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STUDY ON MEASURING SYSTEMS OF INNOVATION ON NATIONAL LEVEL-CASE FINLAND

By:
Syed Yasir Qamar

Supervisor:
Associate Professor Ville Ojanen

Examiner:
Associate Professor Ville Ojanen
Professor Tuomo Kässi

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Author: Syed Yasir Qamar

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Innovation improves human affluence and comfort and is key driver of nation's economic progression. This study focuses on National innovation systems in general and Finnish national innovation system in particular. It is known that innovation process does not work in isolation; rather it is an outcome of role played numerous actors. In this study three aspects are explained- firstly, to define the most important actors of National innovation systems and secondly, a framework to analyze National innovation system. Third aspect of this study highlights and analyzes the key aspects of Finnish National Innovation system. Moreover, during the course of this study emphasis was given on the utmost central processes which are required to come off in innovation system as they can successfully lead towards innovation.

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Syed Yasir Qamar

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List of Abbreviations:

B2B Business to Business

bln Billion

CIS Community Innovation Survey

CPI Consumer Price Index

ECA Export Credit Agency

EFI Expert for Research and Innovation

e.g. exempli gratia

EPO European Patent Office

ER Exchange Rate

EU European Union

EUR Euro

FDI Foreign Direct Investment

GCI Global Competitiveness Index

GII Global innovation index

GDP Gross Domestic Product

GERD Gross domestic expenditure on R&D

HEIs Higher Education Institutions

ICT Information and Communications Technologies

IRP Intellectual Property Rights

KE Knowledge Economy

KEI Knowledge Economy Index

MEE The Ministry of Employment and Economy

mln Million

NIS National innovation system

OECD Organization for Economic Cooperation and Development

R&D Research and Development

SME Small and Medium Sized Enterprise

STP Science and Technology policy

UOTs Universities of Technology

USPTO United States Patent and Trademark office

WEF World Economic Forum

1. Introduction

In this chapter a detailed description about the background, objectives and research gap are provided. In addition, research question, methodology and research structure are also presented under this chapter.

1.1 Background and research gap

Success of an organization, person or a country can be deduced my measuring the simple objectives like gross profit, wealth and improved revenue respectively. However, there are some other strategic objectives particularly those in the Internal Business Process and Learning & Growth perspectives which have been traditionally more complex to gauge.

Innovation is considered as one of the difficult objective to compute (Landau and Rosenberg, 1986). It is of the important factors that makes a business grow and gives competitive advantage over other countries. According to Porter, "nation's competitiveness depends on the capacity of its industry to innovate and upgrade" (Porter, 1990). According to European commission 2013, "Innovation is becoming more central to our economy and to our society". Innovation as a subject is as old as humanity itself but scholarly consideration given to this subjects dates back to 1960s (Resele, 2014). According to Schumpeter (1954) "carrying out innovation is the only function which is fundamental in history". For the period of early 30 years scholarly articles on innovation were quite few and their focal point was on the industrial level. However, in early 1990s, a new concept emerged under the name of "national innovation system" (NIS) which highlighted the interconnection among academia, government and enterprises and this concept was primarily developed by various researchers (Fagerberg and Sapprasert, 2011). Before discussing National Innovation system, it is significant to divide term NIS into two parts for clear understanding of the concept. These two parts are: I) innovation and II) innovation system.

According to common man's terminology innovation could be described as developing new ideas and solutions for customers through management of advances in knowledge which is performed by highly trained and educated labour and is taken as innovation in High–tech industry. However, there is another way to look into innovation which branches out to different

aspect. In a wide spectrum, innovation can be considered as an effort to test novel products and processes and is a characteristic of at best most if not whole commercial actions (Kline and Rosenberg, 1986; Bell and Pavitt, 1993). On top of this, besides high tech innovation, it also consists of progressions in numerous other areas, for instance, logistics, supply-chain and advertising. Furthermore, the term innovation can also be applied to changes which could be new only on national level, with minimum or even negligible impact on international market. In this, comprehensive logic, significance of innovation is of equal importance in developing countries as it is elsewhere in the world (Hall and Rosenberg, 2010).

Innovation System refers to system shaped by creators and users of material and capabilities and user-creator relationship (Lundvall, 2010). Innovation System (IS) is a very important concept; perhaps it is challenging to find one definite definition for the concept. Freeman considered IS as the connections between government and private sector where interactions between the two said sectors commence, revise and diffuse novel ideas and technologies (Freeman, 1987). For Lundvall (1992) an innovation system is "the elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge... and are either located within or rooted inside the borders of a nation state". Nelson and Rosenberg defined innovation system as an arrangements of various institutions whose synergy decides the innovative efficiency and conduct of national firms (Nelson and Rosenberg, 1993). In the meantime, according to Metcalfe an innovation system is "that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies" (Metcalfe,1995; OECD,1997).

National Innovation System (NIS) managed to gain consideration in the eyes of researchers; perhaps it is yet difficult to find one particular definition for the concept. Recent studies shows that there are still research gaps in measuring NIS and proper attention is required on national level to measure the success graph of a country, however, this can be depicted by measuring innovation. The innovative performance of a country is principally dependent on how public and

private actors communicate with one another as rudiments of a collaborated system of knowledge formation. Innovation can be a significant driver of economic progression of a country and in creating employment. Same happens in the least developed countries as well as in the most developed. In all countries, payback can be reaped by well-planned policy interventions to support innovation, but this is not simple, and no one approach suits all. Hence, it is required to have a useful analytical framework which assists in analysing system's performance and simultaneously helps to identify factors which stimulus performance. (Bergek et al, 2008).

1.2 Research objectives and questions

The fundamental benefit of growth rates of different countries, which is outcome of economic growth over longer period, is credited to the existence of social capability for institutional change, particularly if the change facilitates or stimulates technical change such as innovation systems (Freeman 2002). It is accepted globally by researchers that National Innovation System (NIS) is one of the most comprehensive systemic approaches that highlights the economic and innovative performance of a country (Polenakovik et al., 2014). However, the development of the NIS is a difficult and path-dependant process due to the differences in two main sectors involved: academia and the industry with an immense consideration to the interface between them. (Freeman 1995; Hu 1992; Porter 1990; Patel 1995).

The number of projects in Finland related with research and developed showed a rapid growth in during early 1990s. According to Andersson (2009), there are two reason behind such a prompt growth: (I) entrance in European Union in 1995 with consequent fund programs and (II) compact prominence engaged on strategy-formulating commissions in the national administration. Finland has performed well in education, R&D and technology when compared internationally and has managed to attain a top rank in the world with innovation and healthy enterprises operating environments. Furthermore, good quality and well networked educational services and institutions along with continuous and long term support by numerous organizations and public sector in R&D has been a good support for Finland to maintain its success in innovation and technology (Esko Aho, 2008). On the other hand, global escalating competition in innovation activity is challenging Finland's competitive advantages. Hence, there is a need to measure the

national innovation systems of Finland to determine the economic and innovative performance of a country.

As a notion, term innovation has lengthened and diversified significantly in the past few years, yet there is no specific procedure to measure national innovation system. The fundamental research objective of this research is to examine and investigate numerous actors to gauge global innovation in general and Finland's innovation in particular. Moreover, this paper highlights numerous indicators which can be measured to determine the innovation progress of a country and to deduce whether these indicators in actuality measures innovation process, strategy and systems. By this phase, the focal research question can be demarcated as follow:

Research question: What are the systems and indicators to measure innovation on a national level?

This main question can be further expanded into three sub-questions to cater the diverse characteristics of the research problem.

Sub-question 1: What are the Finnish Innovation Policies and how innovation system works?

Sub-question 2: What is the current status of NIS in Finland?

Sub-question 3: What is the performance of Finnish NIS in comparison with Sweden and Germany?

The main research question targets to develop understanding on measuring national innovation systems by selecting true indicators and adopting accurate methods to gauge innovation. Other three sub questions will help researcher to find insight about Finland's innovation policies, strategies and progress and then briefly summarize and compare NIS of Sweden and Germany with Finland.

1.3 Research Methodology

Under this section, theoretical framework is offered first. Second phase adopted in this section discusses about data collection. In the end, the research structure is presented.

1.3.1 Theoretical framework

The concept of innovation process has transformed noticeably during recent years. According to traditional concept about innovation process investments made by an organization on its R&D is recognized to be the fundamental driver of innovation. However, another approach emerged as systems of innovation, which challenged traditional concept and revealed that innovation is undoubtedly dependent on various other actors as well which yields innovation by working in close cooperation. Landau and Rosenberg (1986) mentioned that innovation is rather a non-linear process which involves numerous actors. DeBresson and Walker (1991) mentioned networking as another fundamental driver of innovation and narrated that innovation works in a system. One can find immense literature depicting that innovation process works as a system with the involvement of numerous actors driving the process of innovation (Lundvall, 1992; Porter, 1990 Camagni, 1991; Asheim, 1996; Edquist, 1997; Cooke et al., 1998)

Measuring the national innovation system requires gauging the significance of involved elements and actors which drive innovation in a country. A well-structured national innovation system consists of supporting government policies, strong cluster between companies, industry-academia R&D collaboration and adequate funding. One of the basic tasks in this research is to find the importance of these actors and to analyze their involvement in national innovation system in general and Finnish NIS in particular.

Nations have been taking a more defined and stronger role in recent years regarding national innovation policy (Braczyk et al. 2004) and are figuring out the actors which can promote innovation activities in a country. However, some nations are fast adopter and learner than others and one can clearly compare their innovation systems. All the above mentioned actors are considered as a fuel for innovation by numerous researchers. Availability of institutions and research centres tied in a specific geographical region is considered as an innovation promoter by researchers like Tödtling, (1992) and Simmie (1997). Similarly, industrial cluster are also significant in the eyes of researchers like Saxenian (1994), Enright (1995) to generate new ideas. This study will analyze the extent by which these actors work together to strengthen Finnish NIS and how this can be compared with German and Swedish national innovation systems. However,

in general this research is not targeted to give suggestions on how NIS can be improved in a country whatsoever.

1.3.2 Data Collection

Data plays a major part in the accuracy of a research particularly if the research is qualitative in nature. It is not wrong to claim that data acts as a supporting proof to justify the analysis which is being done in a research.

On the whole, this research is qualitative in nature; however, some of the parts are analyzed quantitatively as well. This research studies a significant practice (National innovation system) on the whole in general and in given context (in Finland) on particular instead of testing a hypothesis. According to Key (1997), "a descriptive research is used to obtain information concerning the current status of a phenomenon to describe what exists with respect to variables or conditions in a situation" and in this research Finnish statistics and previous research are analyzed to depict the role of several actors in Finnish NIS. Moreover, latest data from OECD reports and Finland's national innovation strategy is studied as well to gauge the same.

During data collection, some resources were spent to get first-hand or primary knowledge through interviews and questionnaires. Interviews were either conducted by visiting the corresponding personnel or through telephone. During the interview data was gathered from organization's representative and industry actors. However, this process consumes lot of time and validity of data collected is questionable as well. On the other hand, Saunders et al. (2003) is of the view that analyzing secondary data is a time and resource saving procedure, however, cautions must be taken as well even to analyze secondary data.

This study is conducted in the first quarter of 2016 by collecting primary data from certain SMEs, government departments and universities in Finland. Additionally, secondary data is collected using scientific articles, journals and publications. Furthermore, statistical data is collected using OECD, Eurostat, Statistics Finland, Global innovation index, USPTO and World Economic Forum.

1.3.3 Structure of the Study

This study contains six chapters and a brief outline is given in Figure 1.

The study starts from a theoretical part in which background, research gap, objectives and data collection technique is described. In the next chapter, literature review of National innovation system is mentioned and the framework of analysis is presented. Chapter 3 narrates a detailed descripted of Finnish NIS and highlights the actions taken by different bodies to promote innovation process in the country. Chapter 4 sheds lights on the analysis of Finnish NIS in detail. Chapter 5 gives a brief comparison of Finnish NIS with Swedish and German NIS systems respectively. Finally, conclusions, limitation and some suggestions are presented in Chapter 6.

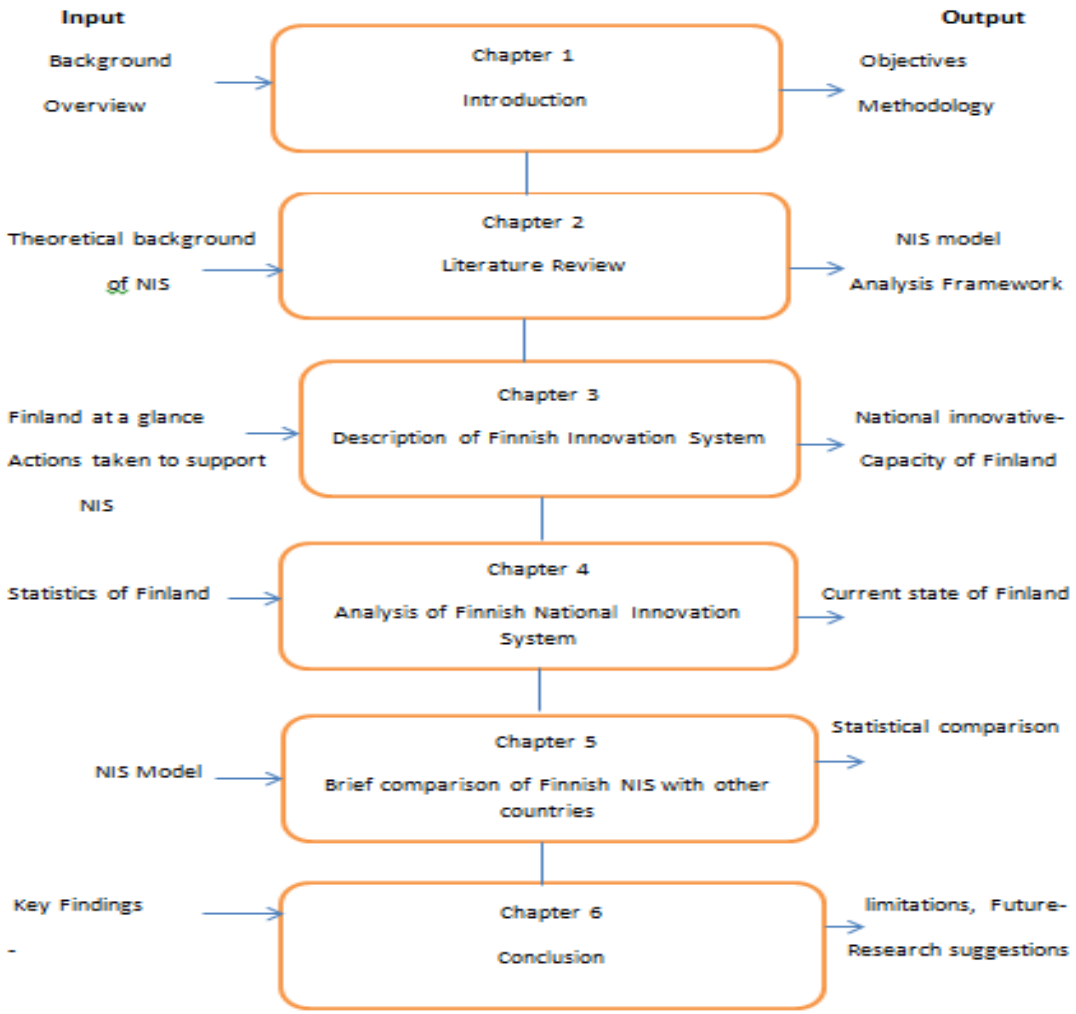


Figure 1: Structure of the thesis

2. Literature Review

The term “innovation” has no particular definition. The description of innovation is a range of attention to researchers and business comparable. The way term “innovation” is defined in an organization regulates the business activities executed in an organization. Researchers give the impression of using a compound methodology in explaining innovation that comprises both novel and incremental variations taking place either in strategies, processes, products and markets or in whichever combinations. There are several definitions of innovation that appear in the literature and organizational practice. Numerous definitions propose that the significance of innovation depends in its input to profit or calculation of economic value. However, significance of innovation cannot be always gauged by analyzing profit generated by organization (Kimberly, 1981).

Based on Webster’s dictionary word innovation is defined as “the creating of a change in something established”. Josef Schumpeter (1934) who is considered as on the first researchers regarding innovation mentioned it as “new combination of existing resources”. Furthermore, Clayton et al. (1996) described innovation as “a change in technology”. Moreover, Onadera and Kim (2008) suggested innovation as the fruitful utilization of novel concepts. Damanpour and Evan (1984) define “innovation is a widely used concept and the term is variously defined to reflect the particular requirement and characteristic of a specific study. Rogers (1998) defines innovation as “the application of new ideas to the products, processes or any other aspects of a firm’s activities”. In addition, innovation is also considered as the degree to which changes are intentionally implemented that is new to the organization (Mohr, 1969). Zaltman (1973) defined innovation as “any idea, practice, or material artifact perceived to be new by the relevant unit of adoption”. Furthermore, The European Commission Green paper (1999) on innovation defines it as “the successful production, assimilation and exploitation of novelty in the economic and social spheres” It might not be wrong to claim that although defining innovation seems simple, however, a specific definition which could cover all aspects and could be quoted in every context is undoubtedly not so straightforward.

Definitions adapted in the study

The definitions adapted in this study derived from literature are as follows:

• Developing something different: depicts an innovation which generates a paradigm shift in market, strategy, skills, technology and understanding.

• Producing simply novel notions: Mentions the capability to determine fresh relationships, to investigate subjects from novel viewpoints and to deduce up-to-date combinations from longstanding theories (Evans, 1987).

• Refining something conventional: Discusses to refine conventional technology, services and knowledge for commercial production or expansion of the system and structure.

• Diffusion of fresh ideas: Diffusion and adoption of innovative practices around the world.

• Implementing something different which aslo runs effectively somewhere else: It explains the implementation of new or improved process, product, or both by an enterprise to add value to organization or for its clients (Davenport and Prusak, 1998)

• Carrying out something in a firsthand fashion: This is referred to doing something by a totally new approach (Davenport, 1991).

Innovation terminology is, therefore, perplexing. It is fairly typical that these different types of categorizations and descriptions are misinterpreted. Christensen et al (2002) presents two different categories of innovation and then clarifies the dissimilarities among them. According to him innovations are characterized into two groups.

- Evolutionary: Sustaining innovation (evolving current business)
- Revolutionary: Disruptive innovation (developing novel business)

Christensen and Raynor (2003) claim that evolving current business aims challenging clients through enactment that is superior to what was offered previously. Furthermore, these innovations must be continuous or incremental. However, this is unquestionably not an easy task to perform.

2.1 Innovation Paradox

A substantial difficultly faced by several enterprises and nations is regarding their limited or partial methodology towards innovation (Leifer et al, 2001). Many organizations believe that they have worthy concepts and ideas, however, they are lacking in the frameworks and strategies to transform those novel ideas into successful innovation which can yield revenue (Hemmelgarn, 2006). Same happens with nation as their goals are to improve their innovation ranking, though they miss the proper framework (Davenport and Prusak, 2000).

The process of innovation is very challenging and characterized by paradoxes, thus, successful innovative nations believe that these paradoxes cannot be avoided. One technique to smooth the route of innovation is to be alert to the most common paradoxes that arise. Interestingly, the biggest barrier to innovation especially in the global market is not the actors involved, rather the paradoxes which blocks the path to innovation (Joseph, 2013; Chandy and Tellis, 2000). According to Berk and Galvan (2009), innovation takes place when multiple ideas and diverse elements are reframed, reimagined, or recombined in new ways. To manage these multidimensional ideas and elements is one of the core reasons for innovation, provided different paradoxes to be taken care of simultaneously. Nations that goal to provide innovative technology finds it extremely difficult to gauge the size of the international market, particularly how the innovation will be acknowledged.

2.2 National Innovation System

Innovation is a methodological process which is undoubtedly a collective process. It happens within the framework of broader system. Generally, businesses do not innovate and improvise in seclusion, perhaps in cooperation with other groups like academia, government bodies and other R&D bodies. Combination of these bodies results a successful innovation. Many scholars believe that globalization (Ōmae, 1990) has taken over NIS (Freeman 2002), however, there are vast numbers of researchers who insist on the status of national innovation systems as they believe that NIS is one of the ample systemic approaches to gauge country's performance

(Freeman 1995; Hu 1992; Porter 1990; Patel 1995). Even with the spectacle of globalization, national innovation system remains vital for economic analysis of a country (Freeman, 1995).

Nelson (1993) defines NIS as "a set of institutions whose interactions determine the innovative performance of national firms". For Lundvall, it ''is constituted by elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge'' (Lundvall, 1992). This concept is broadly defined by Edquist and Chaminade (2006) as "all important economic, social, political, organisational, institutional and other factors that influence the development, diffusion and use of innovation"

Institutions and firms are considered as the fundamental components of innovation, however, policies and government support cannot be neglected as well when it comes about innovation. Government must make sure that their actions and policies are in the favour of innovation; not the other way around. Innovative and economic performance can only be increased through systematic approach and support from involved actors. Collaborations between the actors engaged in technology development are equally significant as investment in R&D as collaborations are the key to translate inputs into outputs. Study of NIS highlights the attention between the connections inside the whole innovation system. The even process of NIS depends on mutability of knowledge sharing between compass and universities.

As stated by Metcalfe (1995) that "NIS is a combination of interrelated bodies to produce, supply then transfer the understanding, abilities and artefacts which describe innovative technologies". The concept of NIS has transformed substantially during past years (Tödtling and Kaufmann, 1999). One of the recent approaches to gauge innovation of national level are established on evolutionary and institutional theory (Dosi, 1988; Edquist,1997) and these methodologies tests linear model on numerous grounds.

1) It is necessary to take innovation as an interdependent process (Kline and Rosenberg, 1986). Networking and policies are equally vital as R&D is. These interdependences are considered to be the backbone of innovation diffusion in a country (Price, A., et al. 1993).
2) Adoption of knowledge on a wider scale is becoming significant. Knowledge distribution is not only important in the start i.e. R&D but all the way through the whole innovation process (Lundvall and Borras, 1997).

3) Institutions which include organizations and universities (Hodgson, 1988) are highly significant for the implementation of innovation in a country. However, government polices to encourage innovation in a country by provide substantial funding is equally important as well.
4) According to Nelson and Winter (1977) another important institution which allows countries to innovate is routine. Routines relating to collection of knowledge provide constancy and course to innovative route by getting firms on a particular technology track (Dosi, 1988). When routines are mutual among firms and universities in a country they establish a 'national trajectory', i.e. detailed yet precise pattern of innovation (Saxenian, 1994) which helps country to innovative effectively.

Another precondition of NIS of a country also depends on the qualification of labour force as well which gives competitive advantage to a country (Simmie and Sennett, 1999). Cluster of skilled labor, universities, research companies and government funding and policies are the keys to mobilize innovation in a country. Countries are taking stronger role in innovation policies these days (Sternberg, 1995; Braczyk et al, 1998). These policies include strengthening of above stated cluster within a country. It will not be wrong to narrate that NIS policies helps to enhance nation's innovative and technological capacity (Feinson, 2003).

2.3 Measurement and Assessment of NIS

Measuring NIS of a country is a lengthy procedure. A basic problem is assessing the NIS is the threat of intensifying the model to a degree where it contains every aspect of a country like social, economic and political condition of a country (Fension, 2003). Practical idea to escape such possibility is to set the boundaries for NIS. Even after intense research by numerous researchers (e.g. Liu and White, 2001; Johnson and Jacobsson, 2000; Rickne, 2000; Edquist, 2005; Galli and Teubal, 1997; Hekkert et al, 2007) presently there is no final indicators that needs to be considered while measuring national innovation system (Resele, 2014)

Assessment and measurement of innovation systems is a difficult process because of wide scope of innovation activities. Measurement suggests that at certain point entities should be qualitatively comparable so that evaluation can be prepared in quantitative terms (Smith, 2006). Literal meaning of term innovation is novelty which is, however, difficult to gauge and measure

(Landau and Rosenberg, 1986; Moore and Benbasat, 1991). However, technology innovation is considered to be one of the main drivers of economic growth in a country and qualitative analysis could be done to measure innovation (Westernhagen, 2002) as it is very vital for countries to gauge their innovation processes to predict economic trajectory (Impact of basic research on technological innovation and national prosperity, 2000).

Statistics of innovation describes various phases of innovation, though; these indicators are generally indirect thus making innovation measurement indefinite. Primarily, innovation involves a series of diverse stages for instance; basic research, applied research, development, and commercialization (Weick et al., 2010). In addition, some statistics can be usable to measure different phases of the innovation progression and flow of knowledge within a nation (Oslo Manual, 2005). In this study combination of both above mentioned indicators are used to gauge Finnish NIS.

Measurement and assessment of NIS can be gauged by monitoring knowledge flow interactions and novelty within a nation. Figure 2, shows the basic layout of NIS in a country, however expansion of the figure 2, concludes below stated six indicators that must be assessed to gauge innovation of national level.

1. Research
2. Interaction among enterprises.
3. Interaction among enterprises and universities.
4. Knowledge diffusion.
5. Government support in the form of favorable policies and funding.
6. Movement of personals within and between private and public sectors.

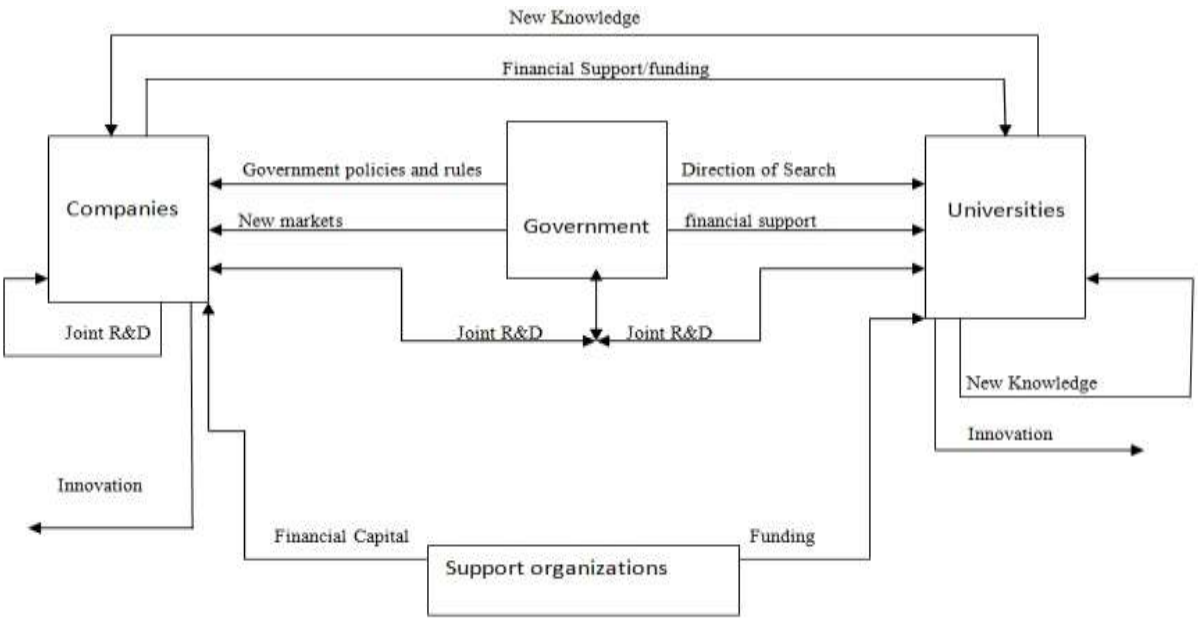


Figure 2. *NIS Model*

It could be undeniable to claim that business sector is the fundamental actor or performer in R&D and main source of innovation as one of the most significant flow of technology and knowledge in national innovation systems are due to collaboration of business sectors with multiple firms and universities. In most of the countries, R&D cooperation among enterprises and tactical technical alliances are emerging promptly.

According to Teece (1992) coalition is characterized as a two-sided affiliation where more than multiple partners combine their knowledge and skills to achieve a common target. Moreover, collaborating not only helps in research, perhaps, it also helps in reducing development cost providing economies of scale. Collaboration like such could however be gauged. On the contrary, there are some other influences among competing companies within a nation which also triggers and push companies to innovate and these are nearly impossible to measure. In studies of NIS, information flow within industries can be mapped using surveys. An example can be 'literature-based alliance counting' (Hagedoorn & Schakenraad, 1992, 1994) as it collects data on business alliances through newsprint media and journal articles reviews, yearly reports and industrial directories. Moreover, studies particularly related to Finnish National innovation depicts that percentage of sales and profit is higher in those organizations which practices co-operative ventures than those which do business in isolation (Smith et al. 1995).

Another key knowledge flow in NIS is connections among government and private research organizations. Government sector organizations comprises of public research organizations, polytechnics and universities while private research sector is composed on private companies. Quality of research institutions, standard of universities and strong relationships and linkages with industry is considered as one of the significant national resources to back and promote innovation. At the present time, increasingly private enterprises are supporting universities by providing funding to researchers as universities are undoubtedly one of the fundamental players of basic research.

There are numerous protocols which can be followed to gauge knowledge flow concerning public and private sectors however there are two main procedures that have been used in NIS to measure knowledge and technical flow.

Collaboration in R&D: Data published by universities, enterprises and government can be used to determine the joint research activities between public and private sector. Joint R&D will include financing of university staff and students by business enterprises to carry research.

Co-patents and publications: Number of co-patents and co-publications which are developed with joint alliance of research institutes and enterprises can be observed through patent records and publication indices. Analysis of these values highlights the extent of collaboration and flow of knowledge on national level between involved actors in national innovation systems.

Third aspects of knowledge flow which can be used to measure knowledge flow within a nation is the diffusion of novel ideas (Rogers, 2003) and their adoptability. Generally adoption of innovation is a time taking process as enterprises and individuals are reluctant to invest on fresh ideas and techniques which are not be tried in the past. Conversely, innovative performance of enterprises rest on putting new technology into action. It will not be a false statement to claim that government support and push is required for innovation diffusion and adoption. Technology diffusion can be measured by outlining inter-industry flow of R&D through purchase of equipment (OECD, 1996).

2.4 Analyzing National Innovation System

According to researchers there are three supreme challenging methodological problems which analyst faces wile analyzing national innovation system. Extent of exploration to which a methodology can be put into action is considered to be the first problem. Second problem arises in defining the boundaries of innovation systems which includes defining the involved actors. Lastly, comes the set of procedures to measure performance (Carlsson et al, 2002). As it is quite evident by now that there exist numerous definitions for national innovation system, likewise, there exist multiple techniques and approaches to gauge and analyze the same (Woolthuz et al, 2005; Bergek et al, 2008).

A non-linear model is proposed by Hekkert et al (2007) in which he suggested that events in the innovation system must be connected together to show the development and progress in innovation and the role played by the involved actors within a given time period. According to Resele (2014) this techniques gives quick analysis of the situation.

Another comprehensive approach to map NIS is through surveys in which questions are asked regarding knowledge flow and innovation policies in a firm. Along with the policies analysis, surveys also gather information about R&D expenditure and other inputs that triggers and promote innovation on a firm level. Data gathered from such surveys act as a source of information which could be used to analyze the role of involved actors from firm's perspective, including inter-industry activities and collaboration between firms, research institutes and government sector. One of such type of surveys is well known i.e. the Community Innovation Survey (CIS) which gathered data from nearly 30,000 organizations in Europe.

Bergek et al (2008) offer a six step pattern to evaluating NIS, unfolding competence and highlighting crucial policy concerns. This agenda spotted the dynamics, key functions, diffusion and adaption of new technology, thus evaluation of NIS becomes possible to some extent. Moreover, Chaminade et al (2012) came up with hierarchical factor analysis to analyze NIS. This technique was used in one of the country of South Asia to assess innovation system. Cluster interactions approach (Porter, 1990) is another important technique which nations are following to analyze knowledge flow in NIS in acknowledgment of the close connections amongst certain kinds of industries. As stated by Porter, that no matter how innovative a country is it is necessary

that cluster of industries should be connected both in horizontal and vertical pattern to be successful (Porter, 1990).

For instance, Finland's forestry cluster has characterized the innovation performance by obtaining cluster of industries which includes wood, paper, pulp, furniture printing and related machinery. All this is done by keeping the main idea of knowledge flow in forestry industry and by doing collaborated research in which both private and public sector participated and played their roles effectively. Flow of knowledge, cluster of industries, joint R&D has given a competitive advantage to Finland in forestry industry.

2.5 Framework for Analysis of NIS

In this thesis, analysis of national innovation system is carried out by combining the research framework developed by Hekkert et al (2007) and Bergek (2008).

In this research analysis is done by using the analysis of related theories, government policies, surveys, interviews and involved actors namely, universities and other participants of national innovation systems. Figure 3 outlines the analysis framework.

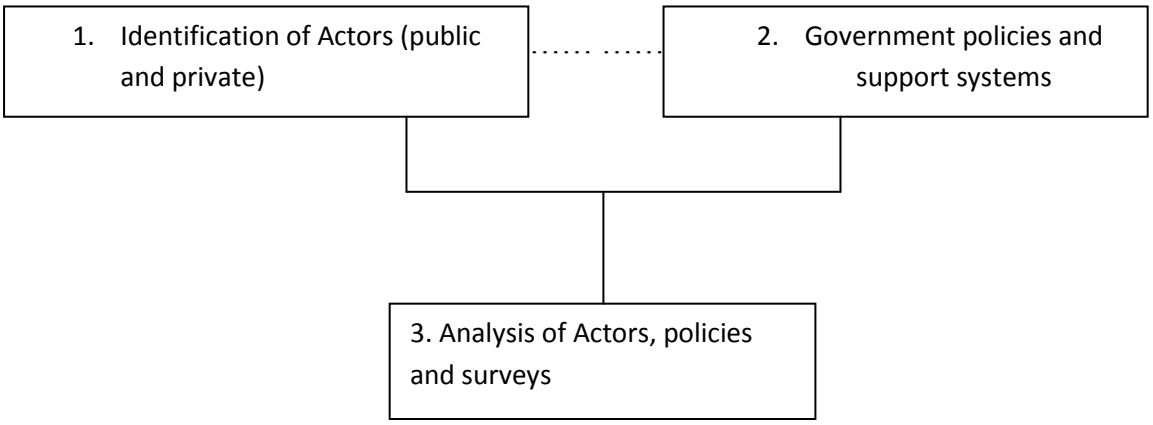


Figure 3. *Outline of Analysis of NIS*

In studying the National innovation system of Finland, first step will be to identify the actors and analyzing their roles and efforts to boost and support innovation in the country. In the second

step, analysis of government policies to promote innovation on a national level will be carried using the surveys and assessing the documents. On top of this, financial support from both public and private sector to promote entrepreneurship will be analyzed as well. In the innovation policy framework government policies regarding education, industrial and region will also be analyzed.

2.6 National Innovation Capacity

According to Villa (1990), "the concept of innovative capacity measures the level of invention and the potential for innovation in any nation, geographical area or economic activity." Furthermore, the theory of innovative capacity is projected as a manifestation that can offer regular indicative of national performance on invention in a course of time (Villa, 1990). A society's innovative capacity can be stated as the successful outcomes of all corporate and individual invention. National innovation capacity not only depicts the innovation level of a country, perhaps, it also reflects the government policy, industrial cluster and investment which generate an environment to promote innovation in a nation (Stern, 2000).

According to Muller (2006) innovation capacity depends on five objects as shown in Figure 4. However, this thesis is more focused on national innovation capacity because of government policies and cluster of private and public sector. Hence, Ferman et al., (2000) elements of national innovation capacity (Figure 5) will be dealt in this research.

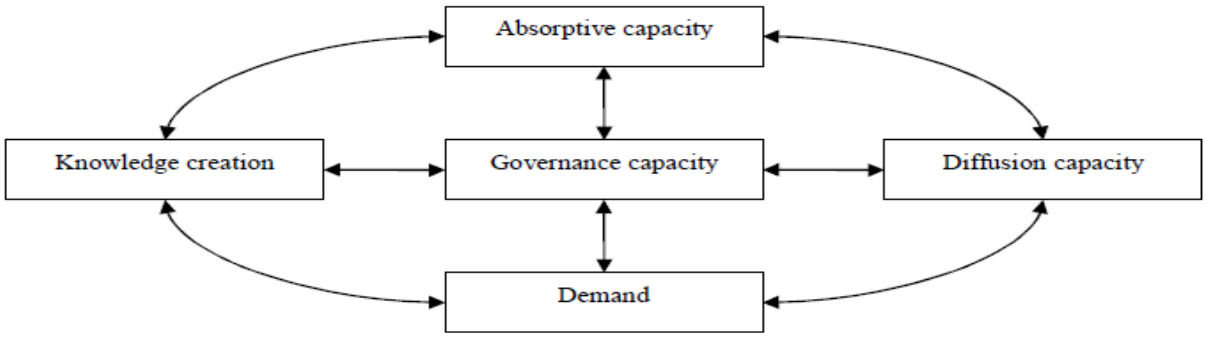


Figure 4. Innovation capacity – five dimensions (Source: Muller 2006)

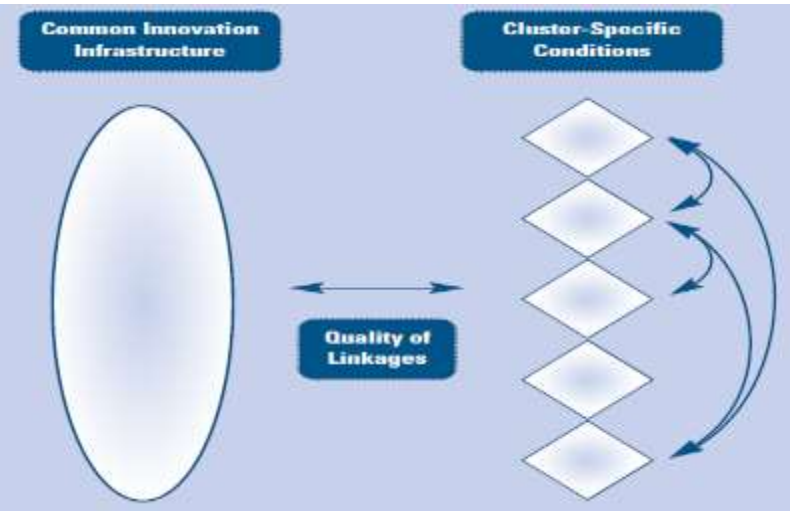


Figure 5. Elements of National innovative capacity (Source: Furman et al., 2000)

As stated by (Furman et al., 2000) National innovation Capacity depends on three broader elements namely, common innovation structure, networking and cluster. Common innovation infrastructure allows country to have cost cutting investments and leverage from government policies to maximize innovation. Since common innovation structure sets the base for innovation, cluster –specific conditions and linkages among enterprises and universities are also very significant to play their roles to promote innovation on national level. Existence of cluster leverage potential advantages to organizations in classifying both the requirement and the opening for innovation.

Finnish paper and pulp cluster is a suitable example to quote here as this industry is pressurized both internally and externally. This pressure has given Finnish paper and pulp cluster a competitive advantage. In fact, Finnish paper and pulp industry faces internal pressure from domestic consumers and paper companies, local rivalry and with companies like Kamyr which is one the leading Finnish process-equipment manufacturers. However, cluster and linkages has made Finnish paper and pulp industry to flourish and excel both on national and international level.

3. Description of Finnish Innovation System

Finland is a large though thinly populated nation state in the densely forested north most part of Europe. It only shares a border with only two European countries; however it shares nearly 1000km of border with Russia. Finland's distant location beside with strange language does not set it back when it comes to expertise in innovation (Kaitila and Kotilainen, 2008). Exquisiteness of Finland innovation system is that it emerges in the midst of geographical and severe northern climatic condition (Woiceshyn and Eriksson, 2014).

Finland's innovation system can be considered as a model for nations who wants to excel in innovation. Finland is also identified as innovation "hot spot" (Kao, 2009) and is frequently graded on top positions in international innovation evaluation (Woiceshyn and Eriksson, 2014). In past recent years investment in research and development is one of the most discussed topics in government, universities and other research institutes in Finland. This emphasis on R&D has enabled high investments by both public and private sector in the field of research and development and quality of education which pays way for innovation. As a result, in just a matter of years, Finland has managed to go from least R&D intensive OECD countries to the top of in research and development. (Georghiou et al. 2003; OECD 2008.) One of the top five goals of Europe 2020 Strategy is to attain R&D intensity of 3% in the EU. In 2013 and onwards only Finland, Sweden and Denmark with GDP intensity of 3.78%, 3.37% and 3.09% respectively manages to exceed goal set by EU of devoting more than 3% of GDP on R&D expenditure (Eurostat, 2013).

In this chapter a detailed description of Finnish NIS is discussed along with the analysis on measuring systems of innovation in Finland. Moreover, role of government, universities and other innovation actors will also be discussed under this chapter.

3.1 Finnish National Innovation System

By the end 1980s, integration of science and technology received great political attention as Science and Technology Policy Council bring together the model of national innovation system.

Work of numerous researchers narrates innovation system as a combination of multiple actors which includes both private and public actors. Moreover, integration and joint work of these actors results advancement in technology and innovation. Government, on top of this, also plays a vital role to promote innovation in a country by coming up with favorable policies, providing vision, setting goals and bridging gap between industries and universities.

Finland's innovation system comprises of developers and users of fresh knowledge and expertise. It is not wrong to claim that pillars on which Finnish innovation system stands are their quality education, bonding between organizations and universities and favorable government policies. Figure 6, shows the structure of Finnish innovation system.

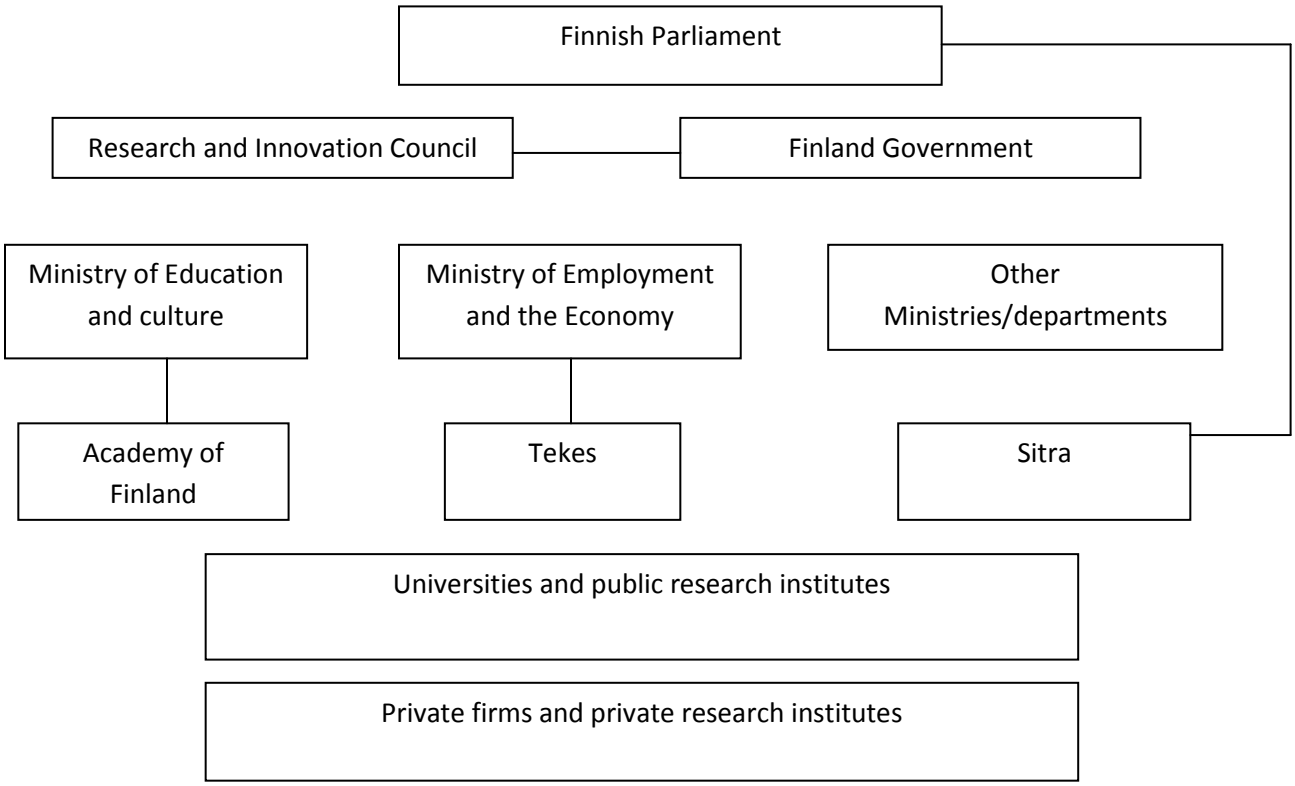


Figure 6. Structure of Finnish innovation system, Source:Research.fi

In Finnish innovation system, the Research and Innovation Council formulates the innovation policies of a country. Matters related to education, training, universities, polytechnics, science policies and Academy of Finland is dealt by the Ministry of Education. The Ministry of Employment and the Economy (MEE) is responsible for providing favorable environment for entrepreneurship and innovation and it also deals with matters related to the Finnish Funding Agency for Technology and Innovation (Tekes), and the VTT Technical Research Centre of Finland. In 2013, policies are developed for universities and enterprises to work with joint collaboration and government has also re-organized state research institutes as well. To summarize, Finnish innovation system is not only a collaboration of companies and universities of Technology (UOTs); perhaps, it is the network of government policies, funding, research institutions, UOTs and businesses (Woiceshyn and Eriksson, 2014). Moreover, among all the OECD countries, Finnish networking level is ranked as one of the bests (Kaitila and Kotilainen, 2008) and such networking enhances trust, which again pays way for more collaboration and joint research and development (Cooke and Morgan, 1993).

3.2 Finland's National Innovation Policies

The Finnish innovation policy follows the policy given by Lundvall and Borras (1997) i.e. endorsing the development, diffusion and effective usage of novel products and processes in markets and as well as in both public and private sector (Jauhiainen, 2008). The roots of Finnish national innovation policy dates back to 1960s and can be linked to Finland's science and technology policy (STP). According to scholars of Finnish STP, Lemola (2003), "the innovation policy in Finland stretched quantitatively" (Jauhiainen, 2008). In 2004, Lemola figured out five elements which promoted science and technology policy in Finland (Lemola, 2004) and he correlated STP policies with Finland's innovation policy. First element was comprised on development of higher education system from 1950s to 1970s which includes the formation of numerous universities in Finland. Second element depicts the formation of Finnish Science and Technology Policy council in 1963. In the present time, this council is playing a major role in national innovation matters in Finland principally in political aspect. In 1967, Finnish National Fund for R&D (Sitra) was launched to promote innovation and technology policy and this step is

considered as third element of Lemola's (2004) analysis. Correlation between STP and current innovation policy can be clearly seen as currently Sitra is one of the major funding bodies to support R&D in Finland. Fourth element highlights the foundation of new Academy of Finland in 1970s and dissolution of old academy. Before 1970s Finland's national authorizes had less control over academy of Finland. Now with the formation of new policy, government could lead Finnish Academy to promote research in innovation. Lastly in 1980s, Tekes, the most significant funding body for technology development was formed to promote R&D in the country (Lemola, 2003).

According to Woiceshyn and Eriksson (2014), "Reliance on technology has been the cornerstone of the economic transformation in Finland" and Finns were quite aware of the difference that could be brought in an economy through advancement in technology. Keeping successful economy in mind, UOTs, industries and government cooperated with each other to promote research and development projects in the country (Kristensen and Lilja, 2011). Even before the breakthrough of Nokia and other similar information and communications technology companies, Finnish government had already shifted it pace to be a 'knowledge economy' (Ylä-Anttila and Palmberg, 2007). Actions taken by Finnish government to boost economy were widely spread and were multidirectional which includes joining the European Union and public and government funding for research and development (Woiceshyn and Eriksson, 2014). As a result it pushed globalization and Finnish statistics reveals an increase of Finnish electronic export from 12% to 31% between 1990 and 2000 (Tainio and Lilja, 2005).

In the year 2015, government of Finland proposed six points and efforts will be made to reach their goals by year 2020. These six points can be segregated into further two parts, where first part focuses on main development areas of research and development policy and second part comprises of main goals for development.

Main development areas of research and development policy:

- A thorough restructuring of universities and polytechnics.
- Indorsing the impact of research and innovation outcomes.
- Supporting new foundations of growth and entrepreneurship.

Supplementary main goals for development areas:

- Development of overall knowledge-base of the inhabitants of Finland
- Promoting collaboration among public sector
- Directing R&D funding towards targeted fields.

3.3. Facilitating Innovation in Finland

In this chapter a detailed description of steps taken by government ministries, universities and other public and private sector will be discussed. Cluster and collaboration of these actors assemble together for shaping high technology development and innovation. High-technology organizations, government policies, and universities require one another in knowledge-intensive activities to support innovation on national level (Asheim and Gertler 2005). Cooke (2009) explained that innovation system in European Union is institutional and it is relying and linked by numerous actors. The government of Finland employs numerous agencies to conduct innovation policy in Finland. This research highlights the contribution and role of these bodies and figure 7, illustrates the important bodies which support Finland's innovation policy.

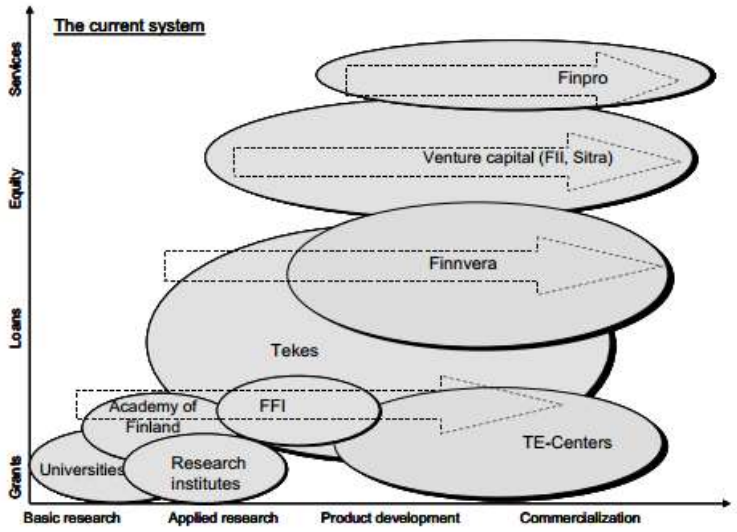


Figure 7. Finnish innovation support system. Source: Georghiu et al. (2003)

3.3.1 Ministries Facilitating Innovation

In 1990 STP council of Finland which was led by Prime Minster published the guidelines in which innovation was the core subject proposed for development. In this report, the fundamental emphasis was put on diffusion and development of innovation in national economic system (Lambooy and Boschma, 2001). The key policy makers declared R&D and better higher education system as the backbone of Finnish economy (Ahonen et al., 2007). Furthermore, simultaneously the national government systematized exercise sequences for decision-makers in which up-to-date innovation based concepts and strategies were studied. In early 2000s, these two actors turn out to be essential in national government policy reports (Kantola, 2006).

The Ministry of Education and culture is in authority to develop educational and cultural strategies and guidelines in the country. This ministry is considered as the highest education authority in the country (Ministry of Education, 2008). One of the core codes of Finnish education system based on equality in the provision of education irrespective of age, nationality and wealth. Academy of Finland comes under the Ministry of Education and Culture. The fundamental purpose of Academy of Finland is to execute the policies set by ministry in the field of research (Aaltonen, 2007). Academy of Finland funds research, provide expertise in science and fortify the same in the country. In the present year, funding amount of 428 million euros is allocated to be spent in research by Academy of Finland. Nearly this authority supports around 8,000 researchers in numerous universities and research organizations in Finland (Academy of Finland, 2016).

The Ministry of Employment and the Economy (MEE) is responsible for providing entrepreneurship and innovation activities and plays a vital role regarding labour employment and regional development. This ministry also deals with industrial policies, energy policies and innovation and technical policies of Finland. Another important role played by MEE is to promote competition in market and industries so that companies can be more innovative and effective (Ministry of Employment and the Economy, 2016). This ministry believes that in the inception of innovation, skilled labour is necessary and MEE supports application of fresh ideas, processes, product and services in the country. In 2008, a report was approved by MEE depicting

the strategies required to develop innovation policy in Finland. Matters related with Tekes and VTT are also catered by MEE (Ebersberger 2005).

3.3.2 Overview of R&D Funding in Finland

In 1990s R&D funding in Finland increased both in public and private sector. In mid 1990s, government increased R&D funding from 2% to 3% of the GDP. This 1% increase in funding was routed through Tekes. On the other hand, public share of R&D spending showed a drastic increment as well (Kaitila and Kotilainen, 2008). In the span of almost two decades (1990-2012), the private share of R&D funding increased from 60% to 70% (Statistics Finland, 2012). However, in the year 2014, government R&D funding decreases by euros 42 million from the year 2013. Conversely, in 2015, government again increased R&D funding budget by euros 47 million. Perhaps, in the year 2016, government R&D funding has decreased enormously. In the year 2015, total R&D funding was euros 2 002,5 million which decreased to euros 1 845,4 million. So in total R&D funding has decreased by EUR 157 million from the year 2015. The reduction is predominantly caused by reducing the funding amount by Tekes and government research institutes. R&D funding granted by Tekes will decrease by EUR 107 million in the present year, and R&D funding of government research institutes will drop by EUR 59 million from the year 2015 (Statistics Finland, 2014, 2015, 2016).

3.3.3 Research in Universities

The education system has been a significant driving body to facilitate innovation in a country. Education system in Finland is playing its vital role to produce skilled workers for Finnish industry. In 1990s successful efforts were made to increase Finnish education system so that it can compete with major European countries. Post-secondary education was divided between universities and polytechnics. Role of universities was to do fundamental research as well as to educate students from undergraduate to doctoral levels. However, role of polytechnics was to focus on undergraduate teaching and applied research. In 1990s, there was a drastic increase

students enrolling for engineering and science subjects. According to OECD, out of the graduate of Finnish universities, nearly 30%are engineering and science students which is more than OECD average of less than 20% (Kristensen and Lilja, 2011)

Universities play a vital role to promote innovation and guide researchers to work on a particular field. On top of this, universities establish close ties with industries through exchange of information, knowledge flow and research activities. As a result, Finland is one those countries which has strong university-industry relationship (Ebersberger 2005). In the development phase of any product, research plays a significant role. No product can be successful without the help of basic research (Nelson, 1959). Partnership between university's research and industry's product development is the integral part of innovation (Wheelwright and Clark, 1992). Right from 1990s, linkage between universities and industry has gain importance in Finland. When national innovation system was taken as the pivotal policy standpoint in Finland, universities were stimulated to build up their ties with industries. As a result universities were able to get fund from industries as well as from government bodies to foster innovation in the country. In keeping with OECD statistics, Finland stands second after Sweden to have the cooperation arrangement between industries and universities (Elvander, 2002).

3.3.4 Academy of Finland

Academy of Finland comes under the Ministry of Education, Science and Culture. The mission of Academy of Finland is to fund research and to raise the bar for science and research in the country. Moreover, this body plays a significant role in increasing internationalization of Finnish research. In the present year their funding amount for research is EUR 428 million (Academy of Finland, 2016). Around 16 per cent out of total governmental research finance is fed by the Academy of Finland (Aaltonen, 2007). Innovativeness of the research proposal is the first characteristics which Academy of Finland notices before granting funds for researchers (Academy of Finland, 2016).

3.3.5 State Research organizations

There are 12 public held research organizations, other than universities, in different field of studies which plays a key role in the national innovation system of Finland. VTT Technical Research Centre is the prime research institute if gauged on the amount of funding received by these 12 research institutes. In fact, VTT is the leading research organization in the Nordic countries. When it comes to Finland, 36% of Finnish innovation includes VTT expertise (VTT Review, 2014). VTT is a significant operative organization in both national and international innovation systems. Another important mission associated with VTT is to connect Finnish companies with European value chain and European Union projects (Anon, 2014)

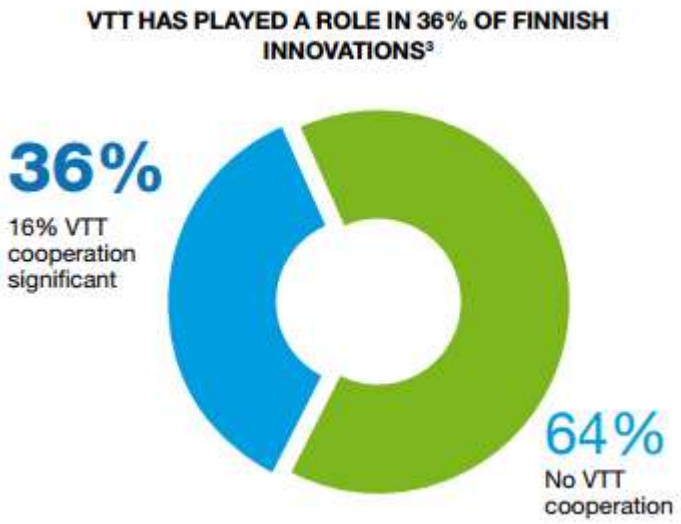


Figure 8. Source: VTT review, 2014

3.3.6 Key Public bodies supporting innovation in Finland

As mentioned before, active participation of numerous public bodies is a key ingredient to support and promote innovation in a country. Finland's private and public funding agencies are playing a pivotal role when it comes to support innovation by providing funds to all the involved actors working on innovation. Linnainmaa and Teppo (2006), categorized these agencies according to the role they play in supporting innovation.

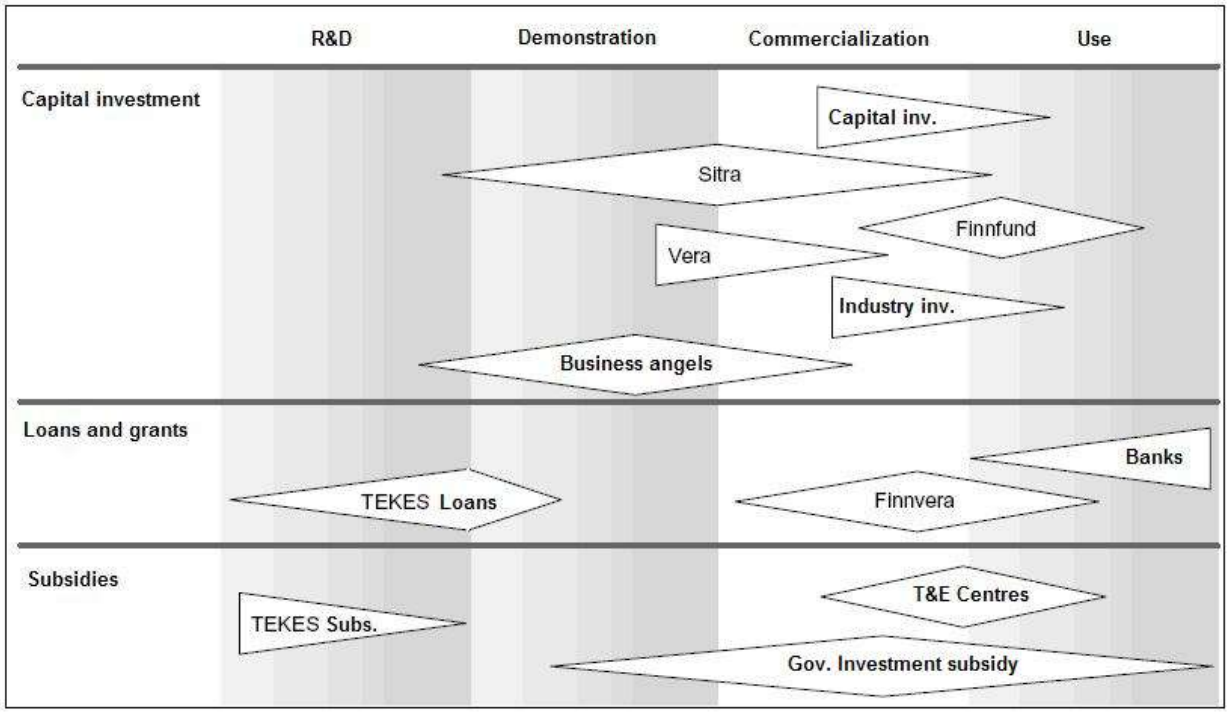


Figure 9. Public and private funding organizations to support innovation (Linnainmaa and Teppo, 2006).

- **The Finnish Funding Agency for Innovation- Tekes:**

Tekes, was started in 1983 to finance collaborated research among UOTs and firms and to support firms as well in their projects. Tekes is the most significant publicly funded organization to sponsor R&D and innovation in Finland (Tekes, 2016). As a matter of fact, Tekes promotes and supports a wide view on innovation. It not only support novel technical ideas, perhaps it also supports business, process, design and social innovation as well by working with the innovative industries, firms and research centers. Tekes not only provides funding rather it also facilities firms by providing expert advice and promotion of national and international networking.

Yearly, Tekes provide fund to around 1,500 business R&D plans, and nearly 600 R&D projects at universities. According to Tekes, out of 3000 application which they receive every year, Tekes manages to accept two-third of it. In the year 2015, Tekes partly funded 65% of the Finnish innovations. Moreover, with the help of Tekes, export done by small and medium size enterprises (SMEs) reached EUR 2 billion just in the span of 3 years and these SMEs expects to produce EUR 8 billion in turnover during their target year. As stated earlier, Tekes not only

support technical projects perhaps it also finances services and processes as well. Projects which were completed in the year 2015 which were supported by Tekes produced 1880 services, product and processes and around 1250 patents and 1320 academic thesis. As a result Tekes is increasing the employment rate in Finland as well. Just in the span of ten years SMEs which have emerged managed to hire around 3000 more employees.

- **Sitra:**

Sitra, the Finnish innovation Fund was started in 1967. This body reports to the parliament of Finland. The principle goal of Sitra is to provide capital for startups and to finance organizations to perform experimental research regarding innovative techniques and processes. In general, Sitra aims to improve and encourage stable development in Finland (Sitra, 2014). In short, Sitra funds explorative actions, whereas Tekes funds generic technology, however, the mechanism used in Finland innovation policy blends in a way that these two bodies along with Academy of Finland supplement each other (Ahlbäck 2005).

- **Finnvera Plc:**

Finnvera is a dedicated funding corporation under the government of Finland and it is the authorized Export Credit Agency (ECA) of the country. Finnvera provides funds for fresh startups, progression and internationalization of organizations. Strengthening of Finnish enterprises are done by Finnvera through loans, domestic guarantees, capital investments and export credit guarantees. Since, the risk is shared by Finnvera and other funding organizations; Finnvera manages to support high risk and big projects. In addition, the government of Finland shields Finnvera guarantee losses. As a result, Finnvera is in a position to take risk in its funding tasks than commercial banks might usually agree.

- **Veraventure Ltd:**

This organization is a venture capital arm of Finnvera Plc and particularly funds startup or expanision of a company. This organization characteristically finances technology-intensive or innovative service enterprises. In order to receive funding from Veraventure Ltd, it is necessary that either it is a fresh startup or the firm is not more than 6 years old. The fund can be in the form of convertible bonds or capital loans.

- **Regional Employment and Economic Development Centres (TE Centres):**

TE offices improvise an important part in implementing the Finnish innovation cluster policy by giving out several economic and consultancy services for entrepreneurs and fresh startups. As a matter of fact these services are provided from two ministries namely, Ministry of Trade and Industry and Ministry of Labour. In 1997, a total of fifteen TE centres were made in Finland with sole purpose of providing grants for startup, development and diffusion of technology and training of individuals (Aaltonen 2007).

- **Strategic Centres for Science, Technology and Innovation (SHOK)**

The Strategic Centres for Science, Technology and Innovation established in the country are public-private collaborations to accelerate innovation process in Finland. SHOK primary target is about renewal of B2B cluster and create radical innovation. SHOK develops and implements fresh ideas regarding firms' collaboration and joint research and development projects. SHOK believes 'Knowledge flow' as a secret ingredient for success. In Strategic Centres, enterprises and research bodies work as a team, conducting research which has been cooperatively stated during the discussion or while narrating 'minutes of meeting'.

4. Analysis of actors involved in Finnish National innovation system

Systemic approaches are providing a fresh yet clear picture of economic and innovative performance in the OECD countries. Analysis related on technology is taking research expenditure as an input and patents as an output. In this section an assessment of the role performed by actors of Finnish national innovation system will be analyzed in different span of time. Moreover, a thorough analysis of their effect and causes will also be discusses in this chapter and this is done using the statistical data gathered from government and private sources of data. Without the help of Finnish statistical data, it is impossible to reach the conclusion of this research and to highlight challenges and recommendation of Finnish National innovation system.

In this research, national innovation system of Finland is assessed by analyzing the followings:

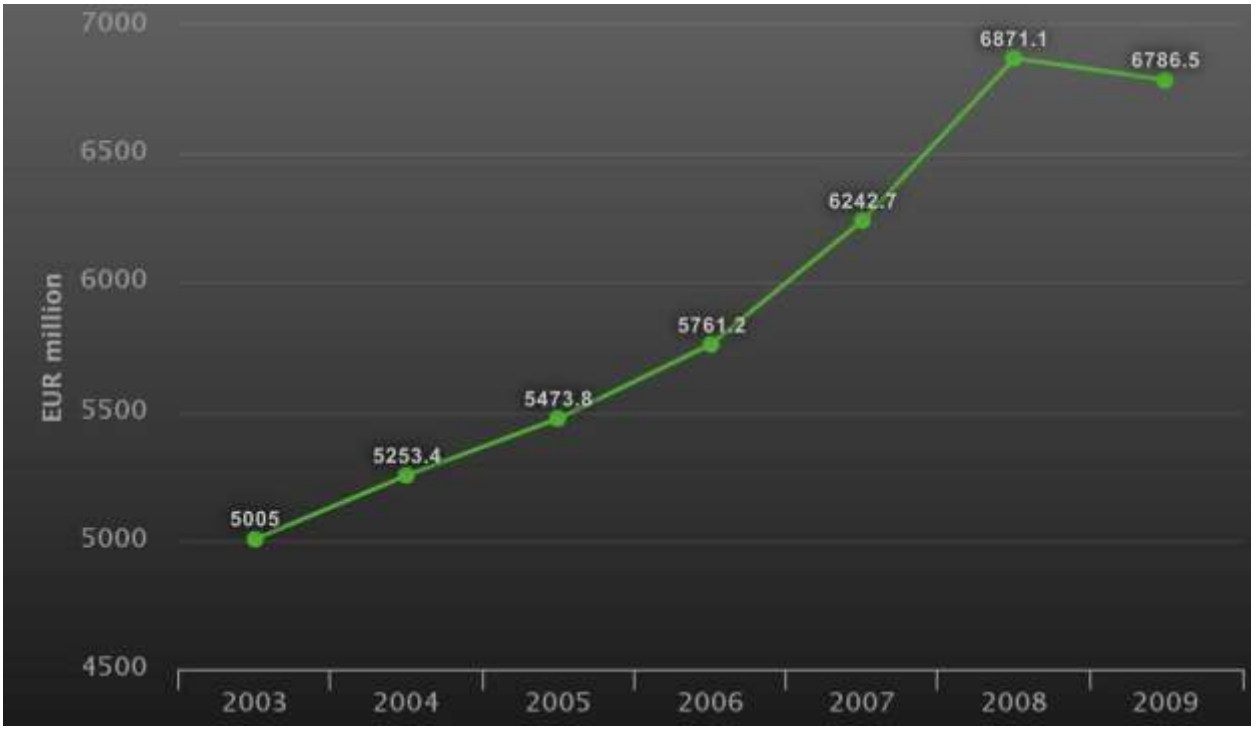
- Analysis of government policies
- Analysis of R&D expenditure in Finland
- Analysis of Technology diffusion and patents
- Interactions among enterprises, universities and research institutions

4.1 Analysis of R&D expenditure in Finland

Spending on R&D is one the drivers of innovation in a country (Baldwin, 1997). According to numerous researchers e.g. Villard (1959), Hamberg (1969) and Nelson et al (1967) innovation is considered as an outcome of resources spend on research and collaboration of research institutions and firms for development of novel technology, process or service. Keeping these studies into consideration it is essential to analyze the resources spend on R&D in Finland to study Finnish national innovation system.

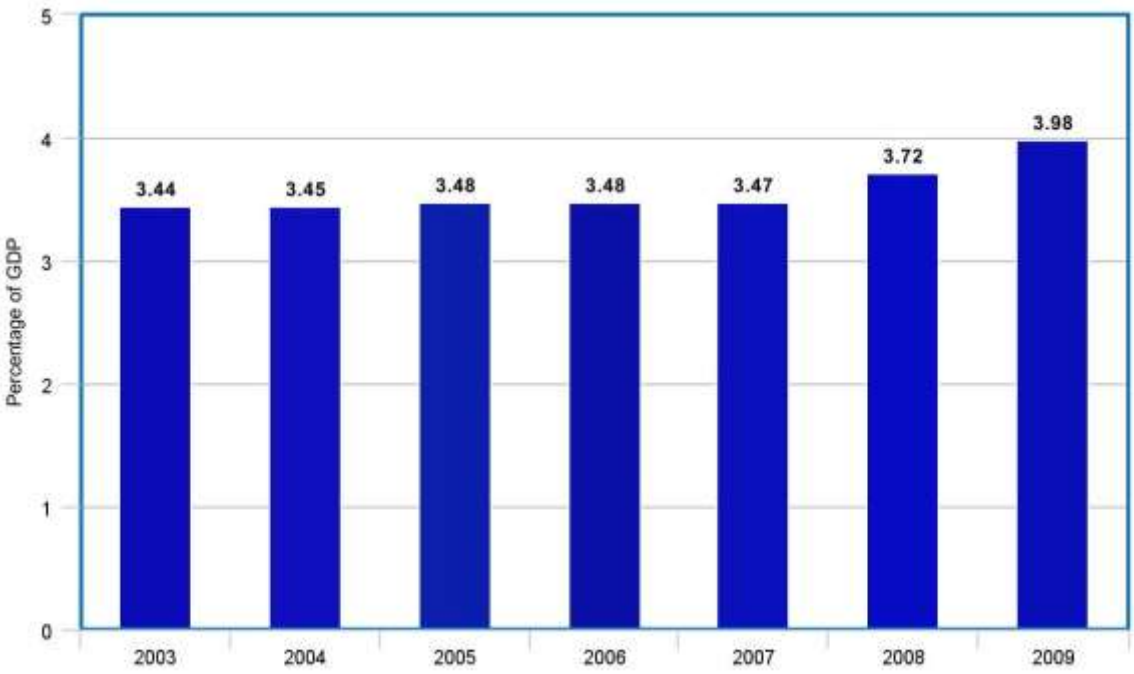
In this section Finland spending on R&D will be analyzed from year 2003 till 2016. From the year 2003 to 2008, Finland's expenditure on research and development increased continuously in business sector, public sector and higher education sector. However, in the year 2009, it decreased by 1.23% from what it was in 2008. However, the GDP share of R&D expenditure

(GERD) showed the same increasing trend. In 2009, although there was a decrease of 1.23% but GDP share of R&D increased from 3.72 to 3.96 between 2008 and 2009 respectively. Graph 1 and Graph 2 shows a clear scenario from 2003 to 2009.



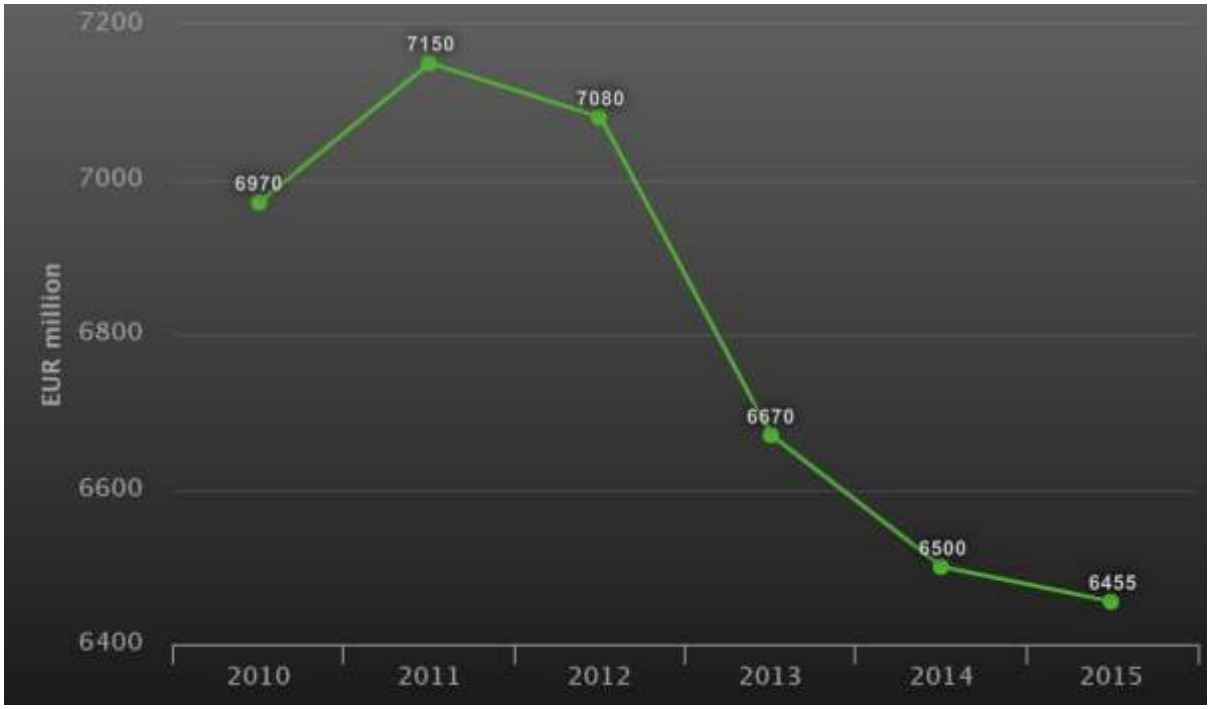
Graph 1. R&D expenditure from 2003-2009

In graph 1 it can be seen that total expenditure on R&D expenditure decreased from EUR 6871,1 million to EUR 6786,5 million. However, the GDP share of R&D expenditure continued to increase from 2003 to 2009.

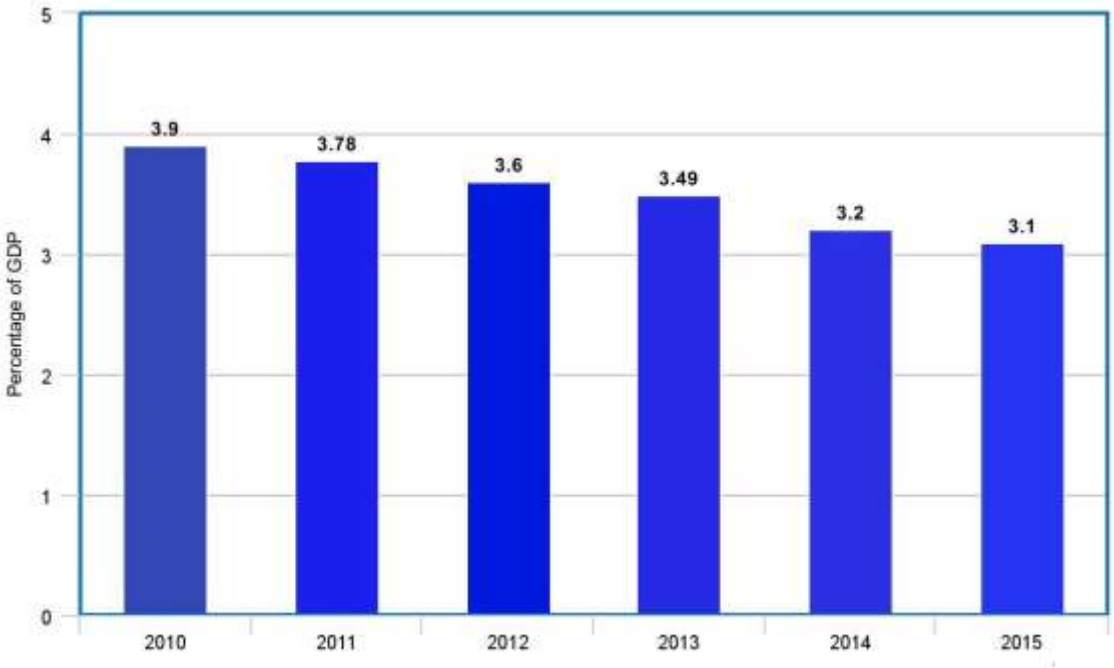


Graph 2: Percentage of GDP spend on R&D expenditure from 2003-2009, Source: Statistics Finland

In year 2010, there was an increase of EUR 185 million which was used on R&D in the previous year. According to Finnish statistics, 77% of this increment was deployed to higher education system in the form of funding. To be more particular, EUR 115 million out of EUR 142 million in education sector actually generated from the growth in external funding. In the year 2011 R&D spending exceeded EUR 7 billion which is highest ever recorded in Finland until now. The R&D spending of business firms was EUR 5 billion, however, higher education and public sector expenditure was EUR 1.4 billion and EUR 0.7 billion respectively. According to Statistics Finland, the sole reason behind an increment of EUR 193 million in 2011 from previous year was due to growth in business enterprises. However, the GDP declined to 3.78% which was 3.90% in 2010. In the year 2012, there was again a decline in the R&D expenditure by EUR 70 million, putting its GDP share to 3.55% and R&D expenditure decreased to EUR 6.8 billion. From year 2011, the amount of R&D expenditure is following a declining trend. This trend can be seen in the graph 3.



Graph 3: R&D expenditure from 2010-2015



Graph 4: Percentage of GDP spend on R&D expenditure 2010-2015, Source: Statistics Finland

The GDP share of R&D expenditure was 3.1% in 2015 and GDP share is showing a decline right from 2009. From 2009 to 2015, it declined by 0.86%. In the present year it is expected that R&D

expenditure will further decrease by EUR 157 million. This decrease will particularly be because of the lowering down funding amount by Tekes and government research institutes. Tekes has announced to decrease funds by EUR 107 million in 2016, whereas R&D funding of government research institutes will decrease by EUR 59 million from 2015.

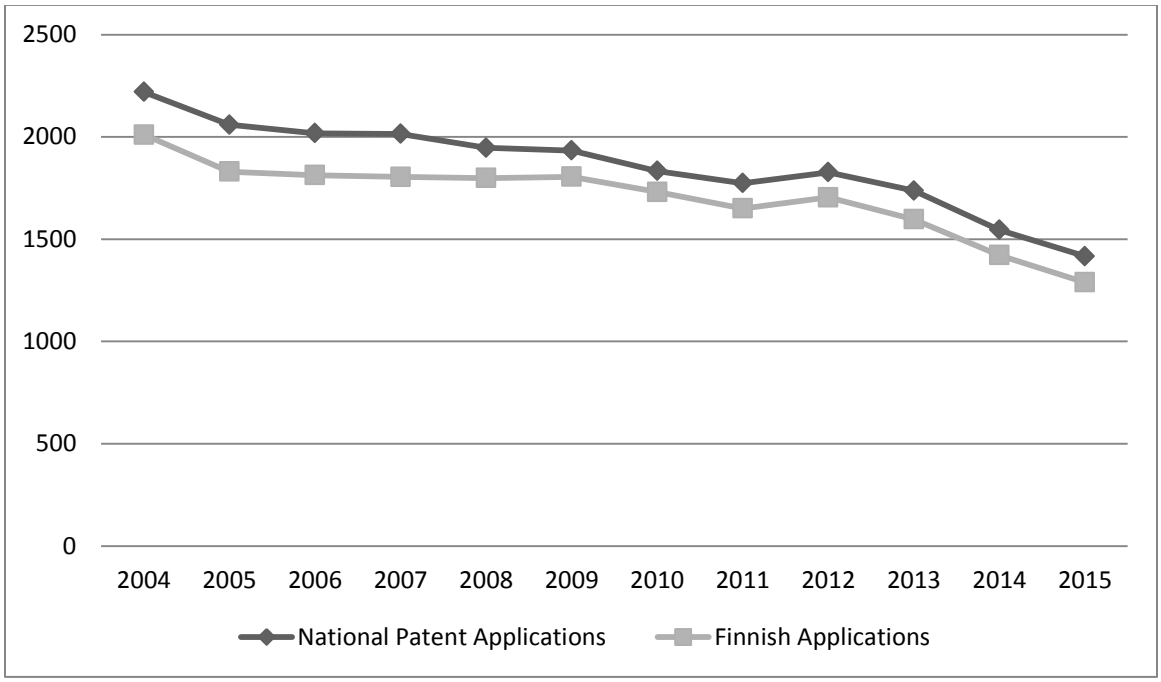
4.2 Measuring Innovation diffusion in Finland

Innovation diffusion is one of the key topic in strategic management to gauge innovation system (Rosenberg,1986; Stoneman & Diederen, 1994). Unfortunately, measuring diffusion i.e. how and when novel processes, technology and services are diffused in a country (Katz, 1999) is a difficult task to perform and often yields data which is not error free (Nelson et al., 2014). Another challenge in measuring innovation diffusion is that actors can manipulate, both nationally and international diffusion indicators (Nelson et al., 2014). For instance, sometimes companies claim to adopt practices which on the contrary is not being adopted (Elsbach and Sutton, 1992). On the other hand, some companies have already adopted novel ideas but they are reluctant to mention it as they believe that numerous organizations are already following the same (Kuczaj and Lederberg, 1977). Due to such reasons it gets difficult for researcher to come up with a dependable diffusion data. In this study, an attempt is made to gauge the innovation diffusion in Finland.

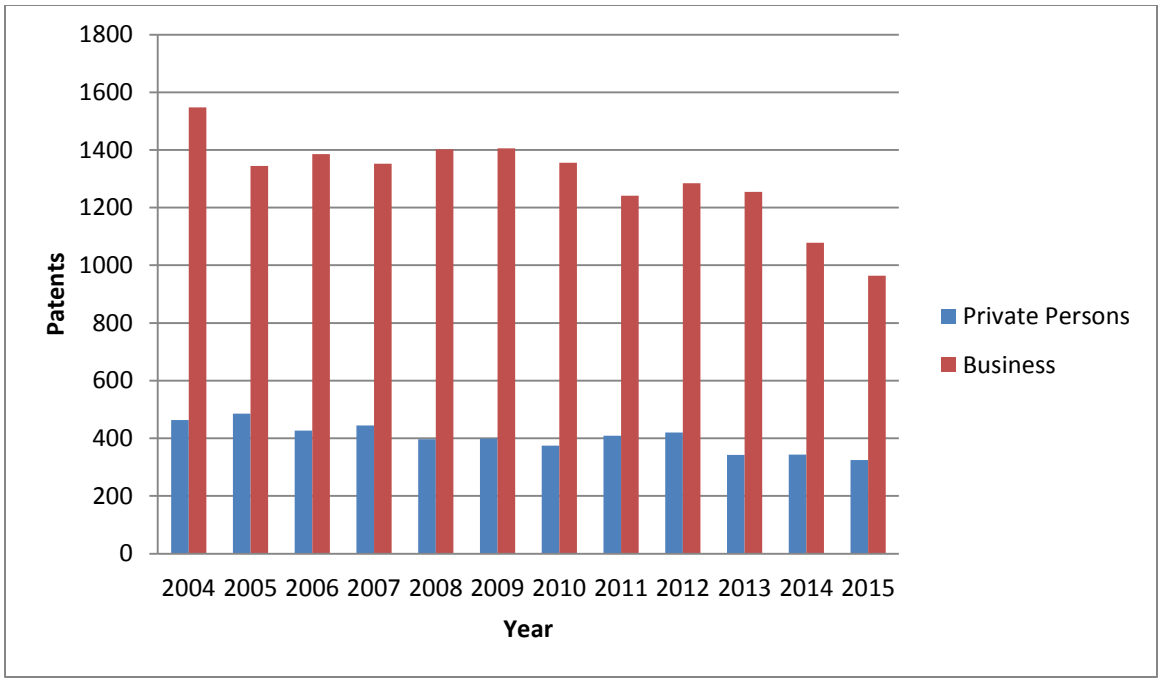
Numerous researchers have employed multiple techniques to measure national innovation system. The commonly used technique is to examine patent and public citations (e.g., Jaffee, 1989). However, analysis done on citation faces a problem as not every innovation defines the patents from where it originated. As a result, tracing the citation becomes difficult. Additionally, if the initial track is available, there is no trail available to highlight its diffusion. Factually, an invention is taken as innovation if a verdict on its patent claims has not been brought up somewhere else, either in Finland or any other part of the globe. The innovation to be patented must be fresh and it must be on a caliber which can be used and implemented in an industry.

Patent indicators are widely used measure of an innovation output of a country as patent is related by description with innovation (Archibugi and Planta, 1996). Additionally, these

indicators define knowledge flow among organizations, universities, nations and multiple field of technology. As a matter of fact, globalization is reflected by the increasing deviation of patent applicant, inventor country and his country of residence (Grupp and Schmoch, 1999; Montobbio and Sterzi, 2013). Graph 5 depicts the total patents applications received by Finland and also narrates the number of Finnish applicants. In Graph 6 patents application from the year 2004 to 2015 are segregated to clearly depict the role played by individual and business enterprises of Finland when it comes to innovation measurement through patents.



Graph 5 National and Finnish patents application (Derived from Finnish patent and registration office)



Graph 6: Patent applications by Business and individuals (Derived from Finnish patent and registration office)

As mentioned by Aho et al. (2008), improvement in productivity and pioneering in innovation are the fundamental goals of Finnish National innovation strategy. As a matter of fact, Finland performance and productivity deserves respect as it has performed well in both dimensions. When it comes to pioneer in innovation, Finland's patents had a continuous rise until year 2000 according to European Patent office. The main company which was behind this rise was, undoubtedly, Nokia. Nonetheless, it must be taken into account that if one removes the patents of top companies of numerous countries, Finland still ranks in top 5 in EU (Figure 10). However, it is required that Finland must pay equal attention to patents outside ICT sector as well. In the year 2008 and 2009, the number of patents application made by Finnish companies and individuals almost remained the same. However, due to increasing number of international patenting, foreign applicants in Finland are decreasing in number. In 2009, enterprises filed 1,407 applications were filed compared to 1,402 in 2008. Although in 2009, number of patents in research and development activity went up, but patents in forest and information and communication industry declined with almost the same numbers. In 2009, EPO granted 642 patents to Finnish enterprises which was 16% less than what was granted in 2008. Moreover in 2009, The United States Patent and Trademark office (USPTO) granted 990 patents to Finland's business enterprises. In the year

2010, patents applications decreased by around 80 from year 2009, however, EPO granted the same number of patents to Finnish enterprises as it was in the year 2009. Moreover, patents granted by U.S. increased by 260 and reached to 1,250 patents in the year 2010. Out of 1,250, 887 patents were from electronics industry. In the year 2012, according to statistics Finland, total number of patents in 2012 was 1704, whereas what was granted by USPTO and EPO to Finnish enterprises was 1177 and 656 respectively.

To conclude this section, a nation which awards patents is considered as most conscious about innovation as it works in a direction to bring novel ideas which could bring economic sophistication. However, Finland performance in patents ranks on the top positions, though the overall trend is following a declining trajectory from last decade.

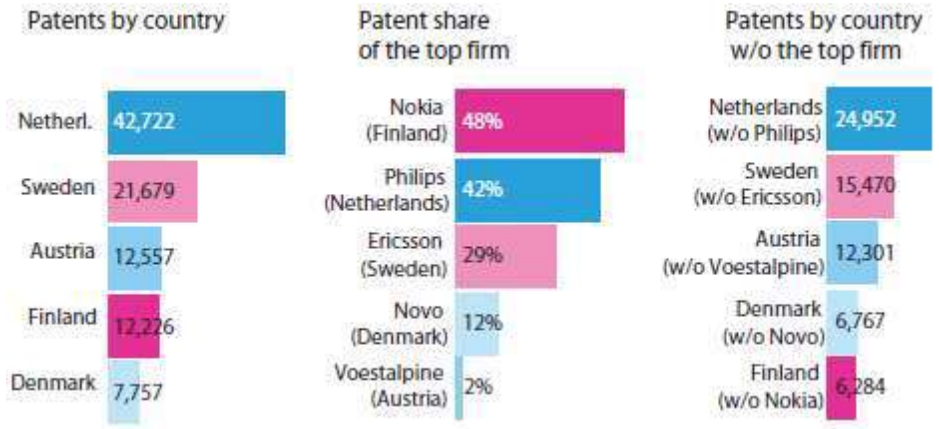
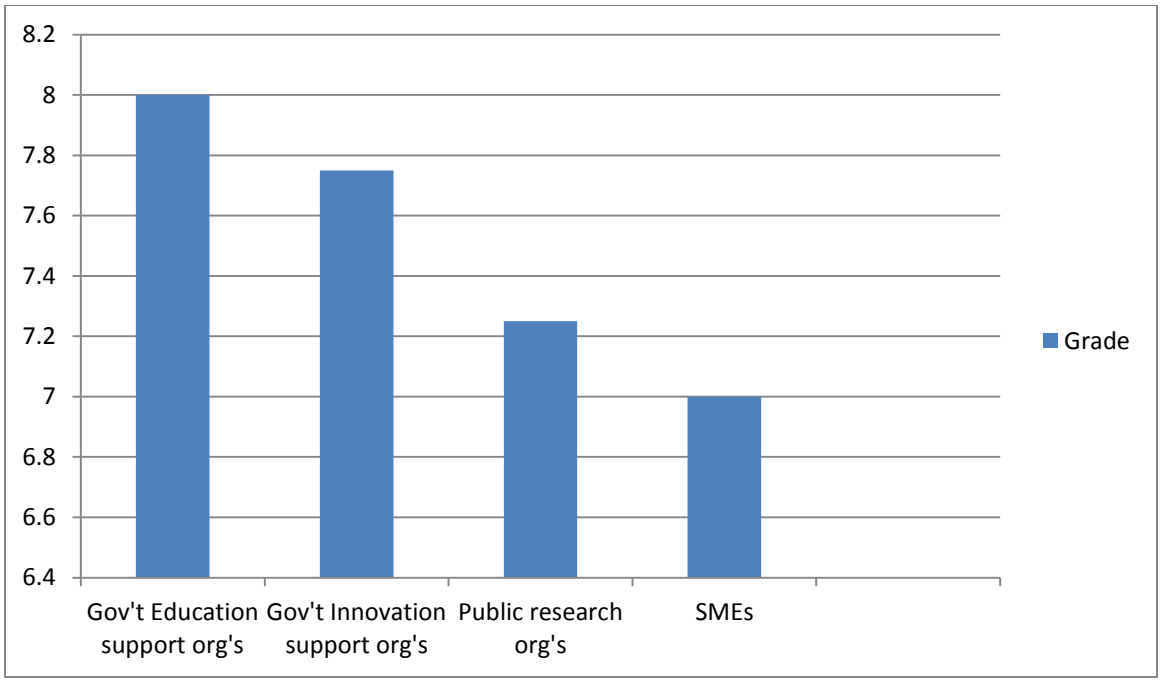


Figure 10: Source: ETLA calculations based on OECD PATSTAT database

4.3 Analysis of Innovation system and policies

Analysis of government policies is based on the data collected in the form personal interviews from some of the small high-tech companies in Finland, statistics of Finland and from previous research work done on the topic (Gebauer et al., 2005; Freel and Harrison, 2006; Kotiranta et al. (2009). The fundamental question asked during the interview was the action and policies delivered by Finnish government to promote innovation and networking among SMEs. Innovation policy of any country generally depicts different elements e.g. direct funding

provided for research and making small and medium size industries to be innovative by indulging them in co-operation, knowledge flow and technology consulting. However, as a consequence, SMEs expects government to be supportive by providing financial aid in the form of loans, grants and infrastructure supply (Hilmi, 2012). During the interview, the financial support and innovation support infrastructure provided by public and private organizations to promote innovation was given high esteem by SMEs and actors believe that Finnish NIS has been improving and will continue to follow the same route in future as well. A technique similar to one used by the Ministry of Education was adopted to gauge Finnish NIS system. The participants of the investigation were requested to grade the performance of the system on the Finnish school grading system i.e. 4 depicting 'fail' and 10 depicting 'excellent'. The average grade received turned out to be 7.5 and actors believe that Finnish NIS is going to improve more in the years to come. In graph 7, Government education support organizations include the Ministry of Education and Academy of Finland; Government Innovation support organizations include the Ministry of Employment and Economy and Tekes; public research organizations comprises of SITRA and Finnvera. Not surprisingly, different actors perceive and rate NIS of Finland in different fashion. SMEs gave comparatively low grade to Finnish NIS than what was given by Tekes and government departments. According to Kotiranta et al. (2009), TE-Centres and other transitional organizations are well thought-out comparatively insignificant both by corporations and other actors. There are only few main funding actors that actually promote innovation in Finland (Aho et al., 2008)



Graph 7: Grade given by organizations

The roots of Finnish national innovation policy dates back to 1960s and can be linked to Finland's science and technology policy (STP). According to scholars of Finnish STP, Lemola (2003), "the innovation policy in Finland stretched quantitatively" (Jauhiainen, 2008). Then in 1980s, a strong network of technology parks was established. Next came liberalization of market sector which yield unmatchable financing options for innovative companies. National innovation system was made a part of political programme by Matti Vanhanen's Second Cabinet. In this programme a proposal for Finnish national innovation strategy was carried out by Former Prime Minister and later by Esko Aho, President of SITRA. This strategy was made in close coordination with the Ministry of Employment and the Economy. On October 8th, 2009, the Parliament launched a political debate on innovation issues for the very first time in the history of Finnish parliament. The motivation and expectation from Finnish NIS is clearly visible in the political debate made on the subject (Aho et al., 2008).

As a matter of fact, Finland is called a knowledge based economy and fundamental role of a government to stay as ' knowledge based' is to come up with fresh policies every now and then to enhance financial sustenance for research and secondly to develop interface among science and the public. Finnish policies tackle these two dimensions quite effectively by providing

adequate capital for research, and figuring out a way to endorse interaction between academia and society, eliminating obstacles to collaboration and simplifying the flexibility of skilled workers (OECD, 1998). Internationally Finnish innovation system is considered as one of the best as it functions effectively. Networking and close industry-university relationship is one of the key strengths of Finnish innovation system. In Finland importance of innovation system is clearly visible if Finnish science, technology and innovation policy is seen in a wide spectrum. Government support for innovation dates back to more than two decades. From 1998 to 2000, nearly 50% of innovative Finnish companies were involved in joint R&D (statistics Finland, 2002). According to OECD report 2002, Finnish firms had the largest share of cooperation contracts with universities and other research institutes. Some of the researcher claims that small size of Finnish economy eases collaboration and networking (Perry, 2002) as it involves less transaction cost to find a partner for joint R&D and collaboration. However, this claim is vulnerable as equally sized economy e.g. Austria has different, in fact less networked industries and low collaboration industry-universities collaboration (Dachs et al., 2008) than Finland. Now another claim made by various researchers like Schienstock and Hämäläinen depicts that Finland has an old culture of collaboration as Finnish funding policies promotes collaboration (Schienstock and Hämäläinen, 2001). In 1980s Tekes started it technology funding program and undoubtedly collaboration was the basis of funding principles (Lemola, 2002). However it is important here to notice that Tekes was not promoting a particular tye of collaboration, rather it was enhancing the every dimension of collaboration. Collaboration could be in the form of networking, joint R&D between firms, universities and other research institutions. It encouraged networking of SMEs both nationally and globally.

Role and position of universities were also taken into consideration while deducing a policy for Finnish NIS. In 1993, the Cabinet pronounced that universities collaboration should be amplified with other research institutions and particularly with sponsors of technical research (Development Plan for Education and University-Based Research 1993). In the year 1996, the Cabinet highlighted and emphasized that focal point of research done at universities must be in a direction to develop and strengthen Finnish industries assisting them compete globally. Moreover, more funds would be granted to universities if they participate in joint industry-universities research projects. As a result, Finnish government suggested a unique goal and role

of academia. From 1996 till present, universities are not only considered as a place to study, rather it is one of the strong pillars of Finnish NIS.

Regarding the aim of Finnish national innovation system, government policies to boost cooperation between universities and industries is very significant for policy makers. Additional funding mechanisms to support entrepreneurship and innovation is undoubtedly holds its importance as well. However, it is necessary for Finland to work progressively and effectively to maintain its position globally in a highly competitive environment. In the Global innovation index Finland declines by 2 spots from year 2014 and now is ranked at 6th position (figure 11). Additionally, In Europe Finland innovation rank dropped to 5th spot (efficiency ratio =0.77) in 2015 from 4th in 2014 (efficiency ratio= 0.80). Finland rank drops more than five spots in the ICTs and knowledge diffusion due to the revolution of the methodology underlying the government online service. However, Finland rank improved in knowledge absorption predominantly as other nations are performing under the belt in this section, indirectly lifting Finland's rank. In the year 2015, the innovation input sub-index of Finland, however, increased from 5th rank to 3rd and innovation output sub-index of Finland dropped from 6th to 10th position. Government of Finland recognizes the importance of innovation and considers it to be one of the essential ingredients to boost Finnish national economy. Keeping the agenda into consideration, it is required that prominence must be employed on joint R&D and internationalization of businesses and universities so that Finland rank could be improved and it can rise up internationally in innovation rank.

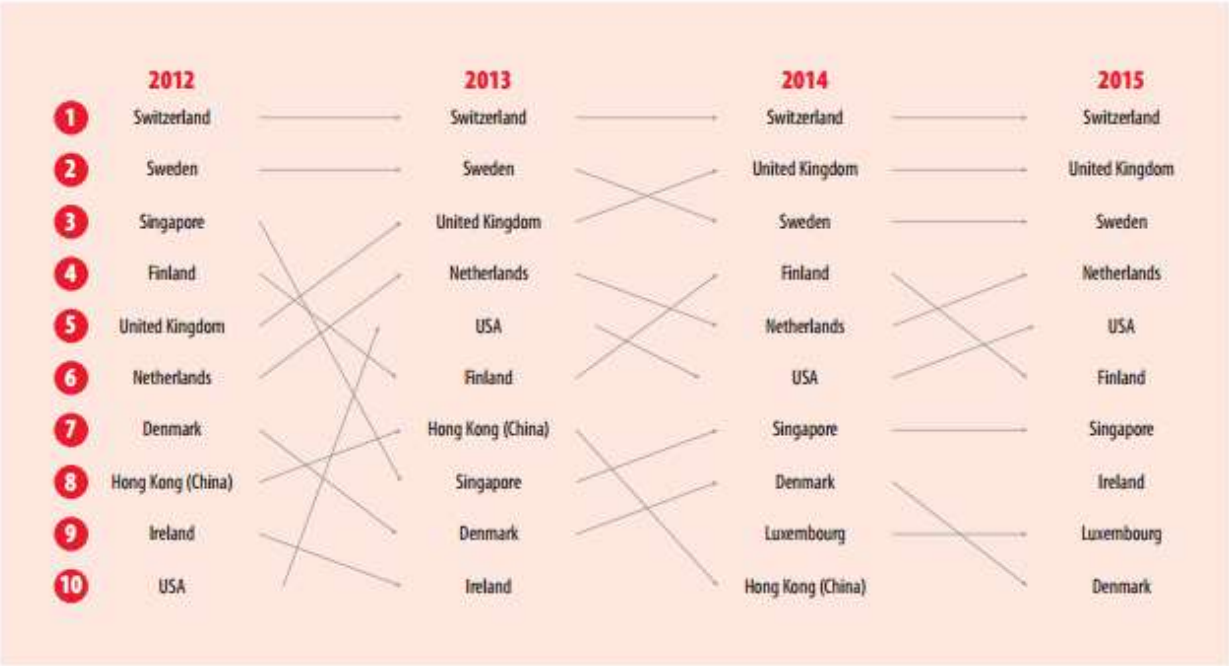


Figure 11. Movement in top 10 of Global innovation index (Source GII,2015)

The Finnish NIS always keeps its focal point on regional development using technology transfer backed up by numerous public and private funding bodies which have already been discussed in this study. SITRA is classified as one of the family which provides financial support to commence technology firms. To be more specific, Sitra funds explorative actions, whereas Tekes funds generic technology, however, the mechanism used in Finland innovation policy blends in a way that these two bodies along with Academy of Finland supplement each other (Ahlbäck 2005). According to Statistics Finland, the product and process innovation in SMEs is following a boosting trajectory these days because of favourable measures taken by public and private sector in the form of grants, loans, research funding and joint R&D with universities. Between the year 2012 to 2014, nearly 48% of the SMEs stated that they are practicing or participating innovation in their activities related to product and process. Just in the span of two years manufacturing and service industry brought 38% and 32% innovation in their product. Moreover, around 29% of the SMEs introduced process innovation in the said time span.

To sum up, the key role of Finnish policies regarding NIS is to develop a well-coordinated national innovation system. The frequent occurrence of discussion, planning and effective networking between government, funding agencies, universities and industries is only possible if

the Cabinet defines it goals, promote cluster and facilitates actors. However, as national economy of Finland is becoming service driven, the success of Finnish industrial products will rely on services linked with products or a set of products and services. As a result, these services can be a part of company's intangible capital and investment. Now it is needed that Finnish national innovation policy cater the requirements for capability and innovation activity related to the growth and use of intellectual capital.

4.4 Analysis of Interactions and networking among enterprises, universities and research institutions

Data collected through the interviews did not clearly depicted the linkages between players engaged in the innovation activity as the question asked during the survey needed detailed answers and required attention. Seemingly, interviewees were reluctant to put best of their efforts and were disinclined to give detail answers.

Surprisingly, during the interview not even a single interviewee mentioned customers and suppliers as the important partner of innovation process, though it is mentioned by numerous researchers like Hakansson (1987) and Lundvall (1992) that innovation generally occur intractably alongside the value chain. User normally brings the basic idea for product development and generates ideas for product development. On the other hand, suppliers are also a valuable source of knowledge as they make available external knowledge that accompaniments company's internal knowledge. According to Henderson and Clark (1990), combination of numerous source of knowledge results innovation. However, according to Finnish Community Innovation Surveys (CIS) nearly 60% of innovative firms collaborate with suppliers and customers. Astonishingly, role of consultants in innovation process was also not mentioned by any interviewee as well, though, it is believed by researchers (e.g. Moulaert and Tödtling, 1995) that consultants are also key players as they prepare and maintain legitimate aspects of patenting and licensing in the field of marketing and distribution.

In order to promote world class innovation environment, Finnish government has taken significant steps during the coast of time. These steps comprises of structural reforms of

universities, public and private funding organizations, supporting Strategic Centres for Science, technology and innovation (SHOK). Additionally it also consists of development of new research centres and introduction of new measures to implement innovation policy of Finland. To summarize, Finland is moving from conventional R&D to collaborated R&D, in which active participation of enterprises, universities, research institutions and customers are working as a network to be inventive in technological and non-technological innovations. Finland innovation system is making the use of both Porter's cluster model (1990) and Triple Helix (figure 12) of academia-industry-government conjunction proposed in the 1990s by Etzkowitz (1993). The Triple Helix thesis describes that innovation and economic development of a knowledge based society lies in the hybridization of government, industry and universities as knowledge can be transferred and shared among the three, making country prevail. Moreover, Finland's forestry cluster has characterized the innovation performance by obtaining cluster of industries which includes wood, paper, pulp, furniture printing and related machinery. All this is done by keeping the main idea of knowledge flow in forestry industry and by doing collaborated research in which both private and public sector participated and played their roles effectively. Flow of knowledge, cluster of industries, joint R&D has given a competitive advantage to Finland in forestry industry.

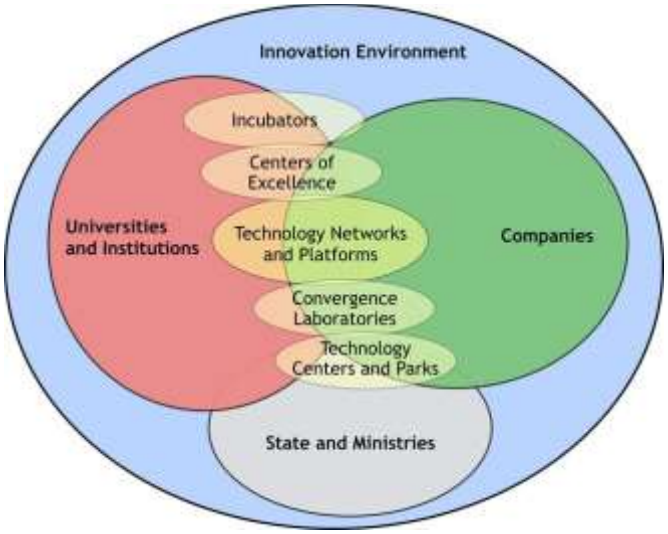


Figure 12. Triple Helix model, Source: Etzkowitz (2002,2004), Etzkowitz and Leydesdorff (1998,2000)

The eminence of public and private research organization and their effective inter and intra network among each other and industries is a valuable national asset to support innovation. Role of universities and other research institutions is to come up with a generic research and provide a body of fundamental knowledge for industry. Moreover, such networking produces fresh methods and techniques which could be further developed on industrial scale.

The quality of linkage is indeed an important asset to support innovation on a national level. As mentioned before, research institutions and universities which are supported by state are key players of generic research and besides producing basic knowledge they are also sources of innovative approaches, instrumentation and skills. Progressively, the research piloted in universities is being backed by firms which pool resources with the public sector in joint technology projects. The development program for Education and Research 2011-2016 goal is to increase networking between universities and industries so that flow of knowledge becomes easy. Table 1 summarizes the work intended by Academy of Finland to promote cooperation between industry, academia and government.

Actions	Explanation
Academy Project Funding (continuing)	Academy of Finland has provided a significant financing prospect for researchers. This funded is announced to improve the quality and to add diversity in the research.
Strategic Centres for Science, Technology and Innovation (SHOKs) (Continuing)	SHOKs are established to promote collaboration between public and private organizations to accelerate innovation process. Their basic goal is to refresh industry cluster and to generate innovation.

Table 1: Academy of Finland and SHOKs actions

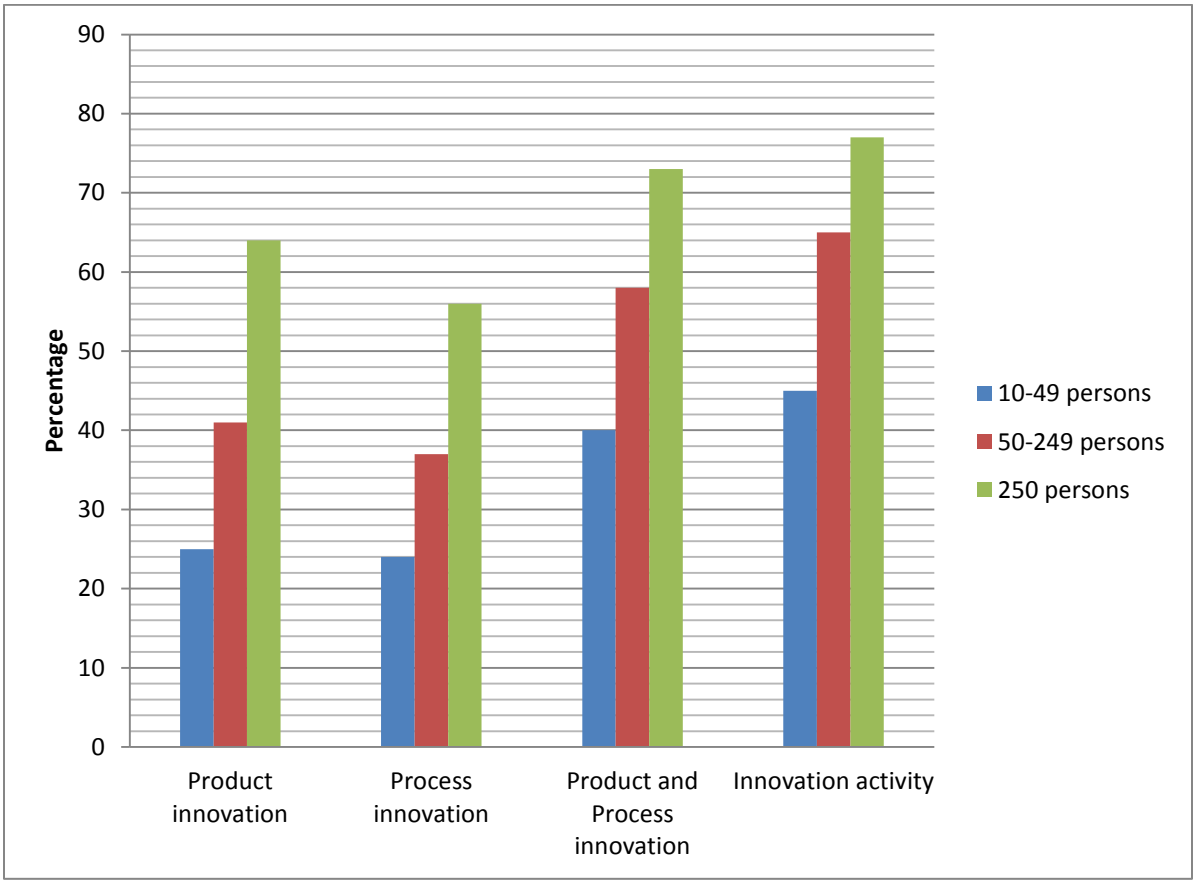
The strategic objectives which can be achieved through joint collaboration could yield two results which can promote innovation process in Finland:

- Companies, universities, research institutions, public and private funding bodies will commit to the innovative activities and could target their resources to have a high quality cluster where knowledge flow produce innovation in process, service and product.
- As a result, high-quality expertise and reputation in technology and innovation will attract foreign direct investment (FDI), global market leaders to Finland, resulting booming economy and more employment opportunities.

During the survey, it was noticed that generally it seems that universities and polytechnics have common feeling when it comes about academia-industry collaboration; however, after close analysis it became evident that there are some clear differences as well. During some years, universities are concentrated on commercialization and IPR management; however, polytechnics are more focused on bidirectional interactions with the companies. Conversely, a study of ETLA (Tahvanainen and Nikulainen 2011) depicts that university researchers of Finland are driven by other factors as well which are not related to commercialization: the principle enthusiasm is inventions' prospective to raise the standard of society; next comes his own motivations and forthcoming research financing prospects. Commercialization has undoubtedly increased the revenue by selling universities IRPs. However, bidirectional knowledge flow impacts more as researchers in universities can receive important ideas and knowledge from industry which could be developed to bring radical innovation. Inappropriateness of funding structures and contingency of contract is considered as one of the biggest problem faced by university researchers. Similarly, shortage of time and subsidy makes partnership challenging for polytechnics and firms. According to Tekes (2015), Finnish universities get important ideas from industries and academia-industry collaboration yields innovative process as knowledge flow between the two. Furthermore, this joint collaboration led to an agreement where visiting lecturers are invited from industry to deliver lectures in the universities.

However, there is an outstanding difference in extent of networking and innovation activities among numerous firms in Finland as it is dependent on the firm size and status. According to Statistics Finland, large and internationally operated organizations have the highest innovation accomplishments. Out of the all the firms which are operating on national level, or target domestic market, only one-third of them are involved in innovation activities compared to 60% of those which are large in size and are operating both domestic and international customers.

During the span of 2010 to 2012, innovation activities performed by enterprises employing maximum of 49 persons, only 45 per cent were involved in innovation activities. For medium sized companies, the share was 65 per cent. However, out of all the large enterprises, around 77 per cent reported innovation activities. These innovation activities are in the form of product innovation, process innovation or both. Graph 8 illustrates occurrence of innovation activity by size grouping of employees from year 2010-2012 and share of firms.



Graph 8. Innovation activity from 2010-2012, categorized on size and percentage of firm's involvement in innovation activities, Source: Statistics Finland.

Among the small enterprises, 25 per cent reported that they had active involvement in product innovation and process innovation. However, around 40 per had active involvement in both product and process innovation simultaneously. Additionally, it is quite clear from Graph that

innovation activity is directly proportional to size of enterprise. Innovation activities, strong networking, and cooperation partners are commonly present in large organizations. Moreover, according to CIS, large organizations receive more funding from both public and private sector compared to SMEs.

5. Brief comparison of Finnish National Innovation System with other countries

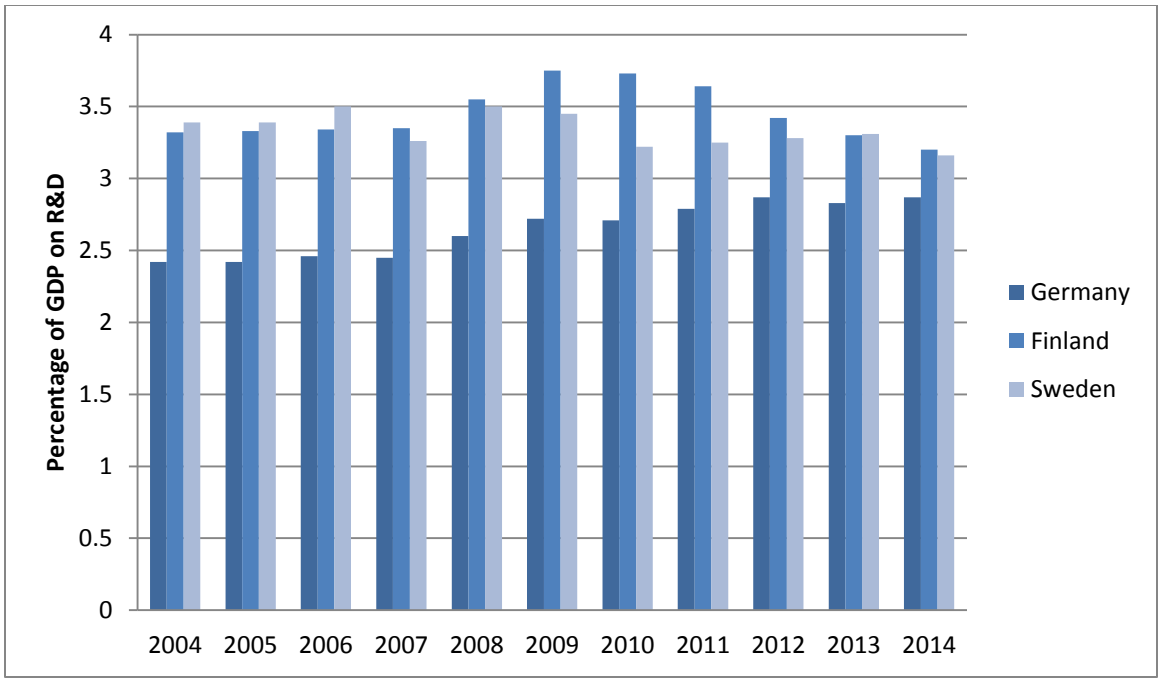
Finland, Sweden and Germany belong to EU and OECD as well. Subsequently, all three countries are subject to identical commercial pacts and EU legal structure. However, above stated three countries could be analyzed and compared in the following aspects:

- Role played by government to facilitate innovation
- A prominent networking between innovators and presence of industry cluster.
- Various public and private research bodies available
- Appropriate funding and supporting organizations available

5.1 Comparison with Sweden

The Swedish NIS is branded by internationalized research, fast acceptance of novel techniques, abandon amount of education expenditure and a comparatively expensive financial system. There are numerous independent authorities whose task is to make sure the implementation of government policies when it comes to innovation. Moreover, these authorities initiate appropriate projects to achieve goals predefined by government. Unlikely to Finnish NIS, most of the responsibilities are assigned to these authorities rather than to ministries.

For a long span of time, Sweden has been one of the dominant nations in the world when gauged on R&D investment correlated with GDP. As a result, R&D performed by Swedish universities also manages to get a top ranking also when correlated with GDP (Vinnova, 2016). Despite an abandon amount of investment on research and development, Sweden's long-term budgetary prosperity is compositely little when compared with Finland. Graph 9, shows a clear comparison of percentage of GDP spend on research and development between Finland, Germany and Sweden from the year 2004 till 2014.



Graph 9: Gross domestic expenditure on R&D (GERD): Source: OECD

The basic structure of Swedish National innovation system is shown in Figure 13. In Swedish NIS role of NUTEK is to promote networking between industries so that cluster could be formed. Vinnova is Sweden's innovation agency with a role to encourage sustainable growth by scaling up the innovative circumstances and funding research. Sweden had a very ambitious structure for a very long duration of time and undoubtedly it grew rapidly; however, according to numerous researchers Swedish policy environment had some loose poles. As a result, its policy though benefited numerous actors but on the expense of Sweden domestic competition. Economy remained under the control of ruling party, unions together with limited percentage of giant multinational enterprises further diminishing the distribution of profit, resulting comparatively less growth compared to resources available.

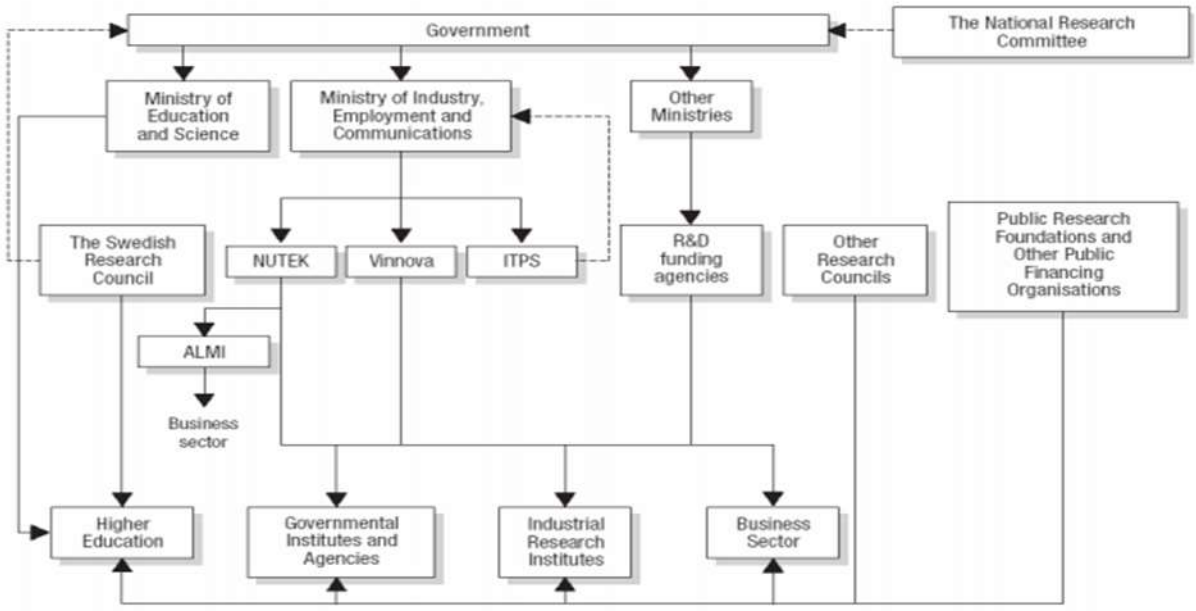


Figure 13: Structure of Swedish NIS; Source: Roos et al., 2005

Global innovate index (Figure 11) of Sweden is remains almost stable from 2012 till 2014 and it leads in innovation in a Nordic countries. Sweden ranks 4th in overall outputs and 2nd in technology and creative output, however, Finland's creative output dropped by 5 places in 2015. In 2015, Sweden improved it ranking by two places securing a 4th position in human capital and research; however Finland still ranks 1st in the same category.

In Global competitiveness index (GCI) Sweden raises one position to pass the United Kingdom in 9th place. On the contrary Finland continues to slide down and is now on 8th spot, though still better than Sweden. Similar to Finland, Sweden benefits from an efficient and transparent institutional framework and its rank is 11th compared to Finland's 2nd. Finland's higher education system being bests according to GCI 2015 and secures 2nd position compared to Sweden's 12th spot. Additionally Sweden has 300 PCT patents filed per million people compared to Finland's 289. As a result Sweden seizes 3rd spot, which is one rank higher than Finland according to GCI ranking 2015. The innovation system in Sweden profits from rapid technological adoption and ICT usage and a sophisticated private sector making it secure a top position in Global innovation index (Figure 15).

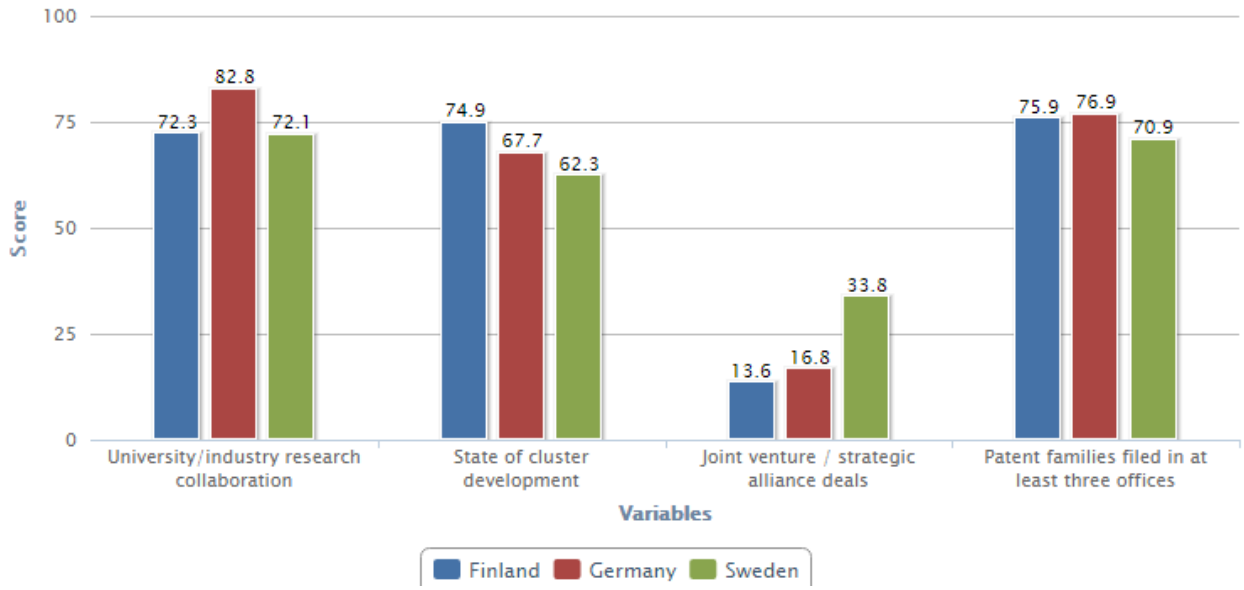


Figure 14: Comparison of scores**,** Source**:** GII 2015

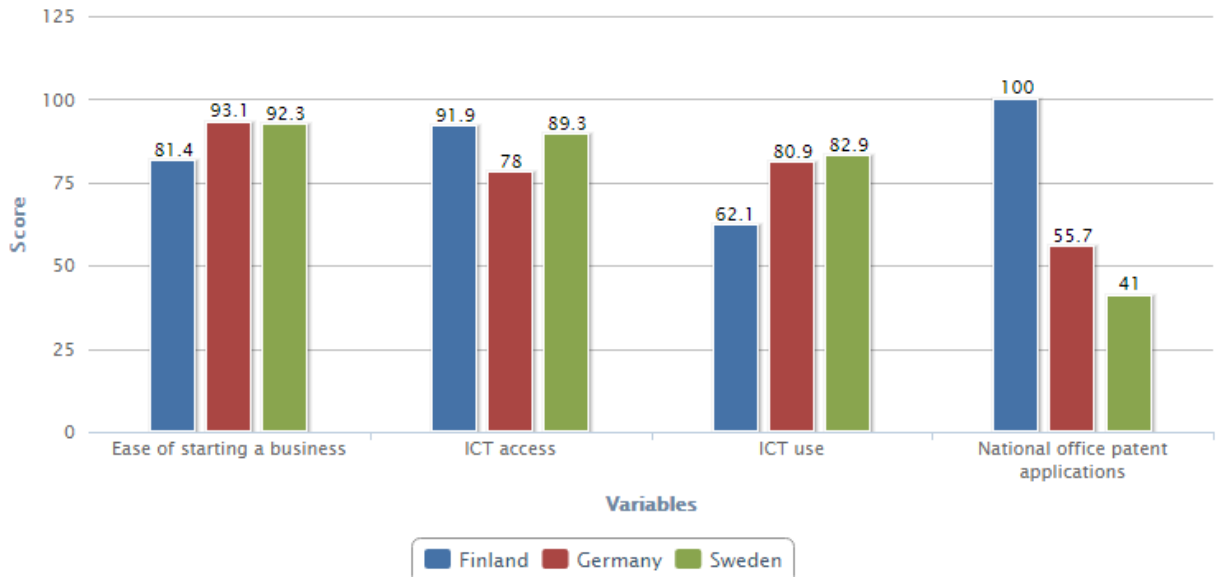


Figure 15: Comparison of Scores, Source: GII 2015

5.2 Comparison with Germany

Comparison of between Finland and Germany seems a big challenge as Germany's statistics differ from Finland with huge numbers. For instance, German's Population is around 81 million compared to Finland's 5.5 million. However, an evaluation between innovation accomplishments of both countries appears to be realistic choice as Germany, though, being the largest economy in European Union has presented average innovative performance in recent times. On the other hand, Finland is carrying out like a 'rising star' among the smaller European countries. The basic structural shift of Finland from resource based to knowledge based economy is setting an example for European countries.

Though Sweden, Finland and Germany are all members of EU and OECD with similar EU legal structure and policies, but unlike Sweden, Finland and Germany are subject to common currency as well. In both Germany and Finland, public and private funding is one of the most important tools to accelerate innovation process in the country.

In Germany, according to Rammer (2005), project funding is executed nearly solely through grants; however, Finnish funding system also grants loans to organizations as well. According to Tekes (2004), since the loan amount is less than 20% of grants which is offered to universities and companies, Tekes does not unequivocally differentiate between grants and loans.

In Germany majority of the funds comes from Federal government, However, a good percentage of funds comes from private sector as well. It is important to notice that one of weakness in Germany's NIS is the amount of funding available for fresh startups. Most of funding that comes from government is spending on expansion and startup receives what is technically 'left over' (Allen, 2010). On the other hand, the Federal Government is planning to enhance the innovation competences of SMEs. To do so, the Federal Government also announced a High-Tech Startup Promotion Fund which is working to boost the formation of new startups which are focused on innovation. Another weakness noticed is in the field of patents. Germany, being the second prime exporter of the world in the field of medical equipment and is rather weak in terms of patents in the medical science. Government is focusing to provide more funding in this field of technology as well in order to maintain its position.

Networking and industry-university collaboration is another factor on which Finnish and German NIS system need to be compared. Networking and industry-university collaboration is another key strength of NIS of both countries. In the year 2000, around 50% of Finnish innovating companies were involved in cooperative R&D (Statistics Finland, 2000). However in Germany in the year 2000, only 17% firms had collaboration contracts; around 15% of firms had cooperation on national level and 7% of the firms had international collaboration partners. University-industry collaboration was only 10% in Germany compared to 29% in Finland (DE Statistics, Statistics Finland, 2000). The innovation survey of 2012 done by Eurostat depicted that almost every country which has shown improvement is innovation was practicing cooperation in 2010 to 2012. This cooperation is with other enterprises, universities and research organizations. The cut of those accomplished innovation collaboration in Finland was higher than average (36%) of the other European Union members (Eurostat, 2012). However, from 2010-2012, Germany had the 67% of enterprises performing innovation compared to Finnish 53% and Sweden 59% of all the enterprises (Eurostat, 2012)

As mentioned before some of the researchers (Ebersberger et al., 2007) that small size of Finnish economy facilitates good networking as it involves less transaction cost, however, certainly this claim is challengeable. More important than the size of the economy, it needs to be observed that Finnish innovation policy emphasizes on strong inter-firm and industry-university collaboration and consider it as one of the key drivers of innovation, certainly not the minimum transaction cost to find the right collaboration partner. According to Europe 2020 strategy, every EU country is expected to spend 3% of its GDP on R&D expenditure. However, according to Eurostat 2013, only Finland, Sweden and Denmark is performing according to the goals. According to 2015 report by Commission of Experts for Research and Innovation (EFI), Germany is declared as ‘not very ambitious’ to attain this goal. EFI told German government to invest around 3.5% of it GDP in R&D intensity by 2020. In 2013, Germany invested only 2.85% compared to Finland’s and Sweden’s 3.31%, 3.30% respectively.

To summarize, a clear comparison can be seen in Figure 14, 15 and 16 depicting R&D expenditure, percentage of enterprises that have carried out innovation cooperation compared with companies that have performed innovation, business enterprises R&D expenditure and level of innovation ranking of these three countries.

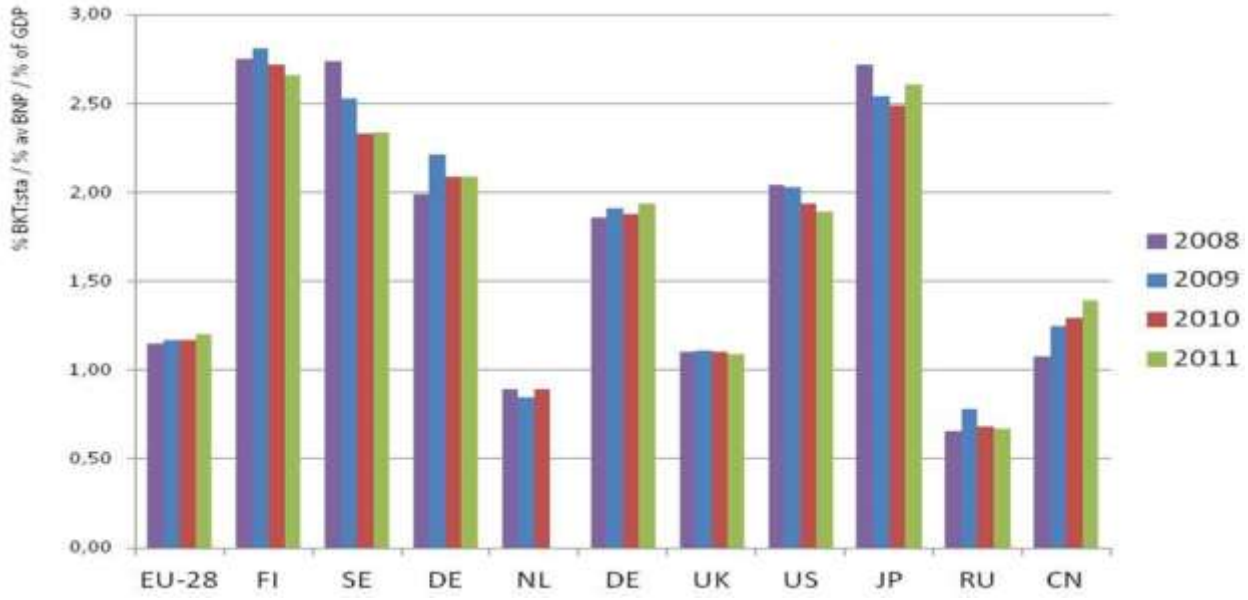


Figure 16: Business Enterprises R&D expenditure, Source: OECD,2013

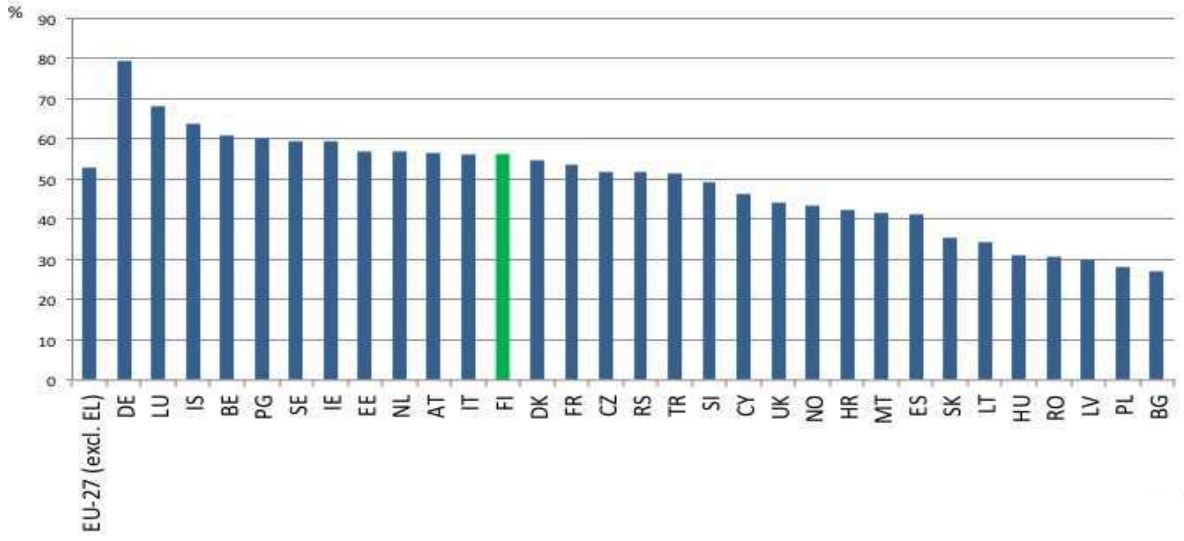


Figure 17: Percentage of companies practicing innovation all of the companies in European Union, Source: Eurostat 2011

Though it is clear from figure 15, that Finland stands on third spot when compared with Sweden and Germany regarding share of companies practicing innovation, however, it is required to notice that Finland captures high rank when it comes about networking and collaboration in

innovation activity (Figure 16) and business enterprise R&D expenditure (Figure 14). However, efforts are required to attract FDI in Finland as it scores a very low score compare to the other two countries under discussion (Figure 17).

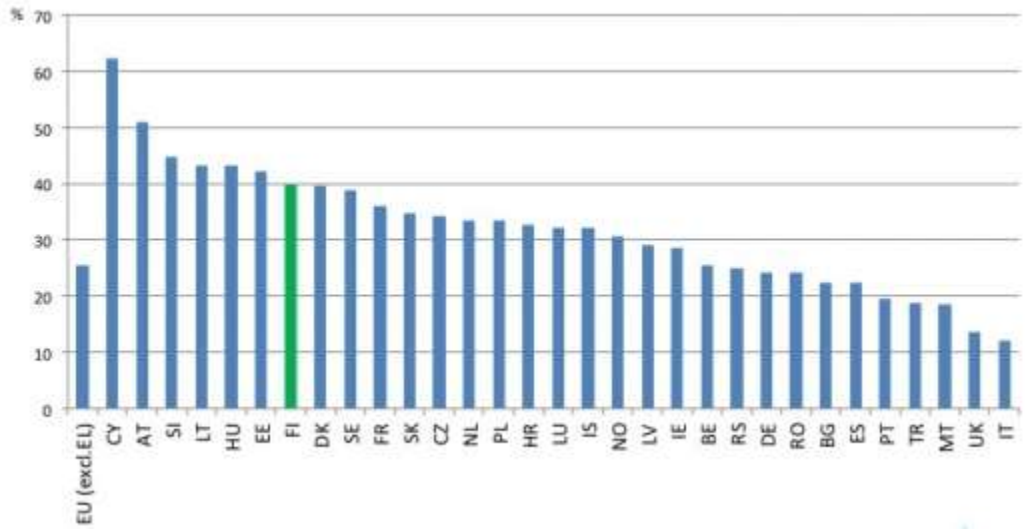


Figure 18, Percentage of organizations involved in collaboration for innovation activity, Source: Statistics Finland

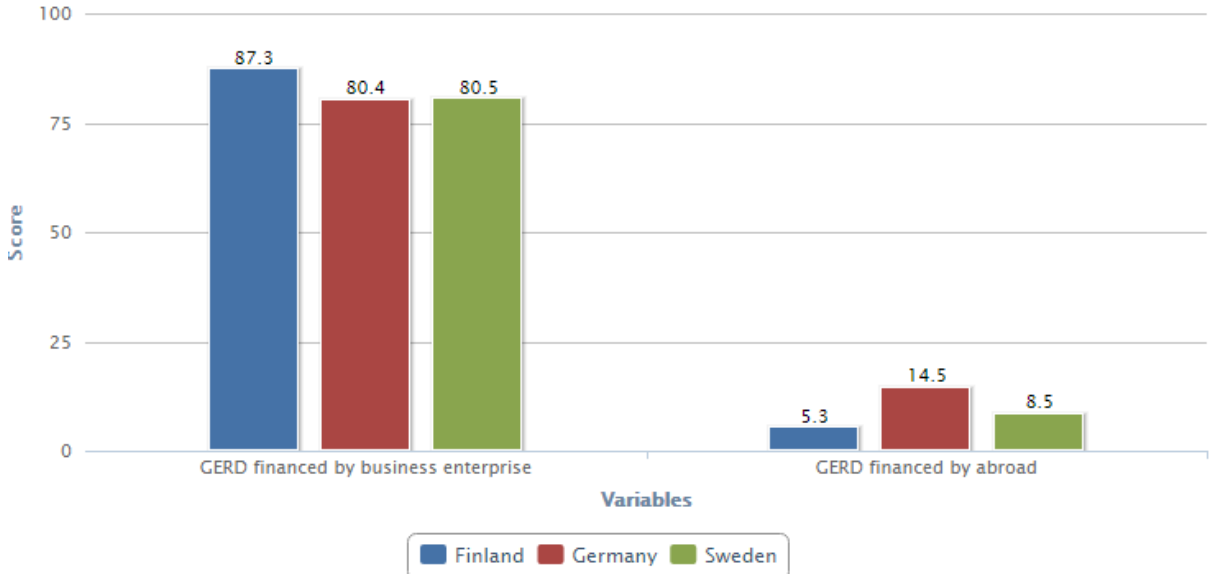


Figure 19: GERD Comparison scores, Source: GII15

6. Conclusion

This study is conducted to measure the national innovation system in general and Finnish NIS in particular. Innovation system are considered as a driver of nation's economy, however, measuring NIS is a difficult task to perform (Nelson et al., 2014). As it is mentioned by numerous researchers that innovation is not an autonomous process, perhaps, it is rooted inside the greater picture. During the course of study significant actors which drive the innovation process in a country are highlighted and their importance is analyzed in detail. Within the framework of NIS, cluster of industries, joint R&D activities between academia and industry, R&D expenditure and government funding policies are the recipes to mobilize innovation in a country.

Due to globalization of world's economy, and the facts and figures discussed in this study, Finland's industrial and innovation policies have contributed in its rapid transformation from natural-resource based economy (mid 1800s to early 1900s) to Investment-driven economy(end of WWII to 1980s)and finally to knowledge-based economy(Since late 1980s). Moreover, the Finnish NIS is classified by public-private collaboration, dense networking among academia, industries and favourable government policies. Measuring NIS is not an easy task to perform and one is required to set the boundaries and figure out the main actors of a country which promotes innovation process in a country. A brief summary of how Finnish NIS works is given in Table 2.

Finland is a country which has small population and limited natural resources, however, several international rankings declares Finland's economy as among the most competitive. The predictable description is the primary stress on NIS and policies, noteworthy financing in high technology R&D and continuous development of an ample education structure and collaboration.

Activity	Action
Enabling welfare state	Easing innovation through capital formation and liberalized foreign ownership and banking.
Integrated Innovation policy	• High-level collaboration to promote innovation in all phases and in every industry. • Support and blend innovation • Support the creation of key innovation inputs • Cultivate a national innovation and production policy for organizations to support it
Public and private bodies facilitating innovation through funding	Tekes, Sitra, STP, Academy of Finland etc.

Table 2: Summary of Finnish NIS

6.1 SWOT Analysis of Finnish NIS

During the course of this study following strengths, weaknesses, opportunities and threats emerged regarding Finnish NIS:

Strengths:

Strength of Finnish NIS can be classified into three categories:

1. Working milieu
2. Education and knowledge based economy
3. Research and Innovation policies and undertakings

Working milieu

- Finland is a politically stable country providing a secure and reliable atmosphere for business and people.
- Finland is a country which has devoted public sector and honest governance.
- Endorsement of social responsibilities by individuals and government is present resulting trust and strong networking.

Education and knowledge based economy

- Finland has an effective educational system with almost 100% literacy rate. Most of the people in Finland have high educational level. Around 85% of Finns aged between 25 years to 64 years are equipped with upper secondary education equated to OECD average of 75% (OECD, 2015).
- Plenty of R&D workforces.
- Moreover, Finland offers equality in education.

Research and Innovation policies and undertakings

- Collaboration of public and private sector
- Academia-industry joint R&D
- Investment in R&D is relatively high compared to international statistics
- Finland has great number of international patents
- Finland's research which is quality based leaves a valuable impact.

Weaknesses:

- One of the upmost weaknesses of Finnish NIS is related with internationalization as Finland has limited number of international researchers and foreign students. Additionally there is low level of FDI and low volume of international research and development funding available.

- Although Finland's has large number of international patents, though majority are centric to ICT sector. As a result, patents outside ICT sector is relatively low.
- Finland has small domestic market.
- Most of the Finnish export is captured by large groups of industries and unfortunately these exports do not cover a wide spectrum of products.
- SMEs in Finland are less proactive and miss the opportunity of growth or window of opportunity.
- To some extent universities and polytechnics do not showcase their strength areas internationally.

Opportunities:

- Promote demand for innovation.
- Promote entrepreneurship by providing sufficient funding and providing capital to companies for internationalization. As a matter of fact, internationalization needs to be integrated in every dimension of research and innovation and it must not be considered as a distinct activity.
- Finland is required to shift its focus regarding the growth of numerous other emerging sectors as well e.g. renewable energy.
- Finnish companies should recruit more international personnel as diversity of culture and mindset results innovation.
- The process of transforming research into startups needs to be facilitated with an active involvement of universities and funding organizations.

Threats:

- Finland R&D expenditure is declining continuously both in public and private sector.
- Finland's outmoded areas of strength are trailing its importance in the international market and unfortunately there is no other enterprise or business available that can replace it.

- Finland's collaboration with international organizations is declining on yearly basis. EU is shifting its generation and production to the countries which lie in the centre or is densely populated as it provides abandon work force and big network of markets.
- Population ageing is also a major threat. Although retired people are an assets as their experience can be utilized in research sector; however future of Finnish society will nonetheless be evaluated by the working youth.

6.2 Limitations and suggestions for further research

Mapping and measuring national innovation systems has not taken a definite formula or technique at a present time which can be seen by the underdeveloped level of numerous statistical indicators debated during the course of this research. Conventional indicators (e.g. R&D expenditures, networking and government policies and funding) are expressively robust; nonetheless they can be used only to get a rough picture or trajectory about the National innovation system.

Another limitation in depicting NIS also undergoes from a deficiency of similar methodologies along different countries. Some countries and researchers adopts an 'all-inclusive' methodology where consideration is given to broad categories of technology based and related inputs, outputs and flow in their research regarding IS. On the other hand, some researchers and countries target exclusively on the flow of knowledge (e.g. joint R&D) and networking.

However, the use of statistical technique (Montgomery and Runger 2003; Neter et al. 1993), particularly 'Regression Approach' can be developed in future to gauge the performance of all the involved actors of an innovation system. In recent years artificial intelligence (AI) is also used widely to monitor and solve problems related to nearly every branch of science and finance. This is made possible because of tremendous advancement in computer technology. According to Haykin (1999), AI can monitor process and predict the activities related to living brain and undoubtedly AI can also be implemented to measure and compare NIS of the countries as well. However, implementation of this idea is a very complex job as AI and Regression technique both

require empirical set of data regarding both dependent and independent variables. Noticeably, there is still considerable effort to do though measuring NIS has a solid beginning.

Nowadays, Finnish universities are going towards commercialization and it is too early to come up with a verdict about the impact that might be possible as a result of transformation of law regarding IP rights of university established inventions and innovation. However, in the past, numerous countries have faced a result opposite to what was expected. Countries face diverse challenges and it is not always a right approach to follow the 'fashion', however, impact of IP rights of academia based innovations needs more research and supporting theories before implementation.

In order to analyze NIS fully, it is required to fully explore the extent to which Finnish innovation policy comprehend a reasonably outlined route. It is needed to scrutinize both the domestic and external context and bodies involved in decision making, trials and errors. Policy makers easily see themselves as the important and more crucial actors to influence innovation process of a country. However, private sector also has its own significance, particularly the top organizations involved in technology. Though Finnish NIS is a role model for others, but pass success not always guarantee the success in future.

The comprehensive suggestion which arises for companies, academia and public research institute is to explore open innovation through building linkages beyond their own sphere (business to academia and vice versa, both nationally and globally) and to work in partnership in research and development in innovation which is non-technical as well. These types of approaches are quite necessary for Finland, especially when global competition is growing, for instance, in forest sector and weakening of its formerly dominant ICT Company, Nokia.

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Appendices:

Appendix 1: Questions asked during interview

Company Name: _____

Contact person: _____

Contact number: _____

Date: _____

- How do you connect innovation, funding and government policies together?

	Very significant	**Significant**	**Less significant**	**Not in use**
Innovation + Funding				
Innovation+ Government Policies				
Innovation + funding+ government policies				

- Are you participating in any kind of innovation activity from last 5 years?

Yes	**No**

- How important do you think the role of customer is when it comes to innovation? Do you involve customers in your innovation activity? Tick the box which best describe your organizations stance on the subject.

	Highly applicable	**Applicable**	**Fairly Applicable**	**Not at all**
Company conduct developments only highlighted by customers				
Company indulge customers and ask their feedback during development phase				
Company propose products with no role of customers				
Any other role (please specify)				

- Is your organization satisfied with government strategies?

	Highly satisfied	**Satisfied**	**Fairly satisfied**	**Not at all**
Any suggestion (please specify)				

- Do you participate in joint R&D?

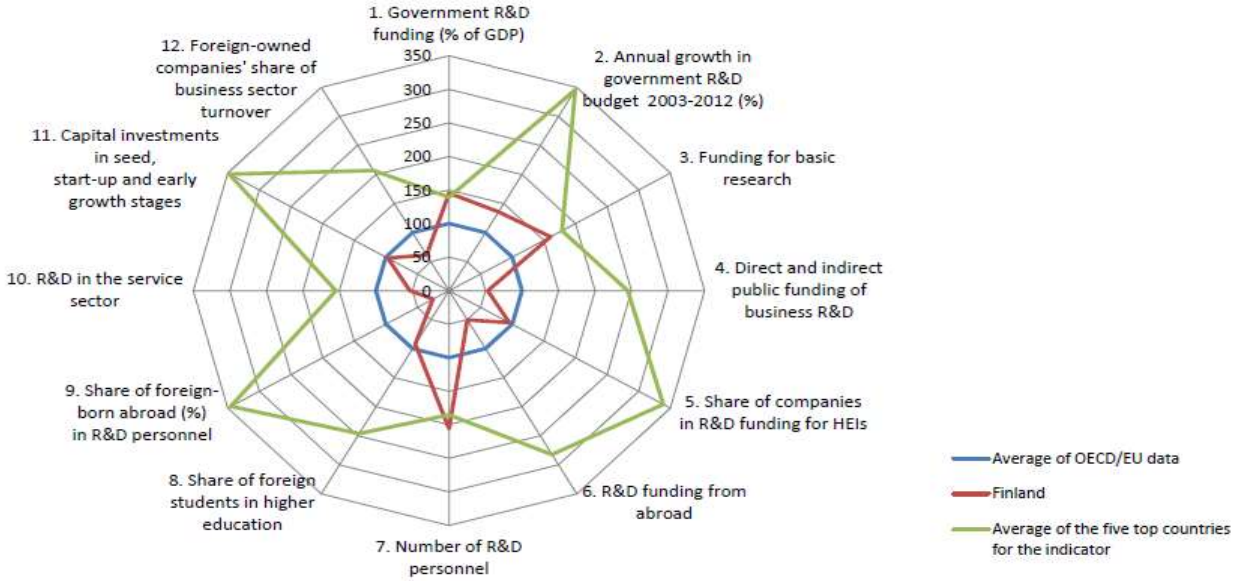
	High collaboration	**Medium Collaboration**	**Fair collaboration**	**Not at all**
Other companies				
Universities				
Research organizations				

- Do you think networking is an important driver of innovation in a country?
- What kind of skills is needed to lead innovation?
- What is the culture of your organization and what does the innovation process look like in your organization?
- Are you satisfied with the amount of funding and the grounds on which loan or grants can be taken from public and private sector?
- What is the biggest barrier for internalization?

Appendix 2: Interviewee Personals

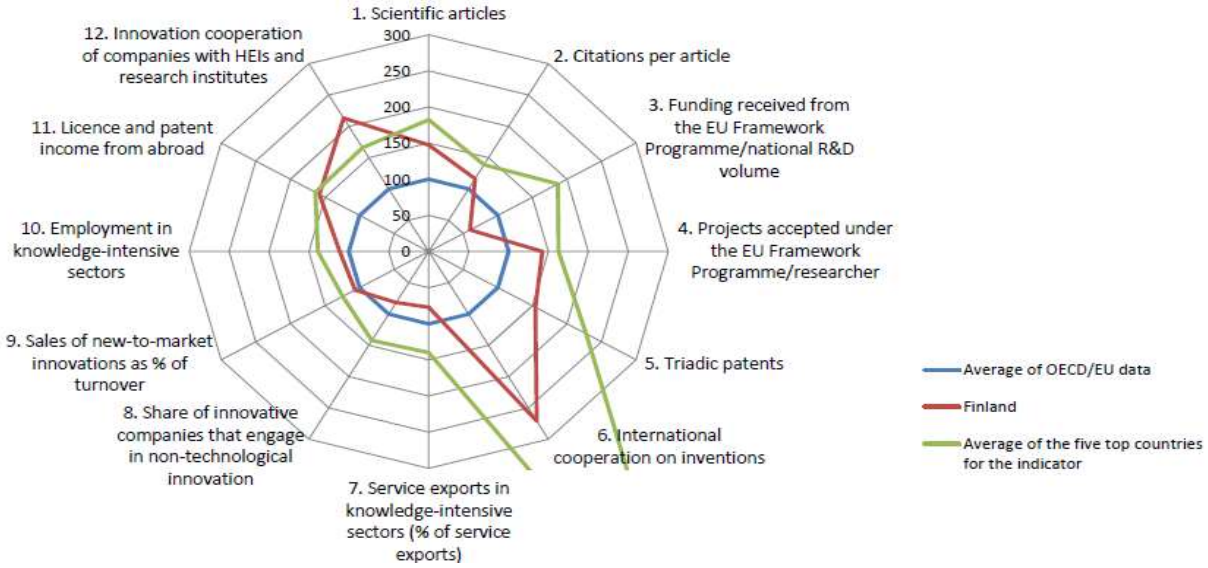
Name	Organization	Date
Lindberg Satu	Ministry of Education and Culture	11.01.2016
Petri Peltonen	The Ministry of Employment and the Economy	13.01.2016
Merja Lumme	Tekes	22.03.2016
Anne Ristola	Sitra	24.03. .2016
Räsänen Rami-Samuli	Aalto University	11.04.2016
Timo Pelttari	Kenno Tech Ltd	12.04.2016
Mikko Anttila	Aste Finland Oy	20.04.2016

Appendix 3: Finnish NIS in an international comparison



Input indicators

Source: Research and innovation Policy 2015-2020



Output indicators, Source: Research and innovation Policy 2015-2020