries. Moreover, the government increased its loans to small businesses that did not get enough attention in previous plans (Saudi Arabia, Ministry of Planning, 1984).

4.3.4.3.6 Funded export and invested in technology transfer

- **1991–1995 Saudi Arabia Fifth Economic development plan (SAFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Funded the export through the Saudi Industrial Export Company and the Islamic Bank	←	→		
	2	Encouraged foreign investments that were accompanied by technology transfer		→		
	3	Obligated local banks to direct local savings to invest in the economy			→	
	4	Encouraged investors to create financial companies and support businesses			→	
	5	Encouraged companies to enter the stock market to increase the size of the companies			←	→

Table 152 the Saudi Fifth Economic Development Plan (monetary institutions policies)

During the Saudi Arabia's fifth economic development plan SAFFEDP, the government started to extensively fund the export by creating the Saudi Industrial Export Company and the Islamic Bank to fund export activities in Saudi Arabia and other Islamic countries.

The government also supported foreign investments, especially in investments that were accompanied by technology transfer from other advanced countries.

The government obligated local banks to direct local savings to invest in economic and industrial activities by providing loans to investors to invest in industrial projects. The government also encouraged investors to create financial companies that provided support to industrial companies. The private companies were conducted by several expert businessmen that could conduct financial industries. Also, the government encouraged companies to enter the stock market to increase the size of their firms and activities (Saudi Arabia, Ministry of Planning, 1990).

4.3.4.3.7 Encouraged banks to increase loans to private business

- **1996–2000 Saudi Arabia Sixth Economic development plan (SASIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Increased the effort to support the private sector			→	
	2	Increased the focus on the financial institutions by increasing the private investments			↔	
	3	Provided loans for private facilities and local industries			→	
	4	Encouraged purchasing local products to give access for local businesses to government loans			↔	

Table 153 the Saudi Sixth Economic Development Plan (monetary institutions policies)

During the Saudi Arabia's sixth economic development plan SASEDP, the government decided to increase the effort to support the private sector by redirecting the government budget from consumable products. Furthermore, the government increased their focus on the financial institutions by increasing the private sector effort in spending on private industries (Saudi Arabia, Ministry of Planning, 1995).

To provide the loans for private facilities and local industries the government imposed several requirements for private institutions. The first requirement was hiring Saudi citizen workers in each facility to have access to the incentive system. The second requirement was purchasing local products to get access to government loans.

The major problem in the private sector investments during this plan was searching for the fast money making instead of innovating. Accordingly, the private sector started to invest in money trading instead of physical and real investments, such as products developments. This behavior made the government restrict its investments opportunities (Saudi Arabia, Ministry of Planning, 1995).

4.3.4.3.8 Allowed banks to use real estate mortgages as a credit guarantee tool

- **2001–2005 Saudi Arabia Seventh Economic development plan (SASVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Increased the financial support to medium and small sized businesses		→		
	2	Allowed banks to fund new businesses using real estate mortgages		→		

Table 154 the Saudi Seventh Economic Development Plan (monetary institutions policies)

During the Saudi Arabia's seventh economic development plan SASVEDP, the government started to increase its support to medium and small size businesses. The major steps were allowing banks to fund new businesses using real estate mortgages as a guarantee for loans (Saudi Arabia, Ministry of Planning, 2000).

4.3.4.3.9 Allowed foreign investment in the stock market

- **2006-2010 Saudi Arabia Eighth Economic development plan (SAEIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
8th	1	Increased the stock market capability to absorb new industrial companies		→		
	2	Allowed foreign investment in the stock market	↔			
	3	Created the general investment bank		→		

Table 155 the Saudi Eighth Economic Development Plan (monetary institutions policies)

During Saudi Arabia's eighth economic development plan SAEIEDP, the government increased its focus on the stock market to absorb new industrial companies. The government also allowed foreign investment in the companies in the stock market to increase the investment in the companies. Furthermore, the government created the general investment bank that provided loans and investments in highly competitive projects (Saudi Arabia, Ministry of Planning, 2005).

4.3.4.3.10 Supported seeds organizations and venture capitalist to support the local economy

- **2011-2015 Saudi Arabia Ninth Economic development plan (SANEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
9th	1	Created Funding programs for the small and medium-sized businesses		→		
	2	Funded businesses through the Islamic funding institution	←	→		
	3	Provided loans to the local borrowers		→		
	4	Provided loans with no interests in small businesses		→		
	5	Created seeds organizations for new businesses		→		

Table 156 the Saudi Ninth Economic Development Plan (Monetary Policies)

During the Saudi Arabia's ninth economic development plan SANEDP, the government realized the importance of funding the small and medium sized businesses through appropriate programs that could support the industry (Saudi Arabia, 2010). The government took the chance to fund these facilities through the Islamic funding institutions and according to the Islamic laws. One of the major Islamic laws was called "MURABAHA." "Murabaha is an Islamic financing structure in which an intermediary buys a property with the free and clear title." Many financial institutions have provided loans to the local borrowers using this method and other similar methods. However, there were other private institutions who provided no interest loans to small businesses, such as "BAB RIZQ JAMIEL" a nonprofit organization that dedicated itself to help small and medium-sized businesses.

For large enterprises, three major organizations took the responsibility to fund them. The seed organizations were the Public Investment Agency, the commercial banks, and the Industrial Development Bank (Saudi Arabia, Ministry of Planning, 2010).

4.3.4.4 Government Research and Development institution GRIs

4.3.4.4.1 Overview

This section will investigate the Saudi economic development plans to identify the evolution of the Government Research and Development Institution (GRIs). The study will explore the industrial policies, incentives, major institutes, and industrial focus through the years. These policies and institutes will reveal the role of the GRIs in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of GRIs in building a robust innovation systems had been identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of Saudi Arabia. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS, RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the GRIs sector. Figure 17 shows the major government research center, which focus on oil and petrochemical related activity. The following discussion will develop an understanding of the evolution of the government research center and its role in developing the connectivity of the innovation systems.

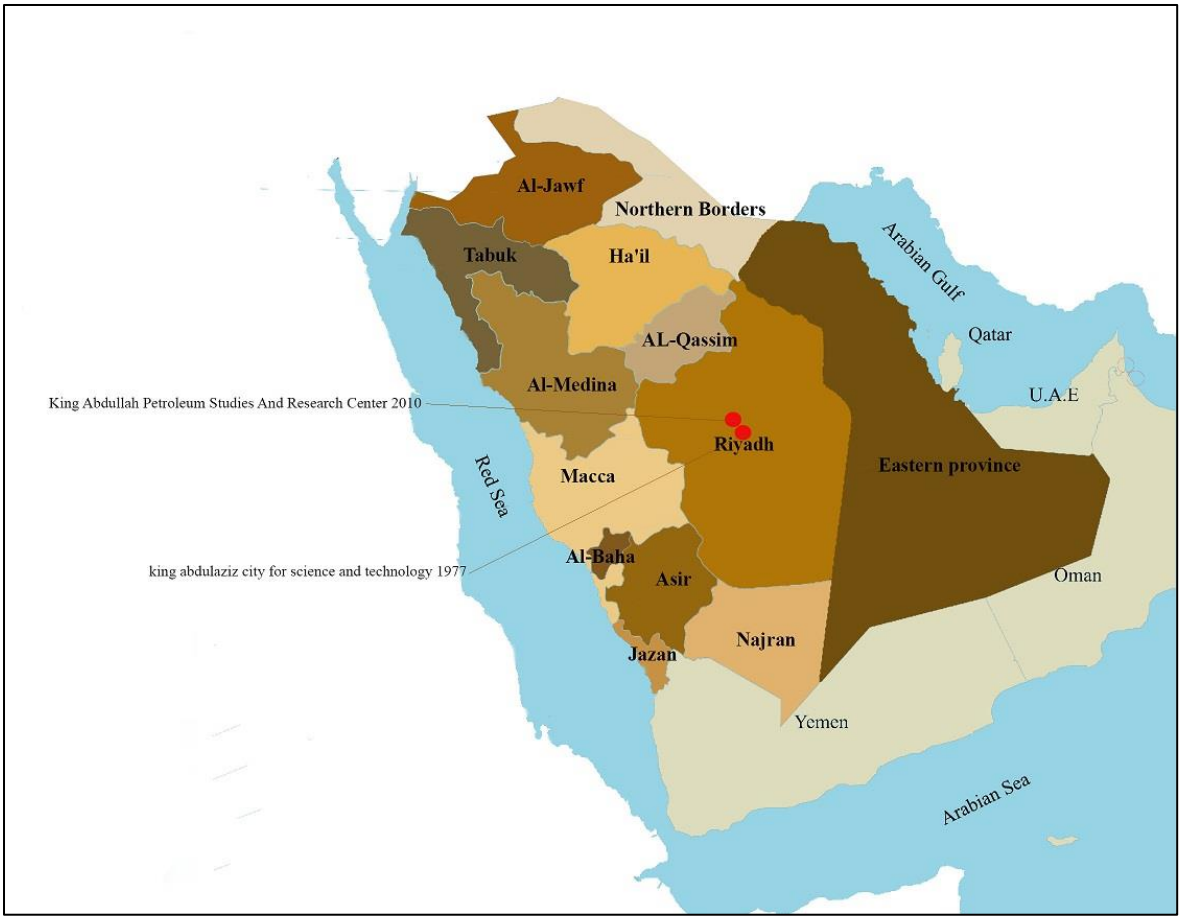

Figure 17 Saudi Arabia's Related Government Research Center

4.3.4.4.2 Established government research infrastructure

- **1970–1975 Saudi Arabia First Economic development plan (SAFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Created several laboratories in major cities			→	
	2	Created the Industrial research and development center to investigate new technologies and provide consultations and training to industrial facilities			→	

Table 157 the Saudi First Economic Development Plan (GRIs policies)

During this Saudi Arabia's first economic development plan SAFEDP, the major government role on GRIs was to create several laboratories in major cities that focus on improving building materials within Jeddah and Dammam Cities.

The government created the Industrial research and development center to investigate new technologies and provide consultations and training to industrial facilities to the private sector and seek new opportunities for new investors (Saudi Arabia, Ministry of Planning, 1970).

4.3.4.4.3 Created the Science and Technology Council

- **1976–1980 Saudi Arabia Second Economic development plan (SASEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Established research programs in government agencies		→		
	2	Established several programs with foreign research agencies	↔	↔	↔	↔
	3	Facilitated importation of foreign researchers and workers to conduct research		→		
	4	Invested in any foreign GRIs that could solve the existing industrial and environmental problems in Saudi Arabia		→		
	5	Increased the support to the Industrial Development Center		→		
	6	Created the Science and Technology Council to conduct direct public sector objectives and technological policies	↔	↔	↔	↔

Table 158 the Saudi Second Economic Development Plan (GRIs policies)

During the Saudi Arabia's second economic development plan SASEDP, the government intended to establish research programs along with universities and government agencies in the fields of water desalination, water availability and agriculture production in all regions. Furthermore, the government established several programs with foreign universities to conduct researches (Saudi Arabia, Ministry of Planning, 1976).

During this SASEDP, the government started to investigate alternative power source and renewable energy to reduce its dependency on oil production for revenue. However, they didn't have the technology or the manpower to conduct the researchers in that field. Thus, the government depended on technology transfer from other advanced countries to conduct this kind of research. To ease technology transfer, the government facilitated importation of foreign researchers and workers to conduct research activities related to

renewable energy, agriculture, and water issues. The government offered to invest in any foreign GRIs that could solve the existing industrial and environmental problems in Saudi Arabia.

Regarding national GRIs the government created two agencies: one was the Industrial Development Center that was intended to provide research advice and consultation to the private sector, and the other one was the Science and Technology Council to conduct direct public sector objectives and technological policies (Saudi Arabia, Ministry of Planning, 1976).

- **1981–1985 Saudi Arabia Third Economic development plan (SATEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Implemented new policies and strategies to increase Science and R&D productivity	→			
	2	Transformed the society to a knowledge-based society		→		
	3	Trained local workforce to master high technology machines and equipment		→		
	4	Decided five areas of interest regarding S&T national and international collaboration		↔		

Table 159 the Saudi Third Economic Development Plan (GRIs policies)

In the year 1978, the government announced the Science and Technology Act and created the Science and Technology Institute in the kingdom of Saudi Arabia. The major aim of the new Science and Technology Institute was to implement policies and strategies to increase Science and R & D productivity in the country.

The new policies had two major objectives; the first objective was to transform the society to a knowledge-based society without affecting its religious beliefs and cultural background. The second objective was to transform the local workforce to be deal with new high technology machines and equipment.

The S&T council decided five areas of interest regarding national and international collaboration. The first area of concern was to increase the international cooperation

between the S&T Institute and the U.S in solar energy and electrical reproduction in addition to energy and heat reproduction.

The second area of concern was to establish an office in Washington DC to be responsible for deciding the major research categories, the number of workers for each field of study and the budgeting needed for these activities (Saudi Arabia, Ministry of Planning, 1980).

The third area of interest was to sign an agreement with the Canadian National Research Council to adopt major policies to help measure the quality of Saudi industrial fiber objects and their mechanical parts.

The fourth area of interest was to increase the collaboration with China in the field of agriculture and the production of proteins of the single cell.

At the national level, the S&T council decided to increase its collaboration in the field of R&D with the national universities. Another main interest for the S&T council was to provide scholarships to any researcher, who have an interest in the major fields of study that was conducted by the council (Saudi Arabia, Ministry of Planning, 1980).

4.3.4.4.4 Increased foreign collaboration

- **1986–1990 Saudi Arabia Fourth Economic development plan (SAFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Conducted new areas of study that required collaboration with foreign institutions	↔			
	2	Signed several agreements with foreign countries to help the Technology Council conducting its job	↔			
	3	Created four major solar power projects in different regions		→		
	4	Managed to finance more than 140 research projects under the supervision of the Technology Council		↔		
	5	Provided information and data to all scholars to help them accomplish their task		→		

Table 160 the Saudi Fourth Economic Development Plan (GRIs policies)

During the Saudi Arabia Fourth Economic development plan SAFREDP, the government, through the Science and Technology Council, identified four major area of research. These areas were:

1- Providing agriculture research
2- Improving technical cities' needs that were ordered by government agencies
3- Improving industrial measures
4- Improving the technical workforce standards

The council decided that conducting these areas of study needs to collaborate with foreign institutions. Accordingly, the council signed several agreements with foreign countries and Saudi Arabia to help the council conduct its job.

The council also created four major solar power projects in different regions and areas where solar rays consistently existed. These regions were chosen to ensure enough power was available to develop the solar panels. These projects were as follows:

1- Greenhouse solar projects.
2- Solar plant desalination projects.
3- Solar and turbine plant projects
4- Solar villages
5- And production of hydrogen using solar panels (Saudi Arabia, Ministry of Planning, 1984).

By the end of the third plan and through the fourth plan the technology council managed to finance more than 140 research projects under its supervision. Furthermore, the council provided the information and data to all scholars to help them accomplish their task.

In addition to its previous work, the council took the responsibility of implementing policies to encourage R&D in universities and educational institutions (Saudi Arabia, Ministry of Planning, 1984).

4.3.4.4.5 Increased the growth of local GRIs

- **1991–1995 Saudi Arabia Fifth Economic development plan (SAFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Increased the investments and research activities in KACST		→		
	2	Increased workforce training to be capable of operating new technologies		→		
	3	Increased investments in water desalination and agriculture		→		
	4	Increased scholarships and financial support through KACST		↔		

Table 161 the Saudi Fifth Economic Development Plan (GRIs policies)

During the Saudi Arabia's fifth economic development plan SAFFEDP, the government increased the investments in renewable energy research and increased the research activities in the King Abdul-Aziz Technology City. The increase in research activities was accompanied by investments in the workforce training effort to be capable of operating new technologies. Furthermore, the government increased its investments in water desalination and agriculture which were considered vital resources to humankind. During the SAFIEDP, the King Abdul-Aziz City started to provide scholarships and financial support for scholars from all over the world and connect with others using GULFNET and BITNET networks (Saudi Arabia, Ministry of Planning, 1990).

4.3.4.4.6 Encouraged the private sector to increase their role in Research activities

- **1996–2000 Saudi Arabia Sixth Economic development plan (SASIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Encouraged private sectors to create companies with foreign shared investments to increase technology transfer	↔			↔
	2	Encouraged the private sector to adopt self-research and development				→
	3	Encouraged research facilities to connect with industries to develop their products				↔
	4	Provided scholarships to the employees of KACST	↔			
	5	Implemented several new research fields in the R&D effort				↔

Table 162 the Saudi Sixth Economic Development Plan (GRIs policies)

The government continued its encouragement of the private sectors to create companies with foreign shared investments and increased technology transfer with developed countries. The government started to encourage the private sector to adopt self-research and development to increase their productivity. Also, the government began to promote research facilities to connect with industries to develop their products (Saudi Arabia, Ministry of Planning, 1995).

The King Abdul-Aziz City of Science and Technology started to provide scholarships to its employees to complete their higher educations in advanced countries to fulfill their goals and needs. During the Saudi Arabia Sixth Economic development plan SASEDP, many parts of the city were still under construction. However, the city implemented several anticipated research fields as follows: Electronics, computers, geophysics, natural resources, oil. Petrochemicals, Space, Orbitz, Solar, and renewable energy (Saudi Arabia, Ministry of Planning, 1995).

4.3.4.4.7 Supported incubators creation in research operations

- **2001–2005 Saudi Arabia Seventh Economic development plan (SASVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	supported incubators and mediator companies that worked on innovation and technology through KACST			→	
	2	Increased the international collaboration in all targeted fields	↔			
	3	Created programs that sought to improve the creativity of individuals			→	
	4	Increased the connectivity between research and industrial facilities			↔	
	5	Obligated large private corporations to establish their research centers and connect them with government research facilities			↔	

Table 163 the Saudi Seventh Economic Development Plan (GRIs policies)

During the Saudi Arabia Seventh Economic development plan SASVEDP, King Abdul-Aziz City for Science and Technology took the decision of supporting incubators and mediator companies that worked on innovation and technology.

The government started searching for talented students in all regions and territories and created centers to adopt their creativity and ideas. The government also aimed to increase the international collaboration in all targeted fields. The government also created programs that sought to improve the creativity of individuals through connectivity between research institutions, universities, and vocational institutions (Saudi Arabia, Ministry of Planning, 2000).

In the SASVEDP, the government realized that there is a lack of connectivity between research and industrial facilities. Accordingly, the government obligated large private corporations to have their research centers and facilities connected with government research facilities (Saudi Arabia, Ministry of Planning, 2000).

4.3.4.4.8 Increased the growth of the local economy

- **2006-2010 Saudi Arabia Eighth Economic development plan (SAEIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
8th	1	Continued developing KACST	↔			
	2	Created incubators to encourage talented individuals to grow		→		
	3	Provided information and databases for all researchers through KACST		→		
	4	Increased Saudi products quality	←	→		
	5	Directed connection between KACST and the foreign research facilities	↔			
	6	Created institutes and programs for individuals and youth to encourage creativity		→		
	7	Signed 45 contracts with foreign governments to increase innovation and R&D	←	→		

Table 164 the Saudi Eighth Economic Development Plan (GRIs policies)

By the end of Saudi Arabia's eighth economic development plan SAEIEDP, the number of research centers in universities had reached 46 centers in the fields of agriculture, water, environment, engineering, humanities, and health (Saudi Arabia, Ministry of Planning, 2005).

However, the major GRI in the country was King Abdul-Aziz City of Science and Technology. The city had seven institutions that focused on different science and development fields in addition to two branches that focused on physics and mathematics. The city continued its policies in developing its R&D bases by buying patents and industrial information bases from different parts of the world. Furthermore, the city continued its policies in sponsoring researchers and scholars until they reached 429 individuals by the end of the seventh plan in different branches and fields. However, the major focus of the city was in solar, renewable energy, Satellite, agriculture production, and water desalination. The city also created two incubators to encourage talented individuals to grow and create their industries (Saudi Arabia, Ministry of Planning, 2005).

King Abdul-Aziz City for Science and Technology also provided all information and databases for all researchers through public libraries and universities. Also, the city aimed to work with the Saudi measurement agency to ensure all Saudi products had a high quality according to the local and international standards.

Regarding technology transfer, the city took two ways to increase the pace of technology transfer. The first one was by inviting the foreign research companies to the country and meet them with local industries to see how collaboration can be increased between the two parties. The second way was by a direct connection between the city and the foreign research facilities, such as the collaboration in remote sensing between the city and France and between the city and Germany and the United States in the field of renewable energy. There are other collaborations in different branches in the city, such as the connectivity between the city and Japan in the field of technical vitality (Saudi Arabia, Ministry of Planning, 2005).

The government also encouraged innovation by creating several institutes and programs for individuals and youth to encourage creativity and intelligence. For example, King Abdul-Aziz and his men for the talented Institute encourages young individuals to be the future scientists.

To increase innovation and R&D, the government of Saudi Arabia has signed in the past several years 45 contracts between the Saudi government and foreign governments and research institutes. These agreements included an increase in S &T collaboration by creating new R&D facilities in Saudi Arabia and the other countries and protect these investments from political interferences. (Saudi Arabia, Ministry of Planning, 2005).

- **2011-2015 Saudi Arabia Ninth Economic development plan (SANEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
9th	1	Encouraged the creation of mediator companies		→		
	2	Increased the technology transfer	←	→		
	3	Initiated the five-year technological plan		→		
	4	Increased the investments in S&T to reach $2 billion USD		→		
	5	Created several research facilities in national universities		→		
	6	Encouraged the local industries to establish their R&D		→		
	7	Increased the support to KACST		*		
	9	Encouraged the protection of the intellectual properties		→		

Table 165 the Saudi Ninth Economic Development Plan (GRIs Policies)

During the Saudi Arabia's ninth economic development plan SANEDP, there were five incubators that could help startups in transforming ideas to a technologically innovative company. The government wanted to at least reach the medium international rate of 1 incubator to 1,000,000 individuals to be able to transform the country's economy to a knowledge-based economy. Accordingly, the government encouraged the creation of mediator companies, such as venture capitalists, technology gardens, and technological incubators.

To take full advantage of the national and international capabilities, the government initiated for the first time, the five-year technological plan. The plan focused on increasing the investments in S&T to reach $2 billion USD. Accordingly, the government created several research facilities in national universities and funded several international research chairs in high ranked universities, such as Harvard and MIT. The government also aimed to increase the number of graduates in science and technological fields, especially at the graduate level. The government also started to encourage the local industries to establish their R&D facilities to increase the quality of their products.

The government also increased its support to the King Abdul-Aziz City for Science and Technology. The city created eight more incubators in several regions and cities. The city increased its relation to and existence in universities by establishing 15 national centers in universities. The five-year technological plan focused on local needs that can be transferred to more practical use, such as health, oil, minerals, gas, renewable energy, environment, geophysics, and agriculture.

The government also encouraged the protection of the intellectual properties as a core value of its technological and industrial activities, which was a major condition in joining the World Trade Organization.

4.3.4.5 Industrial (Large, Medium, and small businesses)

4.3.4.5.1 Overview

This section will investigate the Saudi economic development plans to understand the evolution of the industrial sector. The study will explore the industrial policies, incentives, major institutes, and industrial focus through the years. These policies and institutes will reveal the role of the industrial firms in enhancing the connectivity between the Global Innovation System (GIS), National Innovation System (NIS), Regional Innovation system (RIS), Regional Innovation Cluster (RIC). The importance of indusial firms in building a robust innovation systems had be identified by many scholars in innovation systems, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. Each Plan will have a table that describes the major policies and its effect on the relation between the four major innovation models that shaped the economy of Saudi Arabia. There will be arrows in front of each policy to indicate the level of connectivity between the GIS, NIS,

RIS, and RIC. This step will produce a clear understanding of the connectivity and the evolution of the models in the industrial sector.

Figure 18 shows the distribution of the industrial clusters in Saudi Arabia in addition to the two-major industrial cluster at the Royale Commotion of Jubail and Yanbu.

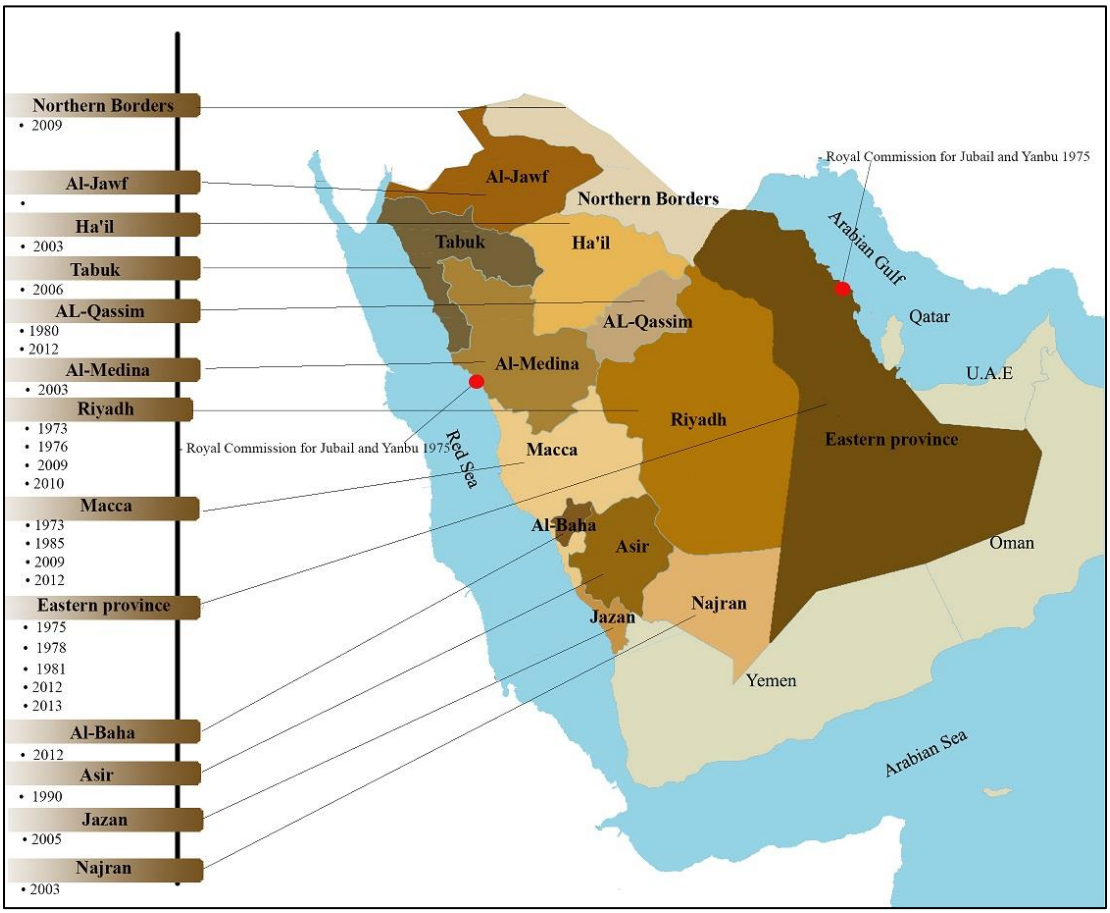

Figure 18 Saudi Arabia's industrial clusters distributions

The following discussion will develop an understanding of the evolution of the industrial sector and its role in developing the connectivity of the innovation systems.

4.3.4.5.2 Supported oil production

- **1970–1975 Saudi Arabia First Economic development plan (SAFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
1st	1	Increased oil productions along with all applicable transformative productions				→
	2	Diversified the countries industrial base and increased training				→
	3	Increased oil refineries facilities in major cities and major regions				→

Table 166 the Saudi First Economic Development Plan (businesses policies)

In the seventies, oil production was the major source of revenue in Saudi Arabia were desert and sand was every was. Accordingly, much of the government policies was focused on increasing oil productions along with all applicable transformative productions accompanied it (Saudi Arabia, Ministry of Planning, 1970).

During the 1975 Saudi Arabia First Economic development plan SAFEDP, Saudi Arabia had only 30 products that were produced locally including oil production. The private sector share was only 2% of the countries entire gross income. Thus, the government started to implement new policies to diversify the countries industrial bases and increase training consecutively. The new industries included cement, petrochemicals, and fertilizers (Saudi Arabia, Ministry of Planning, 1970).

The government took several steps to encourage local investments in its industrial bases, these policies includes:

1- Exempt all machines and primary industrial materials from tariff and taxes.

2- Provide free land within industrial clusters to new industries.

3- Exempt new facilities from income taxes for certain periods, which later canceled due to high oil income.

4- The government followed open market models where demand and supply controlled the market without any government intervention expect when there were local products that could take the place of international products.
5- The government provided money support to local industries to help them nurture and grow.
6- The government provided all kind of information to local industries including data information and feasibility studies.
7- The government encouraged foreign companies to invest in mining along with local investors.

Local marketing by (Petromeen):

The government started to increase oil refineries facilities in major cities and in major regions and territories to ensure sufficient distribution of oil and gas in all local areas (Saudi Arabia, Ministry of Planning, 1970).

4.3.4.5.3 supported the private investment through money incentives and tariff reduction

- **1976–1980 Saudi Arabia Second Economic development plan (SASEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
2nd	1	Focused on industries that do not need water resources because of water scarcity in the country		→		
	2	Provided loans to current and future industries		→		
	3	Helped business men in organizing and initiating new industries		→		
	4	Exempted machines and primary imported material from tariff		→		
	5	Exempted companies from income taxes		→		
	6	Helped to export goods		↔		

Table 167 the Saudi Second Economic Development Plan (industrial businesses policies)

The government's major industrial objectives in the Saudi Arabia Second Economic development plan SASEDP included:

1- "Providing loans to current and future industries
2- Help business men in organizing and initiating new industries
3- Exempt machines and primary imported material from tariff
4- Exempt companies from income taxes
5- Provide support and vocational training to trainees
6- Help to export goods" (Saudi Arabia, Ministry of Planning, 1976).

During the SASEDP, the government started to implement industrial policies to all regions based on its needs and natural capabilities. In the central region, the government focused on industries that do not need water resources because of water scarcity in the country. In the northern region, the government focused on agriculture and mining because of the availability of natural resources. In the eastern region, the government focused on hydrocarbon and petrochemicals because of the availability of natural resources such as oil and gas that can be transformed to another kind of products. During this SASEDP, the government started to increase the industrial activities in all regions to fulfill the needs of local markets and international customers, especially in the oil production fields (Saudi Arabia, Ministry of Planning, 1976).

4.3.4.5.4 Created SABIC and the Royal Commission of Jubail and Yanbu

- **1981–1985 Saudi Arabia Third Economic development plan (SATEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
3rd	1	Initiated one of the major government financed petrochemical and hydrocarbon companies (SABIC)		→		
	2	Created the Royal Commission of Jubail and Yanbu		→		
	3	Established the supportive services to the Royal Commission industrial cities to include new airports and roads		→		
	4	Established several residential areas and schools to accommodate the workers' families in the Royal Commission		→		
	5	Increased oil marketing through the government-lead agency Petromeen	←	→		
	6	Continued supporting the private sector		→		
	7	Increased the industrial bank branches in several regions		→		
	8	Provided managerial training to the industrial bank for future industries		→		

Table 168 the Saudi Third Economic Development Plan (businesses policies)

In the year 1976, the government initiated one of the major government financed petrochemical and hydrocarbon companies, which was named the Saudi Basic industrial cooperation (SABIC). One of the major aims of this company was to handle huge petrochemical production and that it could be supported easily by private investments. Furthermore, the government also created the Royal Commission of Jubail and Yanbu to be responsible for conducting the transformation of the traditional cities of Jubail and Yanbu to industrialized cities.

In the Saudi Arabia Third Economic development plan SATEDP, the work on the two cities had increased by establishing the supportive services to these industrial cities to include new airports and roads. Also, the commission established several residential areas and schools to accommodate the workers' families.

Regarding oil marketing, the government-lead agency Petromeen increased the number of its locations and branches locally and around the world.

The government continues its support to the private sectors by providing the same incentives in the second development plan.

During the SATEDP, the industrial bank increased its branches to several regions to ensure equal opportunities in lending investors in industrial activates. Also, the industrial bank took the responsibility of providing the managerial training for future industries to manage investments (Saudi Arabia, Ministry of Planning, 1980).

4.3.4.5.5 Increased foreign collaboration rather than competition

- **1986–1990 Saudi Arabia Fourth Economic development plan (SAFREDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
4th	1	Used Collaboration rather than competition to maintain the imported technological equipment and machines	↔			
	2	Implemented new policies that obligated new industries to submit extra requirements to have access to loans		→		
	3	Enforced rural areas development program		→		
	4	Encouraged Export program		→		
	5	Provided consultation to new investors about the opportunities in the industrial cities		→		
	6	Provided technical assistance to local industries in how to operate and fix machines		→		

Table 169 the Saudi Fourth Economic Development Plan (businesses policies)

In the Saudi Arabia's fourth economic development plan SAFREDP, the government of Saudi Arabia realized that it was hard to adopt the Japanese model of copying the imported machines and technologies to develop it later. Because the Japanese model led to an extensive competition between them and other international producers, which affected the flow of technological machines to them. The government of Saudi Arabia tried to avoid the same scenario. On the contrary, Saudi Arabia adopted a paradigm of collaboration rather than competition and maintained the existing imported technological equipment and machines. Another major reason for this policy was the newly developed educational and government research intuitions that still did not have the ability to handle

such research requirement to develop the machines (Saudi Arabia, Ministry of Planning, 1984).

Although in the SAFEDP the major government focus was still on oil production, other productions of hydrocarbon and petrochemicals industries started to play a major role in the country's industrial base (Saudi Arabia, Ministry of Planning, 1984).

In the private sector, the government implemented new policies that obligated new industries to submit extra requirements to have access to loans, such as feasibility studies and extra financial and managerial capability.

To ensure the success of the private sector, the government conducted several other programs. These programs are.

1- Industrial resettlement in rural areas program:

   The government encouraged private industries to resettle in rural areas in places where it's easier for nomads to congregate together and establish small cities. In these cities, the government provided major facilities and services to these people. The government also provided industrial and residential loans free from interest to settle them in these areas.

2- Encouraging Export program:

   Before the fourth plan, there were several problems for local private industries to enter the international market. However, after the success of the petrochemical industries, the government started to increase its incentives to the private sectors by providing incentives and facilitating obstacles to export their products.

3- Pre-investment program:

This program was based on providing consultation to new investors about the opportunities in the industrial cities.

4- Industrial development program:

This program was designed to provide technical assistance in how to operate and fix machines and provide consultation on ways for increasing productivity (Saudi Arabia, Ministry of Planning, 1984).

- **1991–1995 Saudi Arabia Fifth Economic development plan (SAFFEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
5th	1	Created the Saudi Industrial Export company		→		
	2	Partnered with the British government to transfer defense technology to Saudi Arabia	↔			
	3	Increased domestic infrastructure by creating several oil distribution facilities in rural areas		→		

Table 170 the Saudi Fifth Economic Development Plan (businesses policies)

There were four major private investment companies that had been created in the previous plan to fund private industrial activities. These companies are The Saudi Investment Group, the Saudi Industrial Development Company, the National Industrial Company, and the Saudi Advance Industrial company. Furthermore, the government created the Saudi Industrial Export company to market the Saudi petrochemical products to the international market (Saudi Arabia, Ministry of Planning, 1990).

In 1989, the Saudi government initiated a partnership with the British government to transfer defense technology to Saudi Arabia. this project was called Al-Yamama project. Also, several other petrochemical industries had been created during this period in Jubail and Yanbu industrial cities. Some of these projects were conducted by the Saudi Industrial Development Company as the main financier to these projects. There were several other projects that aimed to substitute imported projects with local ones.

However, most of these projects were based on primary and petrochemical productions. Even though there was a considerable increasing in nonoil production, most of these products were considered as transformative oil products that were extracted from oil. Thus, most of the domestic production still relayed on oil as a major source of income in the economy.

Regarding industrial marketing, the government increased its domestic infrastructure by creating several oil distribution facilities in rural areas (Saudi Arabia, Ministry of Planning,1990).

4.3.4.5.6 Allowed venture capitalist and increased the support to the open market

- **1996–2000 Saudi Arabia Sixth Economic development plan (SASIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
6th	1	Continued an opened market policy	→			
	2	Allowed venture capital companies to enter the industrial market		→		
	3	Partnered with the private sector and invested in high-risk projects		↔		
	4	Funded 477 transformative production industries		→		
	5	Increased the number of industrial clusters		↔		
	6	Signed eight agreements with foreign countries	↔			

Table 171 the Saudi Sixth Economic Development Plan (businesses policies)

During the Saudi Arabia sixth economic development plan SASIEDP, the government continued its policies on opening the market for individuals, industries, and countries. The private sector increased rapidly during the previous plans in several sectors. The major companies that existed with private government sectors partnerships were cement, agriculture, petrochemicals, transportation, ceramic, and Banks. Although the private sectors registered 1534 companies in the past several decades, most of these companies were food and primary products such as detergents, soaps, shampoos and other products (Saudi Arabia, Ministry of Planning, 1995).

During the SASEDP, there were new kinds of investments that entered the industrial markets as venture capital companies, such as the Saudi Advance Industrial Company, AL Madinah Industrial Investment Company, Al- Ahsa development Company, and other companies. These new businesses were partnered by the government and were willing to take the risk invest in all regions and all kind of business starting from agriculture production to industrial and real estate companies (Saudi Arabia, Ministry of Planning, 1995).

During the previous plans, the government succeeded in funding 477 transformative production industries with $ 3.5 billion dollars in investments. The government-funded 70% of it through the industrial and development Bank. In addition to funding new industries, the government provided free land to these industries in eight mixed-use industrial clusters spread in all regions and two specialized industrial clusters in Jubail and Yanbu city. The government also aimed to increase the number of industrial clusters in all regions to help develop all parts of the country.

The government of Saudi Arabia also signed eight agreements with Britain, France and the United States of America to transfer the technology to local industries (The King Abdul-Aziz science and technology City) (Saudi Arabia, Ministry of Planning, 1995).

4.3.4.5.7 opened oil production investment to the local foreign and private investors

- **2001–2005 Saudi Arabia Seventh Economic development plan (SASVEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
7th	1	Supported the exports support centers in the chambers of commerce		→		
	2	Eased all regulations that were implemented to support the exports	↔			
	3	Increased the support to small and medium sized businesses		→		
	4	Continued supporting the industry through the government loaning banks		→		
	5	Created incubators in industrial clusters		→		
	6	facilitate loans to the small and medium-sized firms		→		
	7	provided local lands and rentable offices to businesses in industrial clusters		→		
	8	Increased the investments with the private sector in the industrial cities in Jubail and Yanbu	→			
	9	Encouraged the private sector to invest in oil refineries and production		→		
	10	Encouraged the creation of new industrial clusters		→		
	11	Increased the Saudi standard, metrology and quality organization		→		

Table 172 the Saudi Seventh Economic Development Plan (businesses policies)

During the Saudi Arabia Seventh Economic development plan SASVEDP, the government increased the support of the export support centers in the chambers of commerce in all cities and regions. Furthermore, the government eased all regulations that were implemented to support the exports (Saudi Arabia, Ministry of Planning, 2000). The government started to increase its support to small and medium size businesses by encouraging the private sector to fund new businesses. The government also supported the small and medium size businesses by creating shared private-public institutions to sustain and fund the industry. Also, the government took the initiative to support the industry through the government loaning banks (Saudi Arabia, Ministry of Planning, 2000).

To support the small and medium size businesses, the government started to create buildings to fit them in all regional industrial clusters. Furthermore, the government encouraged private banks to facilitate loans to the small and medium-sized firms and industries. The government also encouraged these businesses by providing local lands

and rentable offices to encourage them to settle in the industrial clusters. The government also ordered the chamber of commerce in all regions and areas to ease all obstacles to the small and medium sized businesses and provide them with all information and licenses to help them grow (Saudi Arabia, Ministry of Planning, 2000).

To help exports to grow the government transferred the export development departments from the chamber of commerce to an independent agency that can help local government to increase their effort in developing local industries exports.

In the two major industrial cities in Jubail and Yanbu, the government along with the private sector started to grow their investment in public facilities and services. These services included the development of new schools, hospitals, housing, malls, and universities (Saudi Arabia, Ministry of Planning, 2000).

The government also encouraged the private sector to invest in oil refineries and production that used to be controlled by the public sector. The government also encouraged foreign investment to build partnerships with local investors and enter the oil production field. Also, the government encouraged the creation of new industrial clusters and supported the private sectors to be part of it. In addition to the effort of creating new industries, the government helped the local industries to have their research facilities help develop their products.

During the SASVEDP, the government increased the Saudi standard, metrology and quality organization to make sure that all the goods produced by national industries are according to international standards. During this plan and previous plans, the total number of checked industries reached 11746 (Saudi Arabia, Ministry of Planning, 2000).

4.3.4.5.8 Allowed incubators in industrial cluster and increased small and medium sized businesses support

- **2006-2010 Saudi Arabia Eighth Economic development plan (SAEIEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
8th	1	Increased research and development capabilities		→		
	2	Transformed patents into production lines		→		
	3	Increased foreign investment in Saudi Arabia	↔	→		
	4	Treated foreign investors as local investors		→		
	5	Supported the small and medium size businesses through the warranty program	↔	→		
	6	Created an agency that took care of small and medium size business		→		
	7	Developed several programs for the small businesses through financial incentives and managerial support		→		
	8	Joined the World Trade Organization	↔	→		
	9	Aimed to increase foreign direct investment		→		
	10	Created the Saudi industrial property authority		→		
	11	Created several incubators in the industrial cities		→		
	12	Supported industries that had a competitive advantage in the economy		→		
	13	Supported industries that employed high technologies		→		

Table 173 the Saudi Eighth Economic Development Plan (businesses policies)

During the Saudi Arabia Eighth Economic development plan SAEIEDP, the government-led enterprises had increased their research and development capabilities. The first company was SABIC, one of the leading companies in petrochemicals and hydrocarbon industries. The number of its researchers and workers in the R&D field had exceeded 500 hundred individuals, and it had more than 200 hundred registered patents in different countries around the world. Furthermore, the company had transformed many of these patents into its production line with a continues development for its products quality and performance.

The second company was Aramco, one of the leading companies worldwide. Aramco had created its R&D development facilities with more than 400 researchers. During the SAEIEDP, Aramco had more than 17 registered patents and more than 90 under review to be complete registered patents (Saudi Arabia, Ministry of Planning, 2005).

During the SAEIEDP, the number of industries working in the two cities of Jubail and Yanbu had reached 218 that produce 7.9% of the total world demand for the petrochemicals products.

The government through the Saudi Arabia General Investment Authority drew several policies to increase foreign investment in Saudi Arabia. The major policy was to treat foreign investors as local investors by providing loans and tax incentives through the Saudi Industrial Bank and provide low-cost land to any foreign investor without the need to share any investments with local individuals (Saudi Arabia, Ministry of Planning, 2005).

During the SAEIEDP, the Industrial Development Bank announced a new program that aimed to support the small and medium size businesses through the warranty program. This program aimed to guarantee 75% of the total loan that was provided to any business through the private commercial banks. Loans were provided by local banks to the new business through the government industrial banks rather than land mortgages. Also, the government created an agency that took care of small and medium size business and their needs (Saudi Arabia, Ministry of Planning, 2005).

During the SAEIEDP, there were around 693 thousand registered facilities and 93% of them were small businesses. The Saudi government found that these businesses needed help to grow. Accordingly, the government developed several programs for the small businesses through financial incentives and managerial support (Saudi Arabia, Ministry of Planning, 2005).

By the end of the seventh plan, Saudi Arabia joined the World Trade Organization. This step had reduced all trade barriers between countries and allowed free exports and

imports for many products from around the world. However, the government had employed several protective policies to help developing local products and to prevent foreign product immersion.

The government also created an economic offset program that aimed to increase foreign direct investment. The programs resulted in the creation of 17 new industries with more than 500 million dollars in investment in technology transfer, such as airplane wings manufacturing, food and beverages and other production (Saudi Arabia, Ministry of Planning, 2005).

In 2001, the Saudi government created the Saudi industrial property authority. This agency was meant to control all industrial and technological cities expect the King Abdul-Aziz City for Science and Technology, and the Royal Commission for Jubail and Yanbu. The agency's major objective was to support small and medium size businesses; create new industrial cities; support export, and provide facilities for the new industries. To support these objectives, the agency with the government support implemented several policies. These policies were meant to create several incubators in the industrial cities to nurture small and medium size businesses. The city also provided financial support to the industries that had a competitive advantage for the economy. Also, the support was provided to the industries that employed high technologies in their products and production process (Saudi Arabia, Ministry of Planning, 2005).

4.3.4.5.9 Supported technological content products

- **2011-2015 Saudi Arabia Ninth Economic development plan (SANEDP)**

DP	NUM	Policies & Objectives	GIS	NIS	RIS	RIC
9th	1	Created six economic cities around the country		→		
	2	Increased the support to the small and medium size business		→		
	3	Increased the informational base of the small and medium size industries	↔	↔		
	4	Created special areas in industrial clusters to facilitate the small and medium size businesses duties		→		
	5	Supported the products that have a technological content	↔	↔		

Table 174 the Saudi Ninth Economic Development Plan (Industrial Policies)

During the previous eighth plan, the government made the decision to create six economic cities around the country that aimed to absorb foreign investments. These cities existed in several regions around the country. However, bureaucracy interfered with the creation of the cities, which hindered its operation and led the government to interfere and correct the cities' paths (Saudi Arabia, Ministry of Planning, 2010).

The government increased the support for the small and medium size business through special programs. Furthermore, the government increased the informational base of the small and medium size industries to make their information available for the national and international public market. Also, the government started to create special areas in industrial clusters to facilitate the small and medium size businesses duties. Also, the government focused on and increased its support to the products that have a technological content and to be exported to foreign markets (Saudi Arabia, Ministry of Planning, 2010).

4.3.5 Horizontal institutional connectivity (university, financial, GRIs, and industrial)

4.3.5.1 Overview

This section will explore the horizontal institutional and industrial connectivity in Saudi Arabia innovation system. This investigation will include the connectivity of the four major elements for any successful innovation system that indicated by scholars, such as Porter (Porter, 1998), Lundvall (Lundvall, 2004), Nelson (Nelson, 1993), Cook (Yetton, Craig, Davis, & Hilmer, 1992), and others. These elements are the universities (UNV), monetary institutions (MON), government research institutions (GRI), and industries (IND). The search will include the major policies, incentives, organizations and the role of government in enhancing the connectivity between these institutions to develop an innovation system. In each plan, there will be a table that indicates the policies that influenced the institutional connectivity. Beside each policy there will be stars to explain the connectivity between institutions. Each plan will be headed by a categorization to explain the major vision and objective of the plan. However, some plans will not have a specific category because it continued the previous plan objective and vision. The following discussion will develop an understanding of the evolution of the institutional connectivity and its role in developing the innovation systems.

4.3.5.2 Established a connectivity system between the financial and private industrial initiatives

- **1970–1975 Saudi Arabia First Economic development plan (SAFEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
1st	1	Supported the private initiatives financially to create their industries		*		*
	2	Created the Saudi Industrial Bank to fund new industrial projects		*		*
	3	Funded the creation of a solid educational infrastructure	*	*		
	4	Created the industrial development Research Center to provide consultation to private and government businesses			*	*

Table 175 Saudi Arabia First Economic Plan on institutional connectivity

To support the industrial system the government established a connectivity between the industrial system and government finance by Supporting the private initiatives financially to create their industries. The government accordingly the Saudi Industrial Bank to fund new industrial projects.

To support the educational system the government created a financial government supportive system using oil revenues to support the educational system. This support took place by funding the creation of a solid educational infrastructure.

To support the relation between the industrial and GRIs, the government created the Industrial Development Research Center to provide consultation to private and government businesses (Saudi Arabia, Ministry of Planning, 1970).

4.3.5.3 increase relation between the research laboratories and oil production fields

- **1976–1980 Saudi Arabia Second Economic development plan (SASEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
	1	Provided loans and research assistance to investors through national laboratories		*	*	
	2	Invested heavily in large projects such as gas and oil production and encouraged individuals and smaller firms to invest in agriculture		*		*
	3	Supported foreign investment by partnering with foreign companies		*		*
	4	Established research programs along with universities and government agencies	*		*	*
	5	Established several research programs with foreign universities	*	*		
	6	Facilitated importation of foreign researchers and workers			*	*
	7	Created the Industrial Development Center to provide research advice			*	*
	8	Invested in foreign GRIs that could solve local existed problems		*	*	*

Table 176 Saudi Arabia second Economic Plan on institutional connectivity

To increase the connectivity between the educational and industrial system the government created the Institute of public administration to be able to train public employees on how to deal with managerial, industrial, and financial issues.

To support GRIs operations, the government implemented new policies to support the national laboratories by providing loans and research assistance to investors through national laboratories.

To reinforce the industrial sector, the government implemented several new financial policies by investing heavily directly from the general government budget into large projects such as gas and oil production and encouraged individuals and smaller firms to invest in agriculture, food, and other smaller businesses. The government increased the connectivity between the financial and industrial system through supporting the foreign investment and partnership with foreign companies, especially in petrochemicals and oil production. Furthermore, the government increased the connectivity between the financial and industrial sector by funding projects and industries in underdeveloped

regions and created an environment of industrial activities locally and internationally (Saudi Arabia, Ministry of Planning, 1976).

To increase connectivity between the educational, research, and industrial sectors, the government established research programs along with local and international universities and government agencies in the fields of water desalination, water availability and agriculture production. The government eased the process of collaboration by facilitating the importation of foreign researchers and workers to conduct research activities related to renewable energy, agriculture, and water issues. To increase the connectivity between the research and industry the government created the Industrial Development Center to provide research advice and consultation to the private sector. To solve any environmental issues that could occur from the extensive industrial activities, the government invested in foreign GRIs that could solve the existed industrial and environmental problems in Saudi Arabia (Saudi Arabia, Ministry of Planning, 1976).

4.3.5.4 invested in petrochemical infrastructure (companies and clusters)

- **1981–1985 Saudi Arabia Third Economic development plan (SATEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
3rd	1	Initiated one of the major government financed petrochemical and hydrocarbon companies (SABIC)		*		*
	2	Funded the creation of the Royal Commission of Jubail and Yanbu		*		*
	3	Increased the industrial bank branches to several regions		*		*
	4	Provided the managerial training through the industrial bank	*	*		*
	5	Increased and upgraded existed vocational and educational facilities	*	*		*

Table 177 Saudi Arabia Third Economic Plan on institutional connectivity

In the third plan, the government initiated several major policies that increased the connectivity between the financial and industrial sector. The government initiated of one of the major government financed petrochemical and hydrocarbon companies was

conducted in the plan. the government also Funded the creation of the Royal Commission of Jubail and Yanbu. To ease the process of the industrial support, the government Increased the industrial bank branches into several regions to ensure equal opportunities in lending investors in industrial activates. To make sure that investment was properly managed, the government through the industrial banks provided the managerial training for future industries to manage new investments (Saudi Arabia, Ministry of Planning, 1980).

To increase the support for the new industries the government stopped all tax income and relied heavily on oil income to support their economic development. The government also supported the industrial system with training services by upgrading the existing vocational and educational facilities to be capable of coping with new technologies (Saudi Arabia, Ministry of Planning, 1980).

4.3.5.5 Aligned the universities outcomes with the job market

- **1986–1990 Saudi Arabia Fourth Economic development plan (SAFREDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
4th	1	Produced financial incentives to businessmen in the private sector to provide training programs	*	*		*
	2	Encouraged the creation of new financial institutions to provide services to business		*		*
	3	Used universities in R&D activities in the field of applied science	*			*
	4	Changed the vocational and technical curricula to be compatible with the job market	*			*
	5	Provided information and data to all scholars	*		*	
	6	Created the product quality measurement agency			*	*

Table 178 Saudi Arabia Fourth Economic Plan on institutional connectivity

In the fourth plan, the government increased the connectivity between the educational, financial, and industrial sectors by providing financial incentives to businessmen in the private sector to provide training programs to new graduates. The government also created several financial institutions that would provide loans to businesses.

The government encouraged the connection between the educational sector and industrial production by encouraging R&D in the fields applied science and hydrocarbon productions. The government also encouraged the vocational and technical to change their curricula to be compatible with the job market.

In the fourth plan, the government increased the connectivity between the GRIs and industry by using GRIs to increase the products quality measures in the industrial sector by creating the Product Quality and Measurement Agency. This agency played a major role in increasing the product quality and made it most compatible with international standards (Saudi Arabia, Ministry of Planning, 1984).

4.3.5.6 Increased exports and encouraged exports using financial incentives through banks and special funding agencies

- **1991–1995 Saudi Arabia Fifth Economic development plan (SAFFEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
5th	1	Connected all high educational institutions with the job market	*			*
	2	Increased the university research productivity	*		*	
	3	Invested heavily in basic equipment and infrastructure in major industrial cities		*		*
	4	funded the exports by creating the Saudi Industrial Export Company and the Islamic Bank to fund export activities in Saudi Arabia		*		*
	5	Supported foreign investments in the local economy		*		*
	6	Obligated local banks to direct local savings to invest in the economy		*		*
	7	Encouraged investors to create financial companies that provided support to industrial companies		*		*
	8	Encouraged companies to enter the stock market		*		*

Table 179 Saudi Arabia Fifth Economic Plan on institutional connectivity

During the fifth plan, the government increased the connectivity between the educational and industrial sector by connecting all higher education institutions with the job market especially in technical fields. The government also obligated government led research institutions to connect with universities and conduct shared researches.

To enhance the development of the industrial sector, the government encouraged the exportation of local products by funding exports through the Saudi Industrial Export company, which mainly marketed the Saudi petrochemical products to the international market

The government also invested heavily in basic equipment and infrastructure in major industrial cities and in agriculture production to fulfill the country's major needs. The government also increased the connectivity between the financial and industrial sector through the fallowing policies

Firstly, supported foreign investments, especially in investments that were accompanied by technology transfer (Saudi Arabia, Ministry of Planning, 1990).

Secondly, obligated local banks to direct local savings to invest in economic and industrial activities by providing loans to investors. Thirdly, encouraged investors to create financial companies that provided support to industrial companies. Fourthly, encouraged companies to enter the stock market to increase the size of their firms and activities (Saudi Arabia, Ministry of Planning, 1990).

4.3.5.7 Encouraged the development of local industries through money incentives

- **1996–2000 Saudi Arabia Sixth Economic development plan (SASIEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
6th	1	Encouraged research facilities to connect with industries to develop their products			*	*
	2	Provided scholarships to KACST employees		*	*	
	3	Allowed the venture capitalist companies to enter the industrial markets		*		*
	4	funded 477 transformative production industries with $ 3.5 billion dollars in investments		*		*
	5	Increased the effort to support the private sector by redirecting the government budget from consumable products		*		*
	6	Provided incentives to companies that hired Saudi citizens		*		*
	7	Funded local products purchasing to get access to government loans		*		*

Table 180 Saudi Arabia Sixth Economic Plan on institutional connectivity

To increase the connectivity between the Gris and industrial sector, the government encouraged research facilities to connect with industries to develop their products. To increase the workers' capabilities in the KACST, the government led research facility the government connected this sector with the educational facilities by providing scholarships to KACST employees (Saudi Arabia, Ministry of Planning, 1995).

The government increased the connection between the financial and industrial sector by allowing venture capitalist companies to enter the industrial markets. Thus, the government-funded 477 transformative production industries with $ 3.5 billion dollars in investments. This effort supported the private sector by redirecting the government budget from consumable products. The government encouraged also increased the connectivity between the financial and industrial sector by providing incentives to companies that hired Saudi citizens. The government also provided funds for local products purchasing to get access to government loans (Saudi Arabia, Ministry of Planning, 1995).

4.3.5.8 Increase monetary support to the small and medium sized business

- **2001–2005 Saudi Arabia Seventh Economic development plan (SASVEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
7th	1	Increased its support to small and medium sized businesses		*		*
	2	Supported the industry through the government loaning banks		*		*
	3	Encouraged businesses by providing local lands and rentable offices		*		*
	4	Started to grow investment in public facilities and services		*		*
	5	Encouraged the private sector to invest in oil refineries and production		*		*
	6	Allowed banks to fund new businesses using real estate mortgages		*		*
	7	Supported incubators and mediator companies through KACST		*	*	*
	8	Created programs to improve the creativity of individuals	*		*	

Table 181 Saudi Arabia Seventh Economic Plan on institutional connectivity

In the seventh plan, the government increased the relation between the financial and industrial sector by supporting small and medium size businesses and encouraging angel investors to support this type of industrial activities. The government also supported the connectivity between the small and medium sized business through shared private-public institutions to sustain and fund the theses businesses. The government supported existed industries through the government loaning banks and commercial private banking institutions (Saudi Arabia, Ministry of Planning, 2000).

The government also encouraged the industrial system by funding the establishment of local lands and rentable offices to encourage small businesses to settle in the industrial clusters. The government increased the investment in public facilities and services in the industrial cities in Jubail and Yanbu (Saudi Arabia, Ministry of Planning, 2000).

The government also allowed banks to fund new businesses using real estate mortgages as a guarantee for loans. The government also freed its trading system from high taxes and the tariff on industrial, agricultures, and other products.

The government supported the connectivity between the financial, GRIs, and industry by creating incubators and mediator companies through King Abdul-Aziz City for Science and Technology. The government created special programs that sought to improve the creativity of individuals through connectivity between research institutions, universities, and vocational institutions (Saudi Arabia, Ministry of Planning, 2000).

4.3.5.9 Increased the role of GRIs in industrial operations through quality agencies, patent, and R&D

- **2006-2010 Saudi Arabia Eighth Economic development plan (SAEIEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
8th	1	Provided scholarships to qualified candidates to complete their education	*		*	
	2	Increased the number of research centers in universities	*		*	
	3	Aimed to work with the Saudi measurement agency through KACST			*	*
	4	Continued KACST policies in developing its R&D base			*	*
	5	Transformed many patents into production line			*	*
	6	Invited the foreign research companies and meet them with local industries			*	*
	7	Encouraged the industrial bank to increase its support to industries		*	*	*
	8	Supported the small businesses through financial incentives and managerial support		*		*
	9	Increased foreign investment in Saudi Arabia		*		*
	10	Treated foreign investors as local investors		*		*
	11	Supported the industry through the Industrial Development Bank		*		*
	12	Established new spaces to absorb the incoming foreign investments.		*		*
	13	Created the Human Resource Development Fund		*		*
	14	Developed the stock market to absorb new industrial companies		*		*
	15	provided loans and investments for highly competitive projects		*		*

Table 182 Saudi Arabia Eighth Economic Plan on institutional connectivity

In the eighth plan, the government increased the connectivity between the educational and GRIs system by providing scholarships to qualified candidates to complete their education in all fields and ensured the companies and GRI's have access to new technologies through the educational system. To achieve this goal, the government increased the number of research centers in universities had reached 46 centers in the fields of agriculture (Saudi Arabia, Ministry of Planning, 2005).

As for an increased connectivity between the industrial sector and GRIs the government encouraged the Saudi measurement agency through KACST to increase all Saudi products had a high quality according to the local and international standards. KACST the government led research and development institutions supported the R&D bases by buying patents and industrial information bases from different parts of the world. This

step helped in increasing the connectivity between the GRIs and industries by transforming patients into a production line with a continues development for its products quality and performance. The government also encourage the connectivity by inviting the foreign research companies to the country and meet them with local industries to see how collaboration could be increased between the two parties. Accordingly, the industrial and GRIs encouraged the connectivity with financial sector by encouraging the industrial bank to increase its support to industries that were willing to invest in R&D extensively. The government developed several programs for the small businesses through financial incentives and managerial support. These incentives were provided to the industries that had a competitive advantage for the economy. Consequently, the government encouraged foreign investment in Saudi Arabia through the help of the Saudi Arabia General Investment Authority. The government treated foreign investors as local investors by providing loans and tax incentives through the Saudi Industrial Bank and provide low-cost land (Saudi Arabia, Ministry of Planning, 2005).

The financial sector increased the connectivity with the industrial sector through small businesses. The government announced new programs through the Industrial Development Bank that aimed to support the small and medium size businesses. Another program was the Human Resource Development Fund to fund organizations that were willing to employ citizens in their facilities. Furthermore, the government increased its focus on the stock market to absorb new industrial companies (Saudi Arabia, Ministry of Planning, 2005).

- **2011-2015 Saudi Arabia Ninth Economic development plan (SANEDP)**

DP	NUM	Policies & Objectives	EDU	FIN	GRI	IND
9th	1	Increased the technology transfer	*	*	*	*
	2	Encouraged KACST to increase relation with universities by establishing 15 national centers in universities			*	*
	4	Increased the support to KACST		*	*	
	5	Increased the investments on R&D and innovation		*	*	
	6	Increased the number of incubators and technological valleys	*		*	*
	7	Encouraged the universities to support the knowledge-based economy	*			*
	8	Created new research facilities in the universities	*		*	
	9	Created several research facilities in national universities	*	*		
	10	Increased the higher technology grants and scholarships to faculty members	*	*		
	11	Increased the investment in the higher education sector	*	*		
	12	Created six economic cities around the country		*		*
	13	Increased the connectivity between foreign and local private investments		*		*
	15	Encouraged the creation of mediator companies		*		*
	16	Supported the exports through the Saudi Fund for Development Agency		*		*
	17	Funded businesses through the Islamic funding institutions		*		*
	18	Provided no interest loans to small businesses through private institutions		*		*
	19	Established seed organizations		*		*

Table 183 Saudi Arabia Ninth Economic Plan on institutional connectivity

In the ninth plan, the government aimed to increase the technology transfer through public and private companies, research institutions and university system.

KACST increased its relation and existence in universities by establishing 15 national centers. The government also invested extensively in S&T to reach $2 billion USD. During the plan, the government considered KACST as one of the major development motivators accordingly the government increased the support and investments in KACST, innovation, and R&D activities in the whole country (Saudi Arabia, Ministry of Planning, 2010).

The government also increased the connectivity between the industry GRIs and industry by encouraging the creation of incubators and technological valleys (innovative technological startup companies) within the universities and connect them directly with the industries to increase their productivities. To increase this connectivity, the

government created new research facilities in the universities that aimed to achieve the general government goals. The government implemented new policies to invest in several international research chairs in high ranked universities. Furthermore,

The government increased the higher technology grants and scholarships to faculty members to complete their higher education in many technical fields (Saudi Arabia, Ministry of Planning, 2010).

To absorb the foreign investments the government created six economic cities around the country that aimed to absorb foreign and local investments in innovation and industry. The government encouraged connectivity between the educational, GRIS, and industrial sector by strengthening the financial sector. The government eased the creation of venture capitalist and mediator companies. The government also encouraged local banks to provide loans with low-interest rates to the small and medium-sized businesses (Saudi Arabia, Ministry of Planning, 2010).

CHAPTER 5

COMPARING INNOVATION SYSTEMS IN CHOSEN CASES

5.1 Methodology of the Study

This chapter compared the three countries' innovation systems. The First part will investigate the vertical connections between the Global Innovation System, National Innovation System, Regional Innovation System, and Regional Innovation Clusters. Furthermore, this chapter has investigated the horizontal connections between the university systems, financial system, government research system and industrial system. The comparison has included the fifth section to compare the general plans objectives that guided all the plans sections to a goal. This objective has affected all three countries institutional performance to be able to cope with these objectives. The investigation included the commonalities and strength of major individual policies in the innovation system in these countries.

5.2 Vertical connectivity investigation between (GIS, NIS, RIS, and RIC)

This section investigated the policies that affected the connectivity between the four-major vertical innovation connectivity. These levels are the Global Innovation System (Saxenian, 1994), National Innovation System (Nelson, 1993), Regional Innovation System (Cooke, Philip., Asheim, Bjorn Terje.,Boschma, Ron., 2011), and Regional Innovation Clusters (Porter, 1998). These levels have been investigated through the following institutions and objectives that had been identified as vital for innovation systems existence by key innovation theorists:

1- The evolution of economic development plans objectives.

2- The evolution of Government university policies

3- The evolution of Government financial policies

4- The evolution of Government research institutions policies

5- The evolution of Government industrial policies

5.2.1 Evolution of the governments innovation objectives toward the economy

5.2.1.1 Overview

This part of the research investigated the commonalities and strength in the major government objectives in the economic development plans. The comparing elements had been coded according to its importance and vitality for a successful economy and a successful innovation system These element was mentioned by several distinguished theorist, such as Richard Nelson (Nelson, 1993), Maryann Feldman (Feldman & Kogler, 2010), Annalee Saxenian (Saxenian, 1994), Phillipe Cooke (Cooke, Philip., Asheim, Bjorn Terje.,Boschma, Ron., 2011), Bengt-Ake Lundvall (Lundvall, 2004) and others. Also, these elements had been mentioned in several theories, such as the Marshall industrial districts theories (Marshall, 1890), the Three Waves of Economic Development theories (Cencula Olberding, 2002), the Creative Class theories (Florida, 2014) and others. Thus, six major areas that helped these countries in achieving their innovative goals. These areas are:

1- International connectivity policies

2- International Agreements

3- Domestic connectivity policies

4- Major Industrial focus

5- Major innovation Connectivity Policies

6- Major Market policies

5.2.1.2 International connectivity policies

The international competition and world collaboration have its roots in the second wave of economic development and the analysis and investigation of OECD economic models (Cencula Olberding, 2002; OECD, 2014). To increase international collaboration theorist mainly focused on eliminating trade barriers and decreasing taxes (Ash, Michael., Organization for Economic Co-operation and Development., 2010). Each country of the three investigated cases had gradually decreased restrictions on imports and exports. Table (184) shows the rules and policies that increased the relation between the investigated countries and the world. In the early 1950s, India was a conservative country in dealing with imports and restricted many high technological products from entering India. In 1992, These restrictions had been reduced gradually to allow Indian products to enter the international markets. To encourage export, India reduced the Imports duties and tax rates, so other countries would do the same and reduce taxes and duties of the Indian Products and increase the flow of products internationally.

South Korea followed a different path (table 184). South Korea implemented the principle of free enterprises or a free market, which allowed companies and institutions to increase their relationship with international markets. Simultaneously, South Korea allowed the importation of technological equipment to upgrade the industrial infrastructure and restricted many similar domestically produced products. In 1977, the Korean government decided to allow the importation of all products gradually to increase competition and encourage local industries to raise the quality of the local products. In 1982. South Korea adopted an export-led growth to maintain an open economy.

In Saudi Arabia, the situation was different than the other investigated countries. In 1970, the number of factories and industries were limited, and mass production was limited to specific products that cannot compete in the international market except for oil. Thus, Saudi Arabia was in need for all sort of products that can support the economy and it needed to export its oil to all countries without restrictions. Thus, the Saudi government chose to be an open country and reduced tariff to allow the importation and connectivity with the worlds.

International connectivity policies					
	India		**South Korea**		**Saudi Arabia**
1951	Increased the exports and reduced the imports	1962	Implemented the principle of free enterprise to the Korean economy	1970	Allowed open economy to import high technological machines from advanced countries
1961	Expanded exports	1967	encouraged exports and free imports	1986	Allowed the free importation of goods
1992	Reduced the import duties	1972	Encouraged local and medium-sized industries by providing export incentives	1986	Encouraged the importation of new technologies and technical workforce
1992	Reduced the tax rates	1977	Liberalized the imports to increase foreign competition and encourage free trade practice	2001	Freed the trading system from high taxes and high tariff
		1982	Reduced tariff barriers gradually especially on technological import	2011	Supported the exports through the Saudi Fund for Development Agency
		1982	Adopted an export-led growth to maintain an open economy		

Table 184 Major Objectives- International Connectivity Policies

This lead to a conclusion that developing countries need to open its local markets and reduce tariff taxes to allow the flow of foreign goods. These policies will allow domestic products to ship overseas and to create an absorptive capacity that could increase the international relations. The open market policy increased competitions between the

domestic and international products, which obligated the countries to implement extra policies to increase measures and to encourage local industries to innovate.

5.2.1.3 International Agreements

One of the major policy options to increase international connectivity was to sign an agreement with other countries such as the U.S and Europe (Freeman, 1987). Table (185) shows the major trading and international agreements that helped in boosting the connectivity with the global world in the three investigated countries. Although India was the first in implementing Economic development plans, India did not join the world trade organization until 2002. These agreements were important to increase the international connections, which would support the exports and help local products to enter the international market. These agreements were one of the major motivators for India and other countries to reduce their trade barriers and increase the flow of goods and support innovation accordingly. In 2005, India signed several agreements with United Stated that meant to encourage the flow of products and motivated many U.S companies to relocate in India.

Agreements					
	India		**South Korea**		**Saudi Arabia**
1997	Joined OECD	1982	Implemented the GATT code for licensing the imports	1975	Signed several cooperation agreements with countries such as the U.S, the UK, Sweden, Turkey, and Finland, to assist the national effort
2002	Joined regional trade organizations with extremely low rates of tariff	1991	Joined the United Nations	1986	Encouraged private companies to build a relationship with the neighboring countries
2002	Joined the GATT consortium	1996	Joined OECD	1996	Joined the GATT agreement
2005	Signed several trading agreements with the United States	2008	Enforced the United States-Korea Free Trade Agreement	1996	Signed eight agreements with foreign countries
		2008	Enforced the Free Trade Agreement with EU	2006	Signed several free trading zones with foreign countries
				2006	Joined the World Trade Organization

Table 185 Major Objectives- Major International agreements

In 1982, South Korea started to increase its relationship with the world by joining the GATT Consortium to increase the trading relations with the international market. South Korea decided to sign several individual trading agreements with the United States and Europe. These agreements meant to increase the relationship with the international market and helped to increase the flow of product from and to South Korea.

Since 1975, Saudi Arabia signed several trading agreements with international countries to help ease the process of exporting the crude oil to the international market and importing high technological goods to the local markets.

Trade agreement played a crucial role in the international market connections in the three countries and is considered important in finding new markets for domestic products. Increase exports through trade agreements enhance the possibility to create an absorptive capacity. Finding markets for local products could help domestic firms in increasing their

production quality and in reducing the cost of production that could help firms in developing innovative products.

5.2.1.4 Domestic connectivity policies

Domestic institutional connections were encouraged and illustrated by many scholars as an important tool to build and innovation systems (Breschi, Stefano., Malerba, Franco, 2005; Chung, 2002). This part was mainly focused on policies that affected the rural areas to have a clear understanding of the difference in the development patterns for each country.

One of the major objectives that the three countries implemented in their major objectives in the economic development plans was to develop the rural areas and to increase the rural and regional connectivity with central cities (table 186). India's major concern in the early 1950s was to find solutions to develop the rural areas. This includes the development of the industrial, educational, financial, and all economic activities and finds ways to connect them with the central decision makers. To achieve this goal, India worked on reorganizing its administrative system and on creating the Panchayats as village councils that could control villages and deliver the decisions and needs from the highest to the lowest administrative areas vice versa.

Domestic connectivity policies					
	India		**South Korea**		**Saudi Arabia**
1956	Developed the rural areas in the country	1972	Balanced the development in the economy to reach all regions	1970	Increased local worker's productivity as in Nomads and Bedouins
1956	Focused on smaller villages and rural areas and created the Panchayats	1987	Promoted private initiatives in all regions and metropolitan areas	1981	Focused on regions that had the capability to grow using their natural resources
1992	Increased the reliance on domestic resources to finance local investments	1992	Increased investment funds to local cities and created regional funds programs	1991	Provided equal distribution of income based on the population size
				2006	Distributed equal development to all regions

Table 186 Major Objectives- Domestic Connectivity Policies

In 1972, South Korea started to increase its attention toward the local areas, due to the central cities population expansion. In 1987, South Korea supported the private initiatives and increased the support to the private sectors in rural areas. In 1992, the government increased the connectivity with local areas by creating investment funds to local cities and by creating regional funds programs to encourage individuals.

In 1970, Saudi Arabia's major issue was to resettle Bedouins and nomads that lived in the desert in villages and central and regional cities. The government worked to increase services and infrastructure, such as roads, schools, industries, and health facilities to be able to connect the rural areas with the central areas administratively. However, the government focused on regions that had the capability to grow using their natural resources as in the eastern region where the oil first found.

Developing rural areas were very important in these three countries especially in areas that had needs, such as agricultural needs in India, industrial needs in South Korea and oil

needs in Saudi Arabia. The equal development policies helped these countries to create access to the raw material rural areas and increased connectivity to central areas.

5.2.1.5 Major Industrial focus

Coding the industrial concentration and focus for each country is very important to identify the major government trends visions toward its institutions. Each country had its specific goals and visions in developing their industrial and economic base. In 1950, India nationalized all the government enterprises and focused on developing the agricultural fields by encouraging the private initiatives. The government also encouraged the connectivity between the rural, regional, national and international market by supporting products purchasing and money exchange. In 1997, the government Encouraged Information technology as one of its primary objectives to be the world information technology hub.

Major Industrial focus and attention					
	India		**South Korea**		**Saudi Arabia**
1951	Focus on agriculture as the main economic development motivator	1962	Focused on industries such as oil refineries, cement plants, chemical plants, fertilizer plants, and agriculture products	1976	Encouraged oil and transformative chemical production and encouraged the privet sector to invest in agriculture and food
1997	Supported the emerging fields in S&T, such as IT and Microelectronics	1977	Created S&T industrial (semiconductors, computers)	1986	Focused on agriculture and industrial production.
		1982	Heavy industry production (ships, machinery)	1996	Increased mining activities and investments
		1987	Increased the focus on car production and quality		
		2013	Increased the focus on food and global warming		

Table 187 Major Objectives- Industrial Focus and Visions

South Korea Initiated the first economic development plan by focusing on agricultural production and oil refineries as its major industrial focus. In the 1970s, South Korea

started to focus on computers and semiconductors and encouraged all existed companies to be part of the goal. In 1982, South Korea focused on developing the machines and shipbuilding factories as its primary goal and visions and encouraged all large companies to be part of this goal. In 1987, the goal was different; the government decided to invest in cars and encouraged technology transfer from the global market to the domestic industries. In 2013, South Korea focused on developing the food and other emerging issues as in global warming.

In 1976, Saudi Arabia focused on developing the oil and petrochemicals production as the major government goal. Furthermore, the government encouraged the private sector to invest in agriculture and food. In 1996, Saudi Arabia decided to support the mining activities and created several industrial companies allowed foreign investments for the first time in mining activities.

These visions in the three counties helped in diversifying the economic base and increase innovations. They achieve these goals the government established several supportive infrastructures that supported each goal. These the development of this infrastructure was mainly directed to regional and rural areas to support the production of raw materials and to ensure their delivery to domestic and international markets.

5.2.1.6 Major innovation Connectivity Policies

Theories about innovation started to increase in the past three decades. Accordingly, policies and visions started to be implemented in the economic development plans in developing countries according to major theorist model, such as porter, Lundvall, Nelson, Porter, and others announced their model of innovations in the late 1980s and early 1990s.

India started to implement major innovation objectives in its plans. In 2007, India decided to be transformed to a knowledge-based economy and encourage intellectual ideas to be part of the country's economic base (table 188). In 2011, India decided to create several regional innovation areas under a National Innovation Council. This decision was meant to increase the innovation connectivity between the central and regional areas in India.

Major innovation Connectivity Policies					
	India		**South Korea**		**Saudi Arabia**
2007	Transformed the economy to a knowledge-based economy	1977	Promoted Technological innovation as a priority to catch up with the developing countries	2001	Encouraged technological innovation as a primary driver in public policy
2007	Initiated the vision to be a world information technology hub	1997	Announced NIS, RIS, and RIC as models of innovation that must be adopted domestically	2006	Changed the economy to a knowledge-based economy
2007	Created a national innovation policy scheme	1997	Promoted Korea in the international market as an innovation hub in Asia & the world	2006	Decreased the technology gap
2012	Created the National Innovation Council	2003	Used Open Innovation as a model for innovation in the country		
		2003	Created regional technological innovation centers and connected them with the NIS		
		2003	Connected the Domestic Innovation System to the Global Innovation System		
		2013	Transformed the country to a Creative Economy		

Table 188 Major Objectives- Innovation Connectivity Policies

South Korea was a leader in implementing innovation policies between the developing countries world. In 1977, South Korea decided to catch up with the developed countries by promoting innovation as a priority in its economic development plans. In 1997, South

Korea decided to increase the connectivity between the global, national, regional and local level by reorganizing the countries territories using the NIS, RIS, and RIC, methods. The country continued developing its innovation capabilities until the country transformed to be a creative economy as announced by its Prime minister in 2013.

In 2001, Saudi Arabia decided to increase the innovative capabilities as one of its primary goals. In 2006, Saudi Arabia decided to transform its economy to a knowledge base economy and decrease the technology gap.

All three countries decided to increase their innovative capabilities. However, India and South Korea took a different approach by following the models of innovation systems and increase their connectivity between the global and domestic levels by following the theories of Innovation.

5.2.1.7 Major Market policies

The importance of market mechanisms and policies has its roots in the Marshallian and Marxists economic models that support any economy(Becattini, 1990). Accordingly, coding the market policies and the mechanism was very important in creating a successful innovation system. Each one of the three countries used to intervene in the market and controlled the prices that affected the consumers. This intervention would affect the producers and consumers of the goods, which would affect the ability of factories in controlling their products quality and the possibility to grow.

Major Market policies					
	India		**South Korea**		**Saudi Arabia**
1980	Applied the market mechanism for the supply and demand for local products	1982	Increased competition between industries using market mechanism (supply and demand)	1976	Support the market and delete taxes

Table 189 Major Objectives- Market Trends

In 1980, India started to liberalize its market and relied on the market mechanism supply and demand in controlling the market. In 1982, South Korea followed a similar path and applied the market mechanism to increase competition and product quality (table 189). In 1976, Saudi Arabia decided to eliminate taxes and to increase the intervention in the market by supporting many consumable products that affect domestic consumers.

One of the major reasons that led South Korea to apply the market mechanism in the market was to increase competition and encourage local firms to increase their quality to succeed in the local and international market. This step was one of the major reasons of South Korea and India to liberalize the markets.

5.2.2 University + Higher educational connectivity system

5.2.2.1 Overview

All innovation and economic development theorists have urged on the importance of the university system in developing an innovation system and a knowledge-based economy(Kleinman, 2005; Lowen, 1997). This section focused on institutions and policies supportive systems, which had been implanted by governments policy makers to support the higher educational system. The first part of this section focused on comparing the similarities and differences in the three countries' educational supportive institutional system. The second part focused on the major university connectivity policies that increased the innovative capabilities in the higher educational system.

5.2.2.2 Institutions that Supported University System Connectivity

At the early development stages of the three countries, the governments depended completely on the ministry of education to control funds and implement policies and did

not have specialized research-based universities. However, these policies have changed gradually over the years.

Institutions that Supports Educational System Connectivity					
	India		**South Korea**		**Saudi Arabia**
1956	Created the Institute of Technology in Kharagpur and the Indian Institute of Science in Bangalore	1971	the Korean Advanced Institute of Science and Technology	1963	Created the College of petroleum and minerals
1956	the University Grants Commission	1977	the Korea Science and Engineering Foundation (KOSEF)	2009	Created the R&D based King Abdullah Science and Technology University
1961	India Institute of Technology Delhi	1981	the Korean government established The Korea Research Foundation (KRF) which also supported the research and development field in universities		
1997	Created the Regional Sophisticated Instrumentation Centers (RSIC)	2004	Korea Foundation for International Cooperation of Science and Technology (KICOS)		
1997	Created the National Assessment and Accreditation Council (NAAC)	2009	The National Research Foundation of Korea (NRF)		

Table 190 University System- Major Institutions Supporting the Educational System Connectivity

In 1956, India decided to create the Institute of Technology in Kharagpur and the Indian Institute of Science in Bangalore as research-based universities. To increase the control on the university system, India created the University Grants Commission to control the funds and standards for all educational activities. Furthermore, India increased the standards and quality of the higher education system by creating the Regional Sophisticated Instrumentation Centers (RSIC) inside universities and the National Assessment and Accreditation Council (NAAC). These institutes were meant to increase the quality and validity of the higher educational systems outcomes in all regions and rural areas.

In 1971, South Korea created the Korean Advanced Institute of Science and Technology as the first research-based university. One of the major aims of this universities was to increase research collaboration between the International Research centers to achieve local needs. Since 1971, South Korea started to increase the role of agencies in funding higher educational needs instead of direct financial support from the government. In 1981, the Korean government established the Korea Research Foundation (KRF) which also supported the research and development field in universities. Moreover, the government created several other agencies to support domestic and international researchers consecutively.

In 1963, the Saudi government created the College of Petroleum and Minerals that was later changed to King Fahad University for Petroleum and minerals to support the economy with a qualified workforce that could serve in the field of petroleum production. In 2009, Saudi Arabia established King Abdullah Science and Technology University, the first R&D based university. The major aim of this university was to support the research-based activities for the industrial needs of the largest oil company in the country and the world Aramco.

In conclusion, India and South Korea managed to create mediator agencies between the ministries of higher education and universities. These agencies played a major role in enhancing the productivity of universities. These agencies helped these countries in controlling the funds that were provided to universities and helped the universities in developing their standards away from the bureaucratic. Saudi Arabia lacked these kinds of agencies that could help in controlling the universities outcome. However, the oil

production specialization of the previously mentioned universities helped in supporting the universities innovative capabilities.

5.2.2.3 Major University Connectivity Policies

The higher education system is considered one of the major motivator of economic development, which obligated many developing countries to increase their attention develop infrastructure in central and rural areas. One of the major steps that countries conducted to increase the validity of the higher education sector was to acquire knowledge from international universities by following several paths as in the following cases.

In 1951, India focused its attention on developing the practical education in engineering and another related field to develop the agricultural section. Through the years India worked on increasing the number of universities to serve the rural areas and to connect them with the central and global higher education system through scholars' exchange and grants to foreign scientists. In 1980, the Indian government started to increase the attention on information technology (IT). Accordingly, the government started to create several centers in major universities to support IT. In 2012 the government started to create innovation clusters in major universities to support the country's innovation base.

Major University connectivity policies					
	India		**South Korea**		**Saudi Arabia**
1951	Focused on practical educational programs	1987	Established new regional colleges and universities, especially in industrial territories	1970	Increased the number of colleges in engineering, geology, and humanities
1969	Increased attention was given to the advanced scientific institutions	1992	Promoted S&T to the educational system instead of Humanities	1986	Increased the number of higher educational institutions in rural areas
1980	Provided a selective support to universities that improved their scientific based research	2008	Increased financial support for the world-class national research universities	1991	Created new technical colleges
1980	Encouraged IT			2001	Allowed private investments to create private higher education institutions
1985	Created 17 centers in regional areas for information technology training			2006	Encouraged the creation of technology valleys and parks in universities
1997	Increased all university systems' autonomy from direct government control			2006	Created new incubators in universities and increased R&D spending
2007	Created new central universities that focused on IT and computers hardware				
2012	Created 20 Innovation cluster in 20 universities				

Table 191 University System- Major Educational Connectivity Policies

In South Korea, policies initiated toward universities was handled by other agencies and institutions. The central decision-making was kept for major visions and objectives. For example, in 1987, South Korea decided to relocate its new universities in industrial areas to increase the collaboration between the industries and higher educational facilities rather than concentrating on developing rural areas.

In Saudi Arabia, the government worked on increasing the outcomes of universities in all branches including S&T, engineering, humanities and other. Through the years the government maintained to fund seven universities including one specialized in petroleum

and minerals. The government added colleges rural areas to support the locals. However, these colleges were still under the supervision of the major universities. In 2006, the government decided to increase the number of these universities until it reached 28 universities by transforming many enlarged suburban colleges to a university. Connecting the central university system with the suburban areas was very important in developing the rural educational system. However, one of the major leading policies that all three countries took in their policies was connecting the central higher education system with the specialized higher educational system in rural industrial areas.

5.2.3 Financial institutions

5.2.3.1 Overview

Financial policies, intermediate institutions, and venture capitalist played a major role in developing the innovation clusters in notable areas as in the Silicon Valley and elsewhere (Isaak, 2009). Investigating the evolution and development of the financial sector is important in determining the useful links and positive policies in developing an innovation system in developing countries. This section focused on three major areas that enhanced the connectivity between in the financial institutions. These investigated areas include the following:

1- Institutions that supported the financial connectivity

2- Major Monetary International connectivity policies

3- Major Monetary Domestic connectivity policies

5.2.3.2 Institutions that supported the financial connectivity

In the monetary system, all three countries had established specialized banks to fund specific industries (table 192). In many cases, these banks were available in rural areas to

fund industrial operations with specific rules. The operations of these institutions were directed to support local and international investors who had an intention to invest in domestic industries. Some institutions had the opportunities to invests in international activities as in the case of the Islamic Bank in Saudi Arabia table (192). Furthermore, all three governments had eased access to government funds to support industrial and entrepreneurial activities.

Institutions					
	India		**South Korea**		**Saudi Arabia**
1956	Converted the largest commercial bank in India "The Imperial Bank of India" to the public	1991	Established KOICA as a government grant agency to S&T businesses	1970	Created the Saudi Industrial Bank to fund new industrial projects
1956	Created cooperative credit agencies for each industry in the country	1992	Established the Korea Technology Promotion Bank as high-risk venture capitalist agency	1976	Increased its partnership with national and international financial institutions by creating the Islamic Bank
1969	Increased the financial support for the Land Development Bank	1992	Established the National Science Foundation to finance international, national, and qualified regional scientists	2006	Created the general investment bank
		2003	Established the "Daedeok Special Zone Fund" to fund small and medium-sized businesses	2006	Created the Human Resource Development Fund

Table 192 Financial Institutions - Major Monetary National connectivity policies

5.2.3.3 Major Monetary International connectivity policies

All three countries were conservative in dealing with the international monetary system. India and South Korea both suffered from a lack of available funds to support their economic activities. Thus, they both relayed on imported support to support all activities in the country. On the other hand, this situation was different in Saudi Arabia because of the availability of oil income. Saudi Arabia started to support international countries and provide loans and investments in other countries infrastructure.

Major Monetary International Connectivity Policies					
	India		**South Korea**		**Saudi Arabia**
1961	Funded industries through internal loans, equity capital, and international countries	1962	Guided foreign investments to domestic infrastructure and enterprises	1970	Encouraged the open economy with no restriction on money transfer
1992	Eased regulations to allow foreign investments to flow into the economy	1977	Allowed overseas operations	1976	Supported foreign investment and partnership with foreign companies
1992	Reconstructed tax measures and relieved imports and money flow from obligations	1987	Reformed the tax basis to autonomies and liberalize the financial market	2006	Allowed foreign investment in the stock market
		1992	Provided land as an incentive to new foreign investors	2011	Provided land as an incentive to new foreign investors

Table 193 Financial Institutions - Major Monetary International connectivity policies

In 1992 India started to ease its regulations to allow foreign transfer to in and out from the country. South Korea eased its monetary regulations and started to increase foreign transfer in 1977. Simultaneously, in 1976, Saudi Arabia eased its regulations and allowed foreign transfer to flow in and out of the country.

International transfer and monetary connectivity are considered a corner stone in encouraging international companies and countries to invest locally, which consider a motivator for industries to seek these funds and innovate.

5.2.3.4 Major Monetary Domestic connectivity policies

Developing the domestic financial system was a priority for all three countries to be able to support the economy and increase investments opportunities through public savings. Accordingly, all three countries worked extensively to support the monetary system by increasing domestic connectivity. To ensure a sufficient monetary services, all three countries worked on increasing the existence of private and public monetary institutions in central and rural areas. These monetary operations were connected to the central government bank in each country to control the flow funds. Furthermore, these countries

allowed the establishment of the venture capitalists and intermediation institutions to support small business (table 194).

Major Monetary Domestic connectivity policies					
	India		**South Korea**		**Saudi Arabia**
1951	Increased the lending sources to individuals and local cultivators	1967	Sold government enterprise assets in the stock market, such as ship buildings and railways	1970	Encouraged the private banking system to handle part of the growth financing
1976	Increased financial and institutions systems exist in all regions	1977	Encouraged tolerated loans	1986	Obligated commercial banks to increase loans and shorten the period of repaying
1992	Opened mutual fund businesses to the private sector	1977	Promoted competition between institutions through loaning services	1976	Supported the creation of the private financial companies
2002	Increased private intermediation institutions and ventured capitalist role in the economy	1992	reduced the link of mutual loans between a large corporation	1981	Encouraged private commercial banks to take the role of financing new industries
2002	Encouraged commercial banks to provide long-term loans to large enterprises	2003	Provided tax incentives to local businesses to innovate	1986	Instituted the stock market and implemented new policies to develop it
2007	Encouraged private agencies and institutes to support young entrepreneurs financially	2008	Enforced NSTC to coordinate the government R&D budget toward GRIs	1996	Encouraged purchasing local products to give access for local businesses to government loans
2012	Encouraged the creation of venture capitalist and angel investors	2013	Restricted funds on a highly competitive base	2011	Created seeds organizations for new businesses

Table 194 Financial Institutions - Major Monetary National connectivity policies

All three countries had achieved this priority and developed connectivity systems between International and domestic levels.

5.2.4 Government Research and Development institution (GRIs)

5.2.4.1 Overview

One of the major institutions that played a major role in developing Regional Innovation System and a Regional Innovation Clusters in areas such as the Silicon Valley was the government research institutions (De Fontenay & Carmel, 2001; Fairlie, Robert W.,

Chatterji,Aaron K., 2013). The connectivity between the government laboratories at the national level and other local private and government research laboratories played a major role in developing an innovation ecosystem. This ecosystem attracted many businesses and international laboratories to relocate notable innovation clusters in developing countries (Saxenian, 2006). Thus, considering government research facilities and its local and international policy connectivity and its supportive institutions was very important to investigate innovation systems. This section focused on institution and policy supportive system that had been implemented to enhance the productivity of the GRIs supportive system. The policies that enhanced the connectivity of the GRIs included the following:

1- Institutions that supported the GRIs connectivity
2- Major International Connectivity Policies
3- Major Domestic connectivity policies

5.2.4.2 Institutions that supported the GRIs connectivity

During the investigation on the development path of the innovation system, there were several institutional supportive systems for all kinds of GRIs and one central Research center (table 195). All supportive institutions were meant to help new laboratories and government and private research institutions in the whole country to conduct and fund researchers promptly according to specific standards and measurement.

Major Supportive Institutions					
	India		**South Korea**		**Saudi Arabia**
1956	Supported the work of the Council of Scientific and Industrial Research	1966	Established the Korean Institute of Science and Technology KIST	1970	Increased the information to industries through the Saudi statistical agencies
1956	Established the National Research Development Corporation	1962	Established the Korean Institute of Technology information KISTI	1970	Created the industrial development Research Center to provide consultation to private and government sector
1980	Created the State Councils of Science and Technology	1962	Established the Korea Trade Promotion Agency KOTRA	1976	Created the Science and Technology Council
1985	Created a central high data processing unit	1970	established several GRIs to help support and implement new technologies in industries and to build a culture of R&D	1986	Created the product quality measurement agency
1985	Created entrepreneurship cells in all science/engineering/IITs fields	1987	Established the Center for S&T Policy CSTP by KIST to draw policies for GRIs	1991	Transformed the Science and Technology Council to the King Abdul-Aziz City for Science and Technology (KACST)
		1993	Established the Science and Technology Policy Institute (STEPI) by the government to support GRIs activities and planning		
		1996	Established KIST Germany		
		1999	Created KISTEP the Korean Institute of Science and Technology Evaluation and Planning		
		2003	Increased KIST branches in local innovation clusters		
		2003	Launched the Global Research Laboratory		
		2008	Established Korea and India KIST and rename it as IKIST		

Table 195 GRIs - Major Supportive Institutions

In 1956, the India government supported the work of the Council of Scientific and Industrial Research that was reconstructed in 1980 to be the State Councils of Science and Technology. This council supported the operations of research in rural and central areas and India. In 1985, the council started to support the entrepreneurs and innovative young scientists in central and rural areas and helped them nurture and grow creative ideas.

In South Korea, the government created two institutions one was for R&D KIST, and the other was for gaining information about research from international sources to help the local KISTI (table 195). These institutions supported the creation of many central and rural GRIs and helped in connecting them with international laboratories. In 1996 and 2008, KIST established permanent laboratories in Germany and India consecutively to increase international connectivity and operations. South Korea was unique than the other cases in establishing special institutions to draw policies and for the entire S&T system in the country as in the case of STEPI and KISTEP.

In Saudi Arabia, there was the Science and Technology Council that was created in 1976 and was renamed in the King Abdul-Aziz City for Science and Technology (KACST). This council played a major role in supporting some major research domestically and internationally. However, its existence was limited to specific areas that serve its major visions and interest and didn’t establish a permanent international center as in the case of KIST in South Korea

5.2.4.3 Major International Connectivity Policies

Table 196 shows the major policies that the three countries followed to support its GRIs international connectivity and how it encouraged international countries to established research facilities in these countries.

Before 2002, India's major focus was to increase technology transfer and encourage to researchers and joint scholar's connectivity. After 2002 India started to increase the establishment of international scientific research centers. Furthermore, the government started to invite international companies such as Microsoft and Intel to build Research center in in industrial and research areas in India.

Major International Connectivity Policies					
	India		**South Korea**		**Saudi Arabia**
1980	Encouraged international GRIs scientific collaboration	1972	Increased GRIs technology transfer through KIST	1976	Established several programs with foreign research agencies
1985	Increased the technology transfer	1977	Enforced the role of GRI as a major connector with international R&D Institute	1976	Facilitated importation of foreign researchers and workers to conduct research
1992	Increased collaboration in S&T through GRIs with over 40 countries	1992	Encouraged foreign technology transfer and international joint R&D	1976	Invested in foreign GRIs that could solve the existing industrial problems in Saudi Arabia
1997	Signed agreements with 46 countries in the fields of S&T collaboration			1986	Signed several agreements with foreign countries to help the Technology Council conducting its job
2002	Increased the establishments of the international scientific centers			2006	Signed 45 contracts with foreign governments to increase innovation and R&D
2002	Accepted the help of major international cooperation as with Microsoft and Intel				

Table 196 GRIs - Major International Connectivity Policies

In 1992, South Korea started to increase technology transfer by inviting research centers to establish their R&D facilities in South Korea. Furthermore, the government encouraged local GRIs to establish international R&D facilities as in the case of KIST. The international connectivity helped entrepreneurs and local GRIS in adopting new techniques developing researchers and products and helped them to innovate.

5.2.4.4 Major Domestic connectivity policies

One of the major tasks of the GRIs in all three countries was to solve domestic problems that need to be solved using R&D and technology transfer. The policies that supported the connectivity between central and rural areas was different from country to country.

Major Domestic connectivity policies					
	India		**South Korea**		**Saudi Arabia**
1951	Increased the connectivity between already existed agricultural GRIs	1977	linked Rural GRIs with central cities projects	1986	Created four major solar power projects in different regions
1956	Created new agricultural related GRIs	1977	Added new GRIs under KIST supervision	1991	Increased workforce training to be capable of operating new technologies
1980	Allowed GRIs independence from political interference	1982	Increased the distribution of GRIs in rural cities	2001	supported incubators and mediator companies that
1992	Encouraged information and telecommunication technology	1992	Established research complexes in industries	2006	Directed connection between KACST and the foreign research facilities
2002	Increased R&D activities in “information technology, microelectronics,				
2012	Increased the R&D expenditure to reach 2% of the country’s GDP				
2012	Secured 1% of its total GDP in attracting corporate to spend more on R&D				
2012	Encouraged large Indian enterprises to establish world-class R&D centers				

Table 197 GRIs - Major Domestic connectivity policies

Since the 1950s, India encouraged reconstructed and encouraged the connectivity of the GRIs from rural to central areas especially the ones that were in agricultural areas. In 1980, the government allowed the GRIs independence from the financial systems and encouraged GRIs to seek funds from other sources. When it was time to change to information technology as the primary government concern, many GRIs started to follow the government and increased their connection with central GRIs in the IT fields.

5.2.5 Industrial (Large, Medium, and small businesses)

5.2.5.1 Overview

The industrial systems are the cornerstone in developing an innovation system. The connectivity between a concentrated industrial activates at the local level with the industries and the markets at the national level and global level increased the productivity and enhanced innovation activities in Regional Innovation Clusters. (Cooke, Philip, Schwartz, Dafnah., 2007; Cooke, Philip., Asheim, Bjorn Terje.,Boschma, Ron., 2011). In addition to the importance of the connectivity between all innovation levels to increase the clusters productivity, scholars urged on the importance of small and medium-sized businesses and the incentives system to support an Innovation Clusters (P. Cooke, Boekholt, & Tödtling, 2000). This section focused on institution and policy supportive system that had been implanted to enhance the productivity of the Industrial supportive system. The policies that enhanced the connectivity of the industrial system included the following:

1- Institutions that supported the Industrial Sector
2- Major International connectivity policies
3- Major Domestic connectivity policies

4- Small and medium-sized connectivity policies and policies

5- Incentives for industrial connectivity

5.2.5.2 Institutions that supported the Industrial Sector

One of the major motivators for industrial connectivity was the industrial institutions that supported the creation of the entire industrial system in each country. Although each country had its different approach than the other, all countries used these institutions to support connectivity between the industrial levels.

During the 1950s India supported its rural industrial system using the Panchayats as major connectors that connected the central and rural areas. Furthermore, India established several other funding institutions to fund industrial operations in rural and central areas. On the other hand, South Korea created four major institutions to support its industrial activities (table 199).

Institutions that supported the Industrial Sector					
	India		**South Korea**		**Saudi Arabia**
1951	Established a development council	1962	Created KOTRA to advertises local products internationally and gain information from international market	1970	Created (Petromeen) a company that was responsible for marketing oil
1951	Established the Khadi and Villages Industrial Development Board	1967	Established the Korean industrial standards specification	1981	Created a council to increase non-oil product exports and created exhibits in major cities
1956	Created the State Finance Corporations and the Central Small Industries Corporation	2008	Created KIAT to implement policies that motivate innovation in existed industries	1981	Initiated one of the major government-financed petrochemical and hydrocarbon companies (SABIC)
1969	Initiated the Unit Trust of India as a high-risk financial organization	2008	Established KEIT as an R&D management and international corporation in S&T	1981	Created the Royal Commission for Jubail and Yanbu
1969	Created the Industrial Development Bank that was set up in 1964			1981	Established the supportive services to the Royal Commission industrial cities to include new airports and roads
1974	Established regional testing centers to increase and test the quality			1991	Created the Saudi Industrial Export company

Table 198 Industrial System - Supportive Institutions

Since 1970, Saudi Arabia Focused its attention on developing the oil and petrochemical industries. Saudi Arabia created several industrial, advertisement, marketing, clusters, and infrastructural institutions in rural and central areas as complete connected institutions to support one major vision, which is to support oil and petrochemical production table (198).

5.2.5.3 Major International connectivity policies

To increase the international industrial connectivity, all three countries had adopted policies and regulations to support their industrial system (table 200). These policies were

focused on increasing technology transfer by encouraging the import of machines and raw materials to increasing exports through special programs and policies.

Major International connectivity policies					
	India		**South Korea**		**Saudi Arabia**
1980	Allowed selective importation of raw materials	1977	Encouraged technology transfer to local industrial production using R&D	1986	Connected in rural areas with the national and international markets
1997	Considered India to be the global hub and super technological power	1987	Encouraged companies to open overseas offices	1986	Encouraged Export program
2007	Commercialized and absorbed innovations nationally and internationally	1997	Allowed the flow of information between the business globally and domestically	2001	Supported the exports support centers in the chambers of commerce

Table 199 Industrial System - Major International Connectivity Policies

5.2.5.4 Major Domestic connectivity policies

Table 200 shows the major government policies that were directed at the central government to all businesses and industrial areas. At the early stage of development in all three countries, the government started to reconstruct the industrial system. The governments started to implement policies that encouraged the creation of robust industrial base in all areas and territories.

In 1992, India started to focus more on technology content and started to support the creation of in-house research facilities. The government started to encourage industries to adopt information technology and increase technological employment. To increase the connectivity the government announced the National Investments and Manufacturing Zone in 2011, which accommodate of all high technology industries in one area.

Major Domestic Connectivity Policies					
	India		**South Korea**		**Saudi Arabia**
1951	Registered all existed industries	1962	Evaluated the validity and advantages that existed industries would gain from new firms	1970	Encouraged private industrial initiative
1992	Obligated industries to increase their products technological content	1962	Aided businesses in purchasing and selling raw materials	1970	Increased oil refineries facilities in major cities and major regions
1992	Encouraged industrial cooperatives to established in-house R&D institutions	1972	Encouraged business mergers especially	1970	Increased oil productions along with all applicable transformative productions
1997	Increased the Indian workforce in information technology to 25%	1977	Increased the role of R&D facilities in industries	1981	Continued supporting the private sector
1997	Increased private initiatives	1987	Encouraged the companies to be near the raw materials production facilities	1986	Enforced rural areas development program
2012	Created an environment that could absorb and consumed technology between enterprises	1987	Developed companies that had the potential to grow faster	2001	Encouraged private industries to build their research facilities
2012	Announced the National Investments and Manufacturing Zone	1992	Obligated large enterprises to invest 10% of their income in small and medium business	2001	Encouraged the private sector to invest in oil refineries and production
2012	Created an innovation "ecosystems of enterprises."	1997	Implemented S&T in all industrial productions	2006	Transformed patents into production lines
		1977	Provided the highest financial advantage for the highest selling products	2006	Treated foreign investors as local investors
		2008	Spilled the country into seven major regional innovation systems	2006	Supported industries that employed high technologies

Table 199 Industrial System - Major Domestic Connectivity Policies

South Korea intervene in Industrial operation was more intended than India. The Korean government aimed to increase the relationship between businesses in all areas and territories. These policies varied from obligating large companies to invest in smaller ones. Moreover, the government obligated small businesses to ensure their products will be advantaged the large enterprises. To increase this connectivity in 2011, the

government announced the creation of 7 regional centers were businesses in specific fields connects and supported each other (table 200).

In Saudi Arabia, the major focus on increasing the productivity of oil and petrochemicals industries as the primary concern for the economic base. Although the government several other industrial clusters and facilities, the focus on oil and petrochemicals led to concentrated activities in these areas. Table 201 shows the policies the led to the industrial development in these fields.

The government policies in these cases supported the concentrated activities that led to the development of a complete connectivity system that encouraged innovation and productivity.

5.2.5.5 Small and medium-sized connectivity policies and policies

Small and medium-size as one of the major concern for policymakers in all three countries. The major reason for this interest was because of the importance of this sector in employment in these countries. India supported the small and medium-sized businesses special in local areas since 1950. The focus was concentrated on this sector because India nationalized all its large enterprises. So, the government wanted to encourage new companies by supporting the rural agricultural areas and give a chance for small and medium-sized businesses to be part of it. Through the years the government increased the support for agricultural small and medium-sized businesses. In 1997, the government decided to transform more than 5000 small and medium-sized businesses to knowledge-based and increase the support for IT sector.

Small and medium-sized connectivity policies and policies					
	India		**South Korea**		**Saudi Arabia**
1956	Allowed smaller companies to invest in smaller investments	1972	Encouraged local and medium-size industries by providing export incentives	1970	Supported the private initiatives to create their industries
1961	Increased the support to the small and medium-sized businesses	1972	Promoted the alignment of small and medium-sized businesses with large ones	2001	facilitate loans to the small and medium-sized firms
1961	Promoted small industries to the larger industries as an ancillary in their production	1972	Created the credit guarantee funds for small and medium enterprises	2001	Created incubators in industrial clusters
1980	Provided incentives to entrepreneurs in segregated areas	1992	Promoted more than 5000 businesses during this plan on high technology fields	2011	Supported the small and medium-size businesses
1985	Provided equipment to local industries through the State Small Industries Development Corporations	1992	Supported innovative entrepreneur	2011	Increased investments in innovation
1997	Transformed more than 5000 small and medium-sized businesses to knowledge-based	2003	Increased the number of R&D facilities in small and medium-size businesses		
2002	Supported all small-scale industries	2003	Increased the information to entrepreneurs to enhance their innovation capabilities		
2002	Allowed the movement of the professional technician	2013	Supported the start-ups,		
2007	linked small entrepreneurs to create new businesses	2013	Transformed creative ideas to commercialize products		

Table 200 Industrial system - Small and Medium Sized Connectivity Policies

South Korea followed a similar path in supporting the small and medium-sized business. In 1972, South Korea started to support the small and medium-sized businesses in several areas. However, in 1992 the government promoted more than 5000 businesses during this plan on high technology fields.

Saudi Arabia supported the small and medium-sized business operations since 1970. However, this effort was not concentrated in a specific field or area of study.

The connectivity and concentration on specific areas of study are considered a cornerstone in developing an innovative environment. This environment could help in connecting ideas and create an absorptive capacity that all business could produce and consume products and outcomes.

5.2.5.6 Incentives for industrial connectivity

One of the major supportive systems for local industries was the incentives system. All three countries provided incentives for local industries to nurture and grow. India used tariff reduction for local industrial needs and indirect tax incentives to support its industrial system and increase the international connectivity.

Incentives for industrial connectivity					
	India		**South Korea**		**Saudi Arabia**
2002	Reduced the tariff for the imported industrial needs from 90% to 34%	1962	Provided direct tax incentives to small and medium-sized enterprises	1981	Stopped all tax income and relied heavily on oil income to support the economy
2007	Reduced indirect tax rates on large enterprises to 30%	1977	Offered tax incentives to local industries to compete with international industries		
2012	Used tax credits as an innovation development tool instead of tax incentives	1982	Exempted from tax all R&D activities in intensive technological innovation industries		
		1982	Provided buyers credit system to increase the demand for domestic products		
		1992	Increased incentives to any business spend R&D more than 5% of their income R&D		
		2008	Used tax deduction to motivate industrial facilities to increase their R&D spending		
		2013	Increased the support to small and medium-sized businesses that employ less the 20 persons in the local areas		

Table 201 Industrial System - Incentives

South Korea used a different approach in using the support system. The government used the incentive system to increase the relation between the industries locally and internationally. The government also provided incentives on the performance and support for local communities.

Saudi Arabia provided the largest incentives for all industries by eliminating taxes and by providing industrial loans to all industries in central and local areas.

Providing a diversifies inactive system is one of a most important motivator for innovation between industries. The incentives system could lead to a surplus in industrial expensed that could be invested in R&D and investments operations.

5.3 Horizontal institutional connectivity (university, financial, GRIs, and industrial)

5.3.1 Overview

The key theories that explained the relation between the institutions, infrastructure, and industries was the Marshal Industrial district theory and the triple Helix Model. The Marshal industrial districts theory focused on the agglomeration of infrastructures and services to serve the industrial needs (Becattini, 1990; Marshall, 1890). The other model was the Triple Helix model, which focused on the importance of university, industry, and government interactions to create an innovation ecosystem (Park, Hong, & Leydesdorff, 2005). This section focused on policies that supported the horizontal institutional connectivity university, financial, GRIs, and industrial). The policies that enhanced the innovative in the domestic innovation system included the following:

1- Financial Policy connectivity
2- Institutional Policy connectivity
3- Physical connectivity

4- Individual connectivity

5.3.2 Financial Policy connectivity

Financial Policy connectivity					
	India		**South Korea**		**Saudi Arabia**
1956	Provided direct funds from the central government to several GRIs	1967	Sustained self-funding by selling government enterprise assets in the stock market	1970	Supported the private initiatives financially to create their industries
1956	Created the University Grant Commission	1967	Aided businesses in purchasing raw materials	1970	Created the Saudi Industrial Bank to fund industries
1969	Provided special finance to selected products	1977	Established KOSEF organization to fund the universities' research activities	1976	Increased the financial support to the Industrial Development Center
1969	Supported the Land Development Bank that handled the long-term farmer's credits loans	1982	Introduced venture capital system to small and medium businesses	1991	Funded the exports through creating the Saudi Industrial Export Company and the Islamic Bank
1969	Initiated the Unit Trust of India as a high-risk financial organization for businesses	1987	Maintained all grants to GRIs that cooperates with small and medium-size businesses	1996	Funded 477 transformative production industries with $ 3.5 billion dollars in investments
1980	Created the Development Banks for Industry and Agriculture activates	2008	Increased financial support for the world-class National research universities	1996	Funded local products purchasing to get access to government loans
1997	Liberalized foreign venture capitalists to invest in the local knowledge-based industries	2013	Restricted funds on a highly competitive basis between GRIs	1996	Allowed the venture capitalist companies to enter the industrial markets
2012	Attracted corporate to spend more on R&D by a public-private partnership			2006	Encouraged companies to enter the stock market

Table 202 Financial Policy connectivity

The primary motivator institutions in all economic activities are the financial institutions. Table 203 shows all the sort of government-oriented financial institutions that sported the educational, GRIs, and industry in all three countries. Both India and South Korea had managed to create several institutions to support the connectivity between the financial

sector and the other institutions. In Saudi Arabia, the government managed to create several financial institutions to fund industrial operations. However, the government depended completely on financial ability to fund GRIs and universities directly.

The intermediator financial institutions between the government and the educational, GRIs, and industries helped increasing the standards and rising competition between industries and institutions that advantaged the final products. The absence of such institutions in Saudi Arabia would increase the reliance for the educational and GRIs on direct government support.

5.3.3 Institutional Policy connectivity

Table 204 shows the policies that the government implements to encouraged institutions to connect. Each one of the three countries had managed to implement policies that encourage institutional connectivity. However, in the Saudi case, there was not a specific policy that would encourage the connectivity between all four institutions together in the financial, educational, GRIs, and industrial sector. The connectivity between all these institutions as in the other two cases would increase the flow of information and activity that supports the innovation system.

Institutional Policy connectivity					
	India		**South Korea**		**Saudi Arabia**
1956	Created laboratories in 33 universities, 88 R&D centers, and 54 associations in different areas	1972	Educated and trained employees to meet the industries S&T requirements	1970	Created the industrial development Research Center to provide consultation to private and government businesses
1961	Coordinated research work through GRIs, universities, and technical institutions	1977	Created GRIs that is responsible for quality control for new industries	1976	Established research programs along with universities and GRIs
1985	Encouraged industrial firms to acquire knowledge and technology from different GRIs	1987	Localized technological products by using GRIs in R&D	1986	Created the product quality measurement agency to increase the efficiency of industrial products
1992	Allowed freedom of GRIs, and State councils to increase their link to technical Academy	2003	Supported the start-ups, research centers, research universities and creative local industries		
1992	Encouraged IT in many GRIs, University, and industries	2008	Supported the relation between education, human resources, and S&T		
2012	Encouraged the connectivity between Innovation clusters and general industries				

Table 203 Institutional Policy connectivity

5.3.4 Physical connectivity

Table 205 shows the policies that enhanced the connectivity between the domestic institutions. These polices encouraged the institutions to connect in clusters. These close physical relations and connect enhanced the flow of products, knowledge, research, individuals, and monetary support between institutions. All three countries had managed to create and environment institutions that could be generalized to different other places.

Physical connectivity					
	India		**South Korea**		**Saudi Arabia**
1985	Encouraged the connectivity between industry and universities in job training	1977	Transferred the GRIs with specific universities and industrial clusters into a free economic zone	1976	Created the Industrial Development Center to provide research advice
1992	Increased product quality through the connectivity of agricultural universities, GRIs, and industrial laboratories	1987	Established new regional colleges and universities, especially in industrial territories	1981	Initiated one of the major government-financed petrochemical and hydrocarbon companies (SABIC)
2002	Engaged local businesses to work closely with universities in forming coursework	1992	Established research complexes within industries	1981	Funded the creation of the Royal Commission for Jubail and Yanbu
2002	Obligated the vocational institutions to connect with GRIs	1997	Established the center of KIST in Gangneung industrial complexes in 2003	1981	Increased the industrial bank branches to several regions
2002	Increased private intermediation institutions and ventured capitalist	1997	Enforced regional universities to increase the relationship with other industries and GRIs	1991	Encouraged investors to create financial companies that provided support to industrial companies
2007	Created 30 new central universities that focused IT and computers hardware	2003	Established the "Daedeok Special Zone Fund" to fund small and medium-sized businesses	1996	Encouraged research facilities to connect with industries to develop their products
2012	Created 20 Innovation cluster in 20 universities around India			2001	Encouraged businesses by providing local lands and rentable offices
2012	Encouraged large Indian enterprises to establish world-class R&D centers			2001	Supported incubators and mediator companies through KACST
				2006	Increased the number of research centers in universities
				2011	Encouraged KACST to increase relation with universities by establishing 15 national centers in universities
				2011	Increased the number of incubators and technological valleys

Table 204 Physical connectivity

5.3.5 Individual connectivity

Table 206 shows how all three countries managed to encourage individual and scholars between research facilities, university, and industries. This connectivity had been made possible through policies and special funding programs that encouraged individuals in higher educational institutions, GRIS, and industries to connect.

Individual connectivity					
	India		**South Korea**		**Saudi Arabia**
1951	Provided scholarships to students to complete their education in developed countries	1977	Increased support of foreign scientists to join fellowships and postdoctoral programs	1976	Facilitated importation of foreign researchers and workers
1956	Provided scholarships for international students to study in India	1992	Increased the support to foreign scientist to join fellowship and the post-doctoral	1986	Provided information and data to all scholars
1961	Connected all rural farms under a cooperative umbrella	1992	Increased the research funds based on research capabilities of faculties and students	2006	Provided scholarships to qualified candidates to complete their education
1961	Provided scholarships through the University Grants Commission			2006	Invited the foreign research companies and meet them with local industries
1985	Trained the workforce on information systems and technologies through education			2011	Increased the higher technology grants and scholarships to faculty members
1997	Encouraged faculty movement between universities and in-house industrial R&D				
2002	Offered scholarships for scientists to complete their education in the CSIR labs				

Table 205 Individual connectivity

CHAPTER 6

CONCLUSION AND ROAD MAP FOR SUCCESSFUL INNOVATION SYSTEM IN SAUDI ARABIA

6.1 Overview

This section included all recommendations that could support innovation clusters in Saudi Arabia as a developing country. These recommendations included the vertical and horizontal connectivity. To increase the validity of the finding this chapter contained a section of research limitation that the reader should be aware of when reading this material. Also, several future investigations could be conducted to enrich the subject of innovation systems. Finally, the concluded remarks addressed the research question and managed to answer all questions and claims in the first chapter.

6.2 Vertical connectivity recommendation

This section suggested several recommendations to be adopted by the Saudi officials to increase the possibility of creating future innovation clusters. The results depended on the comparison between the examples of innovation clusters and systems of India, Saudi Arabia, and South Korea. These recommendations included the major economic development plans objectives, university innovation system, financial systems, government research institutions and industrial system. The recommendations are considered as a road map for creating innovation clusters in possible areas in Saudi Arabia.

6.2.1 Recommendations for government innovation objectives

This part will illustrate the major objectives and economic conditions that should exist in the innovation systems plans and policies. This section has six major categories that the

Saudi government should consider. These categories are international innovation policies, international innovation agreements, domestic innovation objectives, Industrial focus, innovation connectivity policies, and market policies and mechanisms.

6.2.1.1 International Innovation Policies

One of the major categories that the government should be aware of is to maintain an international oriented economy. All three countries had increased their relationship with other international countries. However, not all the three countries had a deep international innovation connectivity.

South Korea and India had increased their innovation connectivity with international innovation hubs and locations vice-versa. Saudi Arabia also encouraged the innovation connectivity through King Abdelaziz city for Science and technology. However, Saudi Arabia needs to encourage other innovation institutions, such as universities, financial institutions, GRIs, and industries to increase their relation and connectivity with international innovation hubs vice-versa.

Furthermore, the Saudi government needs to increase the support for businesses that are involved in technology transfer. This support would be financial incentives, tariff reductions or trade barriers elimination to encourage imported machines. In South Korea, this support was increased toward industries that managed to produce and sell their innovative products. The incentives system that was designed for such industries was very important to increase the competitiveness and to encourage local producers to innovate.

6.2.1.2 International Innovation Agreements

South Korea and India conducted individual Science and Technology Agreements with countries, such as the United States, Europe, and Brazil. These agreements were meant to increase the technology transfer between the countries and support the innovation base in their science and technology hubs. Saudi Arabia was one of the pioneering countries in signing individual agreements and joining international organizations. However, one of the major clauses that these agreements should enforce is the innovation and technology connectivity among universities, GRIs, and industries between Saudi Arabia and other individual countries. This connectivity could take the form of joint research labs and visiting scholars in both countries.

6.2.1.3 Suggested domestic innovation objectives

South Korea and India implemented many policies to support rural areas by establishing many innovation institutions and industries based on local innovative needs and capabilities. These institutions were connected to the national level to secure financial and logistical support by connecting rural markets with international markets. Saudi Arabia should continue its practices in developing rural areas by investigating the opportunities in each region and develop its innovative capabilities according to its strength and possibility to grow. The government could easily do that by creating regional funds agencies that could be conducted by both the private initiatives and government support. The government should allow local officials to freely draw policies and collect funds from several resources to develop the rural areas.

6.2.1.4 Major Industrial focus

South Korea had managed to create several innovative industries by focusing on developing specific industries each ten years. This diversification helped South Korea in building a multi-innovative industry that helped to increase the dependability of South Korea's economy. One of the major issues that the Saudi government should focus on is to have a clear vision of what is the government next industrial step and how to be a world leader in the field. The government should indicate the weaknesses, opportunities, strengths, and threats for each industrial field. After the achievement of each goal, the government needs to move on to the next goal. Each goal could last from 5 to 10 years until achieved.

6.2.1.5 Major innovation Connectivity Policies

Both South Korea and India had managed to create an innovation system that includes National Innovation System, Regional Innovation System, and Regional Innovation Clusters. These innovation levels helped these countries in implementing the innovation visions and objectives in each level. One of the major policies that the government needs to adopt is to create a regional innovation system that connects with a National Innovation system and a lower Regional Innovation Clusters. The design of this system needs to be based on each region opportunities, local natural resources, and existed industries.

6.2.1.6 Major Market policies

All three countries have a degree of an open market and a market mechanism that rely on supply and demand in controlling the prices. In the case of Saudi Arabia, the government needs to apply the market mechanism of supply and demand for many products. This

policy was implemented in India and South Korea to increase the competition and encourage the local industry to innovate and compete with the international products.

6.2.2 University + Higher educational system recommendations

This part will illustrate the major University and higher educational system recommendations that should exist in the innovation systems plans and policies. This section has two major categories that the Saudi government should consider. The first part laid the recommendations for institutions that could support the university system innovative capabilities and the second part suggested universities innovation policies.

6.2.2.1 Institutions that Could Support the University System Innovative Capabilities

South Korea and India reduced their direct intervein with the university and higher educational facilities. These two countries created several intermediated government-oriented institutions. These institutions took the responsibility of directing the university system toward the government's main objectives and policies. Moreover, these institutions evaluated the universities outcomes and provided financial support according to the validity of the universities outcomes. The government of Saudi Arabia should establish several intermediated institutions between the Ministry of Education and public universities. These institutions should deliver the major government policies and visions sufficiently to improve the performance of universities and eliminate bureaucracy in dealing with the higher educational needs. These institutions should include standard and accrediting institutions that would evaluate the performances of the higher education universities and colleges. The government also should establish financial agencies that provide grants and financial support for special research. Furthermore, the government

should change the way of funding the university by focusing on individuals rather than the whole university system as in the case of India.

6.2.2.2 Suggested University Innovation Policies

The Saudi government should replicate the success of the Royal Commission of Jubail and Yanbu in developing their university system. The university system in these industrial clusters helped the industries in securing their workforce. These policies that connected the rural with national areas also existed in both India and South Korea. They both investigated the needs of rural areas and established universities and higher educational institutions in these areas.

There are several policies that the universities in Saudi Arabia could apply to increase their innovative capabilities and understand the job markets exact needs. The universities should increase their existence in the industrial clusters through special research centers. These centers should provide research assistance to local industries and understand the problems and real needs that face the industry in local areas. Furthermore, the universities should design the programs according to the local areas special needs and concern. To increase the possibilities of achieving these policies, the central government should increase the autonomy of all universities and allow them to seek different sources of financial support. This policy will allow the universities to move freely and investigate local areas true need to increase their chances of gaining funds to operate successfully.

6.2.3 Financial institutions recommendations

This part will illustrate the major financial system recommendations that should be existed in the innovation systems plans and policies. This section has two major categories that the Saudi government should consider. The first part is about institutions

that that could support the financial connectivity and the second part laid the major monetary international connectivity policies and recommendations.

6.2.3.1 Institutions that Supported the Financial Connectivity

India and South Korea had encouraged several international agencies and venture capitalists to invest in specific industrial fields to support its visions and objectives. Saudi Arabia did the same in its petrochemical industries and encouraged international investment in special petrochemicals areas. What's different in South Korea and India case that they encouraged international investors to invest in small and medium-sized business. The Saudi government should create several specialized funding agencies that could play as a mediator between the international investors and local entrepreneurs. These agencies should have a better understanding of the local businesses needs and international investors capabilities. These agencies should be located in industrial clusters, universities, and GRIs and provide services to talented entrepreneurs and young scientists.

6.2.3.2 Major Monetary International connectivity policies

South Korea had created a special agency that advertised the local opportunities to the international market. This agency was called Korea Trade Agency (KOTRA), the agency has around 126 branches around the world to support the local industries financial and advertisements needs from the international market and search for new markets to local products. The Saudi government should create special advertisement agencies that advertise the opportunities in local industrial and innovation cluster. These advertisements agencies should explain the investments opportunities and general

regulations that facilitate the investments. These agencies should target Banks, venture capitalist, financial institutions, and individuals.

6.2.4 Government Research and Development institution (GRIs) recommendations

This part will illustrate the major Government Research and Development institution (GRIs) recommendations. These recommendations should exist in the innovation system plans and policies. This section has three major categories that the Saudi government should consider. The first part illustrated the recommendations for the institutions that should exist to support the GRIs connectivity. The second part illustrated the major international connectivity policy recommendations. The third part illustrated the major domestic connectivity policy recommendations.

6.2.4.1 Institutions that supported the GRIs connectivity

Both India and South Korea have their central research facilities. These central research centers played a major role in creating several other research facilities in rural areas. After the central research centers created these research facilities, the government started to increase the autonomy and competitiveness in providing funds to these research facilities. This policy helped in creating a series of research facilities that served in serving the government objectives and local needs. The King Abdul-Aziz city for science and technology (KACST) in Saudi Arabia is playing the major role in controlling most of the research activity in Saudi Arabia. However, the concentrated activities in KACST may hinder the possibility for the city to grow and to serve the country's major needs. The Saudi government needs to distribute the concentrated research activity in KACST to increase the numbers of a research center in different areas and territories.

6.2.4.2 Major International Connectivity Policies

India and South Kore had established actual research facilities in international research hubs and encouraged international research centers to establish their research facilities in South Korea and India. KACST and other GRIs in Saudi Arabia should establish joint research facilities in international countries in research clusters and encourage visiting scholars between the GRIs.

6.2.4.3 Major Domestic Connectivity Policies

Although rural government research centers need to be administratively separated from central research centers, a central research center at the national level needs to have a degree of connectivity with rural research facilities. This policy increased the connections between South Korea and India rural research centers with the international ones. KACST in Saudi Arabia must play as the intermediator and connector between different research facilities. This could allow KACST to be an information center and a technology hub for researchers in different fields and branches.

6.2.5 Industrial system recommendations

This part will illustrate the major Industrial system recommendations that should exist in the innovation systems plans and policies. This section has three major categories that the Saudi government should consider. First, the recommendations for the institutions that supported the industrial sector. Second, the recommendations for the major domestic connectivity recommendations. Third, the recommendations for Small and medium-sized connectivity policies.

6.2.5.1 Institutions that supported the Industrial Sector

One of the biggest problems that face the world industrial sector is to find a market that could absorb local products. The South Korean government created special agencies that served as information centers for a local producer in international markets. Saudi Arabia had several similar advertisements agencies in the field of petrochemicals and oil productions. However, most of these centers were privately owned by large companies as in the case of ARAMCO and SABIC the largest oil and petrochemical companies in the country. The government needs to create several agencies to support local products and advertise local products in international market.

6.2.5.2 Major Domestic connectivity recommendations

To support the major government visions and objectives, the government of South Korea increased the support for businesses merger. This step allowed small and medium-sized business to increase their capabilities to support the economy. The government of Saudi Arabia needs to encourage businesses mergers especially with companies that engaged in a cutthroat competition to encourage them to export rather than compete. Also, the government needs to increase the role of R&D facilities in industrial firms. The Saudi government should obligate large enterprises to invest 10% of their income in small and medium business.

6.2.5.3 Small and medium-sized connectivity policies

South Korea and India encouraged the creation of small and medium sizes innovative businesses. To ensure that these businesses would operate successfully, the government encouraged entrepreneurs to connect with large enterprises and make sure that the small

businesses products would support large enterprises need. The policy helped in creating an absorptive capacity that supported the growth of small and medium-sized business and that there is a demand for their products in the local and international market. The government of Saudi Arabia should follow a similar path and encourage the alignment of small and medium-sized businesses with large enterprises

6.3 Horizontal Institutional Recommendations

This section will illustrate the recommendations and suggestions to the Saudi Arabian Innovation system depending on the comparison results between the innovation systems of India, Saudi Arabia, and South Korea. These recommendations would enhance the connectivity between the university innovation system, financial systems, government research institutions and Industrial system. The recommendation is considered as a roadmap for creating innovation clusters in anticipated rural and central areas in Saudi Arabia. The recommendation explained the relationship between the financial institutions and as the major development motivator to all other institutions. The recommendation also explained the relationship between all institutions and innovation policies.

6.3.1 Financial Policy Connectivity Recommendations

This part illustrated the financial policy recommendations that should exist in the innovation system plans and policies to increase the connectivity between financial institutions and all other institutions.

South Korea and India in the past several decades started to encourage GRIs to collaborate with each other and with other institutions using financial incentives as a tool to motivate this collaboration. Saudi Arabia needs to provide financial incentives to encourage GRIs to cooperates with small and medium-size businesses. The Saudi

government also needs to fund the universities' research activities especially in the highly ranked research universities in international accredited organizations. South Korea and India provided these incentives to universities that concentrated on research.

Also, India and South Korea liberalized their financial system and allowed international venture capitalist to invest in local based knowledge research activities and innovations industries. The two countries attracted international and local corporations to spend more on R&D through a public-private partnership. Saudi Arabia has followed a similar path, but the focus of such investment needs to be more attracted toward innovation and research activities.

6.3.2 Institutional Policy Connectivity

This part will illustrate the major institutional policy connectivity recommendations that should exist in innovation systems plans and policies. This section has several recommendations that the Saudi government should consider.

There were several successful examples in India, South Korea, and Saudi Arabia that encouraged innovation in industrial clusters. In these successful examples, the connectivity between industrial clusters and other similar industrial activities were enforced in the economic development plans. This connectivity had been increased in these examples to include the connectivity between successful industrial and innovation clusters and other GRIs, Universities and technical institutions. The Saudi government needs to replicate this successful case and generalize these policies and connectivity encouragement to other anticipated innovation hubs.

6.3.3 Physical connectivity

This part will illustrate the major physical connectivity recommendations that should exist in the innovation systems plans and policies. This section has several recommendations that the Saudi government should consider.

It was clear that successful cases in all three countries share a common location development model, which is a concentrated activity in large clusters. These clusters contain government research institutions, universities, vocational institutions, financial institutions, and industries all in one place. These industries and institutions all serve the major activities of the clusters. One of the Saudi cases is the Royal Commission of Jubail and Yanbu. These two cities have all kind of institutions concentrated in serving the petrochemicals needs. The Saudi government needs to replicate this example in other places with new needs and new industrial focus.

6.4 Research Limitation

This research investigated the economic development plans for the three countries and used several other numeric materials from OECD and the United Nations sites. This investigation did not investigate the websites of the intermediated institutes or any university, monetary, GRIs, or industry. The researcher returned to the sites of individual industries and institutions only to reassure the dates, vision, and existence of information that had been stated in the economic development plans. Furthermore, the researcher did not investigate the projects and policies that had been implemented by private or individual government agencies.

6.5 Future Possible research

There are several future investigations that could be conducted by scholar in Innovation systems. Scholar could conduct the following fields of study.

1- Conduct a participant observation for government institutions to understand their role in developing the innovation system.
2- Researchers could visit actual innovation clusters and understand how educational, financial, GRIs, and industry connect.

6.6 Conclusion

Government policies and investments could create Regional Innovation Clusters if there was an innovation system that connects the Global innovation system National Innovation system, Regional Innovation System and Regional innovation cluster. Furthermore, this system needs to be connected domestically with the educational financial, GRIs and industry. This relation will facilitate the job of innovation cluster by increasing the flow of information and product in and out of the country. This wholistic system is what creates a successful knowledge based economy that many governments attempt to implement in their economic development plan. If a successful system existed in any country, it will be easy to replicate the success on innovation clusters in different places in developing countries.

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