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EFFECT OF KNOWLEDGE SOURCES AND INSTITUTIONS OF CLUSTERS ON FIRMS' INNOVATIVE PERFORMANCE: AN APPLICATION ON CLUSTERS IN DIFFERENT LIFE STAGES

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THESIS APPROVAL PAGE

DECLARATION

I hereby declare that this doctoral thesis titled as “The Effect Of Knowledge Sources and Institutions of Clusters on Firms’ Innovative Performance: An Application on Clusters in Different Life Stages” has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resourses in the reference list. I verify all these with my honour.

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ABSTRACT

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Regional Innovation Systems (RIS) concept suggests that innovation is systemic at the regional level where interaction among the RIS components and institutions is vital. Being located in RISs, clusters and their innovative performance are highly affected by the institutional context; however the role of the institutions in the cluster evolution is an important topic to be discovered.

This study aims to identify the differences in different life stages in terms of institution types and knowledge sources; and their influence on cluster firms innovative performance. In order to identify the differences, the research was applied on two clusters which are in emergence and maturity phases, both having synthetic knowledge base. Data was collected by structured questionnaires.

In order to figure out the important institutions and the knowledge sources in each life stage, Social Network Analysis were applied. The results were compared by Mann-Whitney U Tests. To explain the effect of knowledge sources and institutions on innovative performance, a multivariate model was formed. The model was tested by Ordinal Regression Method.

The multivariate model analysis show that institutions predict innovative performance. Second, the information received during the interviews revealed that the cluster organisation and the development agency has been supporting the mature cluster's development by effective projects and funding schemes.

In terms of type and spatial level of knowledge sources and the type of institutions; there is no meaningful difference between two life stages. The difference is rather between high and low-level innovation categories.

Keywords: Cluster, Regional Innovation Systems, Knowledge Sources, Institutions, Synthetic Knowledge Base, Cluster Life Cycle, Social Network Analysis.

ÖZET

Doktora Tezi

Kümelerde Bilgi Kaynakları ve Kurumların Firmaların Yenilikçilik Performansına Etkisi: Farklı Yaşam Fazındaki Kümeler Üzerinde Bir Uygulama

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Bölgesel Inovasyon Sistemleri kavramı yenilikçiliğin bölgesel düzeyde sistemik olduğunu ve bu sistem içinde yeralan aktörler arasındaki iletişimin yenilikçilik için gerekli olduğunu vurgular. BIS'nde kurumlar ve bilgi kaynakları hayati önem taşımaktadır. BIS'nin içinde yer almaları nedeniyle kümelerin yenilikçilik performansı kurumsal yapılardan büyük ölçüde etkilenmektedir; ancak kurumların kümelerin zaman içindeki değişim ve gelişimini ne şekilde etkilediği ve zaman içinde nasıl değiştiği hala aydınlatılması gereken önemli noktalar arasındadır.

Bu araştırma, kurumlar ve bilgi kaynaklarının farklı küme hayat aşamalarında nasıl değişiklik gösterdiğini ve küme firmalarının yenilikçilik performansına olan etkisini açıklamayı amaçlamaktadır. Farklı yaşam aşamalarında bilgi kaynakları ve kurumların nasıl değişim gösterdiğini belirlemek amacıyla; çalışma, "olgunluk" ve "oluşma" aşamalarında olmak üzere iki farklı yaşam aşamasında yer alan iki kümede uygulanmıştır. Bilgi tabanlarından kaynaklanabilecek farklılıkları ortadan kaldırmak amacıyla, aynı bilgi tabanına sahip "sentetik" bilgi tabanlı kümeler seçilmiştir. Bilgi toplama aşamasında küme firmalarına anket uygulanmıştır.

Değişik yaşam aşamalarındaki ağ (network) yapıları ve bilgi kaynakları Sosyal Ağ Analizi yöntemi kullanılarak belirlenmiş ve Mann-Whitney testleri ile iki küme karşılaştırılmıştır. Bilgi kaynaklarının ve kurumların yenilikçilik

performansına olan etkisini ölçmek için ise çok değişkenli model oluşturulmuş; analizde Sıralı Regresyon Analizi yöntemi kullanılmıştır.

Çok değişkenli model fon sağlayan kuruluşların yenilikçilik performansını yordaladığını göstermektedir. Ayrıca, çalışmada alınan bilgiler, küme organizasyonu ve kalkınma ajansları gibi kurumların önemli projeler ve fonlar ile olgunluk aşamasındaki kümenin gelişimine destek olduğunu ortaya koymaktadır. Bilgi kaynakları çeşitleri, uzamsal seviyeleri ve kurumlar anlamında ise her iki faz arasında anlamlı bir farklılık gözlenmemiştir. Farklılık daha çok yüksek ve düşük yenilikçilik seviyeleri arasında bulunmaktadır.

Anahtar Kelimeler: Kümeler, Bölgesel Yenilikçilik Sistemleri, Bilgi Kaynakları, Kurumlar, Sentetik Bilgi Tabanı, Küme Yaşam Döngüsü, Sosyal Ağ Analizi.

EFFECT OF KNOWLEDGE SOURCES AND INSTITUTIONS OF CLUSTERS ON FIRMS' INNOVATIVE PERFORMANCE: AN APPLICATION ON CLUSTERS IN DIFFERENT LIFE STAGES

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CHAPTER THREE
EVOLUTION OF CLUSTERS

CHAPTER FOUR
AN APPLICATION ON THE KNOWLEDGE SOURCING, INSTITUTIONS AND INNOVATIVE PERFORMANCE OF CLUSTERS

ABBREVIATIONS

BERD	Business Enterprise Expenditure on R&D
BRIICS	Brasil, Russia, India, Indonesia, China, South Africa
CAT	Competitive Advantage of Turkey
DUI	Doing Using Interacting
EBSO	Aegean Region Chamber of Industry
ECCP	European Cluster Collaboration Platform
EEG	Evolutionary Economic Geography
EPO	European Patent Office
ERIS	Entrepreneurial RIS
ESSIAD	Association of The Aegean Industrialists and Businessman of Refrigeration
EU	European Union
GAP	Southeastern Anatolia Project
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
GEKA	South Aegean Development Agency
GERD	Gross Domestic Expenditure on R&D
GREMI	European Research Group into Innovative Milieus
HVAC-R	Heating, Ventilation, AirConditioning and Refrigeration
ICT	Information and Communication Technologies
IPP	Innovation Policy Platform
IRIS	Institutional RIS
ISIB	Air Conditioning Sectoral Exporters' Union
IVAC-R	Industrial Ventilating, Air Conditioning and Refrigeration
IZKA	Izmir Development Agency
İTKİB	Istanbul Textile and Apparel Association
JPO	Japan Patent Office
KIPO	Intellectual Property Office
KOSGEB	Small and Medium Enterprises Development Organization
MAKSİAD	Association of Machinery Businessman

METI	Ministry of Economy, Trade and Industry
MFP	Multifactor Productivity Growth
NIS	National Innovation Sytems
OECD	Organization for Economic Co-operation and Development
ORM	Ordinal Regression Model
R&D	Research and Development
RCOP	Regional Competitiveness Operational Programme
RIS	Regional Innovation Systems
SIPO	State Intellectual Property Office of the People's Republic of China
SIS	Sectoral Innovation Systems
SME	Small and Medium Size Enterprise
SNA	Social Network Analysis
STI	Science, Technology, Innovation
TCI	The Global Practitioners Network For Competitiveness, Clusters And Innovation
TEKMER	Technology Development Centers
TEPAV	The Economic Policy Research Foundation of Turkey
TIS	Tecnological Innovation Systems
TSE	Turkish Standards Instıtution
TURKAK	Turkish Accreditation Agency
TÜBİTAK	Scientific and Technological Research Council of Turkey
UBTYS	National Science, Technology and Innovation Strategy
UNDP	United Nations Development Programme
URAK	National Competitiveness Research Agency
UR-GE	Development of International Competitiveness Programme of Ministry of Economics
USA	United States of America
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organisation

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INTRODUCTION

Innovation has become a top priority topic both for governments and for the companies. Governments are designing various policy measures and incentives to promote innovation, firms are looking for ways to increase their innovative performance innovative performance which is vital for competitiveness and national progress (OECD, 2015c). This is mainly due to the effect of innovation and technological advances on the economic growth. R&D expenditures, innovation, productivity, and per capita income affect each other and provide means for long-term growth for countries (Hall and Jones, 1999; Rouvinen, 2002). From Schumpeter (1946) on the relationship of innovation and economic growth is explained by various models.

Innovativeness has been seen as an important factor supporting the regional development and increasing the competitive capacity of regions also (Armatlı, 2005). Various territorial models of innovation are introduced in literature. Among these, clustering has become another key concept for policy-makers as a tool for promoting regional growth and competitiveness (Martin and Sunley, 2003). Clusters are "Geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions …. in a particular field that compete but also cooperate" (Porter, 1998a, p.197). Regional clusters are foreseen as "the best environment for stimulating innovation and competitiveness of firms" (Asheim and Isaksen, 2000).

Regional Innovation Systems concept relates innovation with the regional context with a larger scope. It suggests that the innovation processes were systemic at the regional level (Cooke, 1992), the region is a network (Cooke 1997; Cooke and Morgan, 1998), and this network is composed of firms, and supporting institutional context (supporting organisations) and that the learning takes place through the interaction of the actors. RIS also suggests that the economic growth and innovation is based on the knowledge, skills and capabilities, infrastructures -shortly- on local characteristics of the region, and the distinctiveness of these characteristics (Cooke, 2008). Based on these statements, an RIS can be defined as a framework in which intensive communication and collaboration occur between the components of the system, which are companies, knowledge generating organizations, policy support infrastructures and the other institutional setting (Cooke, 1998).An RIS consists of two main subsytems; a) knowledge exploitation and application subsytem and b) knowledge generation and diffusion subsystem (Cooke at al, 1997). In the knowledge exploitation and application subsytem, firms, their customers, collaborators, suppliers and competitors take place, these actors network horizontally and vertically. In the knowledge generation and diffusion subsystem there are educational institutions, research organisations, technology mediating organisations and workforce mediating organisations.

Clusters are included as an important component of an RIS, an RIS may host several sectors and clusters (Asheim and Coenen, 2005). Embedded into the RIS, a cluster cannot be analysed isolatedly; the characteristics of specific RIS that the cluster locates in has to be included in the analysis.

One of the important characteristic of the RISs is the knowledge bases which suggests that the innovation process of firms in various industries and sectors differ since they require specific knowledge base(s) (Asheim and Gertler, 2005; Asheim and Coenen, 2006). In other words, they depend on the knowledge bases of the industries and sectors, namely Analytical (science-based), Synthetic (engineering-based) (Laestadius, 1998) and Symbolic (creativity-based). Therefore, for a precise cluster analysis, the RIS and the knowledge base should be considered.

In RISs institutions play an important role (Cooke, 1997). Clusters are not isolated from the RIS's institutional context, a poor institutional context may be hampering the innovative performance of the cluster (Tödtling and Trippl, 2005; Kuştepeli et al.,2013) Therefore, while analysing the clusters, specific problems and barriers of the RIS should also be examined. Today a one-size-fits-all policy (Tödtling and Trippl, 2005) approach was shifted to designing innovation policies as per the specific needs and problems of the RIS.

In today's world, innovation is no longer seen as an isolated effort, it is rather a collective process where learning and knowledge takes place (Lundvall, 1992; Nelson, 1992, Cooke, 1992,1997; Powell et al., 1996;). RIS also suggests that all the actors in an RIS form a network and the network theory suggests that the structure of the network affects the access to information (Cooke 1997; Cooke and Morgan, 1998). The dense ties are important since it facilitates the knowledge flow; however too dense ties can have a threat of lock-in since the homogenity of the network members in terms of ideas, competencies, etc. forms a barrier for innovative ideas. Therefore the knowledge flows from external sources are required (Bathelt, 2004). In addition, different spatial levels of the knowledge can be required for different types of innovation (Tödtling, 2009).

The use of network approach in clustering studies has also opened new merits on the evolution of the clusters. As the network cluster suggests, the clusters are dynamic structures that are evolving and changing, therefore taking a static approach in cluster analysis will be misleading.

In the light of the above discussions, while this research analyses the effect of clustering on the innovation performance of the firms, it analyses the clusters based on three pillars.

i) The knowledge base of the RISs that the clusters are located in,

ii) The features of the networks in the clusters

iii) The life stage that the cluster is in

The dissertation is structured as follows: Chapter 1 “Innovation and the Territorial Models of Innovation”, Chapter 2 “Clusters as Networks and Knowledge Sourcing” and Chapter 3 “Evolution of Clusters”form the theoretical background of this research based on the literature survey on related topics; whereas Chapter 4 explains the application process and findings of the study. The details of the chapters are explained below.

Chapter 1 briefly introduces the innovation terminology in the literature, innovation in the world, the relationship between innovation and the economy, and territorial models of innovation. Clusters, Regional Innovation Systems, knowledge bases and the relationship between institutions and innovation are discussed in this chapter.

Chapter 2 focuses on the network approach and knowledge sourcing. It starts with explaining the network concept and discusses why the RISs and clusters have to be analysed as networks, the relationshipbetween the knowledge sourcing patterns and the innovation performance of the companies, by providing evidence from the literature.

Chapter 3, evolution of the clusters, discusses that the clusters are dynamic rather than static structures and they evolve in time, suggesting that the performance of the cluster change due to the phase or stage that the cluster is in. It also compares two different perspectives in cluster evolution: Life Cycle Approach and Adaptive Cycle Model.

Chapter 4 presents the objective of the research, the research methodology and the findings of the applied research.

The research was applied on two clusters having same knowledge base in different life phases. The knowledge sources and the network structure of the clusters were identified by using Social Network Analysis. The relationship between innovation, knowledge sources and the institutions were tested by a multivariate model controlling for the life stage of the clusters. The type of institutions and the knowledge sources in different life stages were tested by Mann Whitney U-Tests.

The findings of the Social Network Analysis show that in both clusters, knowledge sharing is at very low levels both locally and externally. However, the mature cluster has more organized social capital and cluster initiative than the emerging cluster, the companies are active members of the cluster organisation, and work for the benefit of the cluster to get funding, to expand the scope of the cluster and so on. The multivariate model verifies that KOSGEB and TÜBİTAK are related to innovative performance given that the university and controlling for the life stage. High innovation firms and large firms benefit from the institutions in terms of funding, utilization of an expert/consultancy service. The hypothesis tests show that there is no significantly meaningful difference between the clusters in terms of "type and spatial level of knowledge sources" and "type of institutions important for the innovative performance". Although the analyses do not prove a direct effect on innovativeness of the companies, based on the information received during the interviews, it can be concluded that institutions have an indirect effect on the cluster evolution. The analysis of the RISs as per institutional context reveals the difference between two clusters in Denizli and İzmir. Denizli cluster has been suffering from being in a peripheral region, where institutional context is weak. As opposed to Denizli, İzmir has a strong institutional context, which supports the development of the IVAC-R cluster. However there is alock-in risk for the mature cluster since external knowledge flows are at very low levels.

This study is original in the sense that it compares two life phases of the clusters in terms of knowledge sources and institutional context and their relation to innovative performance in the synthetic knowledge base. It contributes to the literature by

1.showing that the cluster life phase do not affect the pattern of knowledge sources and cooperation of firms with institutions,

2.the pattern of cooperation with institutions change in different innovation categories, it is at highest level in the high innovation category,

3.a developed institutional context affect the cluster development positively.

CHAPTER ONE
INNOVATION AND THE TERRITORIAL MODELS OF INNOVATION

1.1. INNOVATION AND ECONOMY

Innovation has become a top priority topic both for governments and for the companies. Governments are designing various policy measures and incentives to promote innovation, firms are looking for ways to increase their innovative performance. Even the major R&D performer countries are re-designing their innovation policies; EU has set Lisbon Agenda in 2000 and The United States introduced "Innovate America" strategy in 2005 which are updated according to changing conditions(OECD, 2015c).Having an impact on the economic growth, innovative performance is vital for competitiveness and national progress. R&D expenditures, innovation, productivity, and per capita income affect each other and provide means for long-term growth for countries (Hall and Jones, 1999; Rouvinen, 2002).

Economic growth is defined as the increase in a country's productive capacity of two subsequent years, as measured by comparing gross domestic product (GDP) which is the standard measure of the value of final goods and services produced by a country during a period minus the value of imports. Economic growth can be fostered either by raising the labour and capital inputs used in production, or by improving the overall efficiency with which these inputs are used together, i.e. higher multifactor productivity growth (MFP).Innovation increases multi-factor productivitygrowth by increasing the efficiency in the use of labour and capital. Multi-factor productivity growth typically becomes a more important driver of growth as countries exhaust for productive investment in tangible capital and as their population ages. As the labour force has started to decline, in many OECD countries and some emerging economies, the contribution of labour input to growth has diminished as a factor of production already. Moreover, the rate of increase in the human capital stock is expected to slow in the future (OECD, 2015a). For these reasons, innovation driven productivity will be the main source of future growth (Braconier, et al, 2014). Figure 1 shows the contribution rate of each factor on GDP on country basis. Innovation also contributes to the GDP by technology embodied in fixed capital and investment in knowledge based capital (such as R&D, design and other intellectual property, data, firm-specific skills or organisational capital) (OECD, 2015b).

Figure 1: Contributions to GDP Growth

Source: OECD, 2016a :3

The literature supports that innovation has a positive effect on per capita outputs. 1 percent increase in innovation raises per capita income by around 0.05 percent in both OECD and non-OECD countries (Ülkü, 2004). The positive relationship between innovation and GDP and GDP per capita is also evident for developing countries such as South Korea (Lee and Kang, 2007), Malaysia (Hegde and Shapira, 2007), Taiwan (Yan Aw et al., 2008), China (Jefferson et al., 2006), Turkey (Adak, 2015), Central Eastern Europe Countries (Poland, Czech Republic and Hungary) (Pece et al., 2015).

There are various economic growth models which takes technological advances as a factor for economic growth. The next section gives a brief introduction of these models.

1.1.1. Economic Growth Theories

1.1.1.1. Neo-Classical Growth Theory

This paradigm constructed by Solow (1956) and Swan (1956) suggests that the economic growth is based on capital accumulation (savings); however due tothe diminishing marginal product of capital, this growth will not last forever without technological progress. It claims that if the technological progress stops, in the long-run the economic growth will also cease. These models predict that economies affected by technological change, saving rate and population growth rate which are all are independent from the economic forces, in other words, they are exogenous factors. Later, Cass (1965) and Koopman (1967) developed the model with including the endogenous factor of consumer optimization. Neoclassical model's analysis of how capital accumulation affects national income, real wages, and real interest rates for any given state of technology is valid also when technology is endogenous (Aghion and Howitt, 2009).

The main limitation of the neoclassical model is that *"it ….(takes) technological progress as given by some unspecified process that generates scientific discovery and technological diffusion, ……. it offers no economic explanation for persistent cross-country differences in growth*" (Aghion and Howitt, 2009, pp.39).

1.1.1.2. Endogenous Models

As opposed to the neo-classical theory, endogenous growth models assume that the technological progress depend on economic forces, therefore it is an endogenous factor. Although they take technological factor as endogenous, models under this approach vary with respect to the sources or reasons they take to explain the economic growth. Main models under this approach are; AK model, Product variety model and the Schumpeterian model (Aghion and Howitt, 2009).

AK model (Arrow, 1962) suggests that technological progress is an outcome of "learning by doing" while producing new goods, in other words productivity can increase by learning by doing. This model is used and developed by many scholars to explain the effect of human capital accumulation on knowledge creation and transfer (Lucas,1988; Romer, 1990), government policy (Rebelo,1991) and fiscal policy (King and Rebelo, 1990) on growth. According to the model, economic factors such as thrift and the efficiency of resource allocation affects the long-run growth rate (Arrow, 1962); however new endogenous models explain the growth by innovation. R&D based models build on R&D activities, R&D labor force and the product variety. These models suggest that the more the economy has the R&D labor force and the more effectively use these inputs in R&D activities for new products and technology, the higher will be the economic growth rate (Ateş, 1998:26).

Main innovation based models are Endogenizing Technological Change (Romer, 1990) and Schumpeterian Model (Aghion and Howitt, 1992). Endogenizing Technological Change, although very similar to the neo-traditional model, departs from it in the sense that it takes technological change is due to intentional actions, thus it defines it as an endogenous factor. The main idea is that product variety increases productivity and that the sunk costs which occur while developing a new product creates a barrier for new entrants, therefore firms producing new products gain monopolistic competitive advantage. It also suggests that the stock of human capital determines the rate of growth, integration into world markets will increase growth rates, and that having a large population is not sufficient to generate growth (Romer, 1990). Although this model suggest that the economic growth is based on the increase in R&D labor force, Schulstad (1993) and Jones (1995) found no evidence for this.

Another model is the Aghion and Howitt Model (Aghion and Howitt, 1992). This model suggest that the growth rate is dependent on the R&D activities, and the R&D efforts of a period will be negatively related to the following period's efforts due to the creative destruction (Schumpeter, 1946). Schumpeter was the first economist to take innovation to the main driving force of the economic growth. He explains it with "creative destruction" where the entrepreneur makes innovation and this innovation deconstructs the existing economical situation and create a new one. In his seminal work, he states

"Capitalism, then, is by nature a form or method of economic change and not only never is but never can be stationary. And this evolutionary character of the capitalist process is not merely due to ….(wars, revolutions and so on), (they) often condition industrial change, but they are not its prime movers. Nor is this evolutionary character due to a quasiautomatic increase in population and capital or to the vagaries of monetary systems of which exactly the same thing holds true. The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates" (Schumpeter, 1946).

According to the Schumpeterian theory technology transfer increases productivity (Aghion and Howitt, 2009). Also new entrant firms sometimes grow quickly and thus increase their market share and replace other firms with low productivity, as a result of this creative destruction, reallocation of resources boost productivity growth (Andrews and Criscuolo, 2013). Innovation and the related process of creative destruction lead to new technologies, entrepreneurs and business models, contributing to the establishment of new markets and eventually to the creation of new jobs (OECD, 2015c).

1.2. DEFINITION AND TYPOLOGY OF INNOVATION

To date, various definitions and the types of innovation have been introduced in the literature. As the nature of the processes improved and the research has been deepened, the definitions and the typology have changed throughout the time. In this section the latest definitions and the typology of the innovation based on a) business processes b) the impact it creates and last but not the least, c) knowledge and learning will be discussed. Although these definitions and classifications describe innovation from different aspects, they are not necessarily contradicting, in fact they can be considered as complementary.

1.2.1. Definition and Typology Based on Business Processes

The definition and the measureof innovation vary in literature. Conventional definition of innovation described it as "the process by which firms master and put into practice product designs and manufacturing processes that are new to them" (Nelson and Rosenberg, 1993:4). Schumpeter (1946) has emphasized the key role of different forms of innovation, including product, process, market, and organizational innovations, for the performance of firms. However, in the following periods, research on innovation took a linear approach where innovation was related only R&D activities which only took the technological product and process innovations into consideration (Tödtling and Grillitsch,2012). Starting from the second half of the 80's, scholars started to argue that technological innovations was only a subset of innovation and this view was only applicable to manufacturing firms who sell a tangible product which resemble Schumpeter's definition (Kline and Rosenberg 1986; Lundvall 1992; Cooke, 1997). Technological improvement was not the only factor that fostered firms' performance, opening up of a new market and conquesting of a new source of materials should also be taken into consideration. Some scholars have suggested that the innovation should be seen as institutional change (Pavitt and Patel, 1988; Dalum et al., 1988) as technical change is also possible if it is accompanied by cultural change or a change of habits or routine (Cooke et al., 1997). The broader perspective today defines innovation as the "smart use of advanced knowledge" (Capello, 2011), thus the modern view argues that innovation can emerge from new technological and non- technological knowledge. Non-technological innovations are closely related to the know-how, skills, and working conditions that are embedded in organizations (World Economic Forum, 2014). In a similar vein, OECD re-defines innovation. The organisation argues that while technological changes are a key driver of change, innovation is much broader than technological change which are only applicable for the manufacturing firms (OECD, 2005). According to the revised version in Oslo Manual (OECD-Eurostat, 2005) innovation is defined as the implementation of

i) a new or significantly improved product (good or service) or
ii) process,
iii) a new marketing method or
iv) a new organisational method in business practices, workplace organisationor external relations.

The definition implies four types of innovation: product, process, marketing and organisational innovation. Definitions of each type is given below:

i) Product innovation: The introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.

ii) Process innovation: the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.

iii) Marketing innovation: the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

iv) Organisational innovation: the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations (OECD-Eurostat, 2005),

The National Innovation Surveys conducted by OECD reveals that the most innovative firms introduce new marketing or organisational methods alongside product or process innovations; in fact new organisational methods may facilitate the introduction of a new production process or the new process may even require them. This holds true for both large firms and SMEs in both manufacturing and services (OECD, 2015d). Figure 2 illustrates the innovation types of firms by firm size.

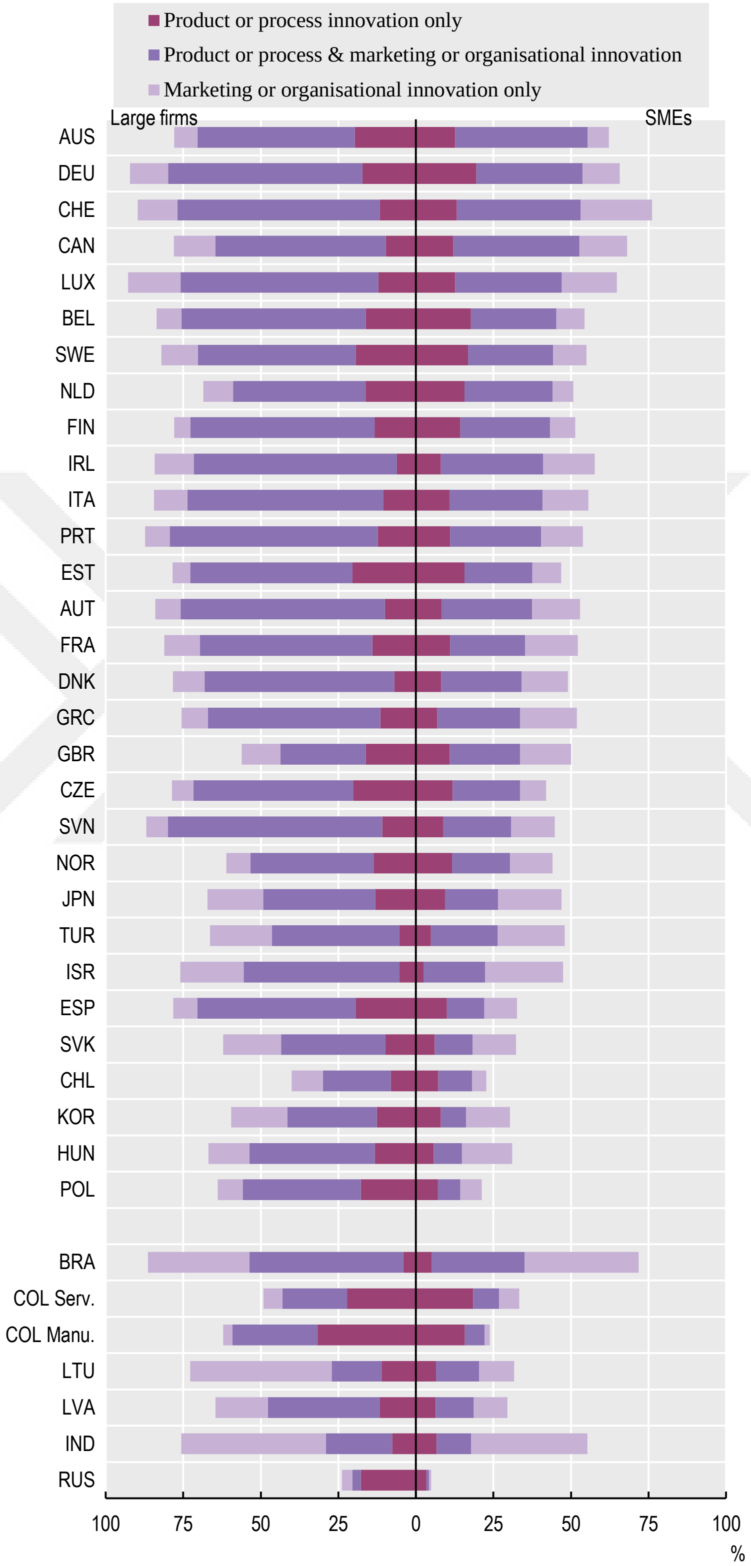
1.2.2. Radical and Incremental Types of Innovation

In neo-Schumpeterian innovation theory, which is based on Schumpeter's business cycles (Andersen, 2011) innovation can be radical or incremental (Cooke, 2011). In Schumpeter's view "radical" innovations create major disruptive changes, whereas "incremental" innovations continuously advance the process of change (Schumpeter, 1939). The Innovation Policy Platform (IPP), developed by theOECD and the World Bank defines radical and incremental innovation as "A radical or disruptive innovation is an innovation that has a significant impact on a market and on the economic activity of firms in that market. This concept focuses on the impact of innovations as opposed to their novelty. The innovation could, for example, change the structure of the market, create new markets or render existing products obsolete.

Incremental innovation concerns an existing product, service, process, organization or method whose performance has been significantly enhanced or upgraded. This can take two forms: For example, a simple product may be improved (in terms of improved performance or lower costs through use of higher performance components or materials, or a complex product comprising a number of integrated technical subsystems may be improved by partial changes to one of the subsystems." (Innovation Policy Platform website,2015).

Radical innovation brings radical changes to processes, it involves changing the fundamental principles of a technology (Freeman, 1974). Incremental innovation introduces minor changes to the product. They call for the improvement or use of existing resources and seek development within an existing technology. Incrementalinnovation is used to solve emerging problems with the aim of increasing the efficiency and effectiveness of existing products or processes. In contrast, radical innovation involves a whole set of new knowledge (Liyanage, et. al., 2006).

Figure 2: Types of Innovation by Firm Size



Source: OECD, 2015d :162

1.2.3. Modes of Innovation

The modes of innovation view places the knowledge and learning in the center of innovation. Although modes of innovation is introduced by Jensen et.al (2007), the relation of innovation with learning and knowledge was discussed in learning economies[1] (Lundvall and Johnson, 1994) and systems of innovation (Edquist, 1997; Cooke, 1992; Bathelt et al., 2004).

Jensen et al. (2007) suggest that there are two modes of innovation: STI (science, technology, innovation) and DUI (doing, using, interacting).In general, the STI mode contributes to the generation of advanced scientific and technological knowledge, through analytical processes to identify natural principles and mechanisms especially in technology based industries. DUI mode refers to learning-by-doing, by-using and by-interacting that translate scientific, analytical knowledge inputs into synthetic knowledge. STI produces explicit/codified knowledge, whereas DUI knowledge is implicit/tacit knowledge. STI is global knowledge where DUI is localized (Jensen et al., 2007). The study on 4000 Danish companies, revealed that the most productive innovation mode is the combination of the STI and DUI (Jensen et al., 2007), other studies conducted in Norway, China and Spain supported the findings (Aslesen et al., 2012; Chen et al., 2011, Gonzalez-Pernia et al., 2014). The combination of STI and DUI requires that the companies not only depend on codified knowledge but also interact formally and informally with the value chain and other stakeholders to gather tacit knowledge (Gonzalez-Pernia et al, 2014).

As the above discussion on innovation shows, as the innovation processes had changed and the research on innovation had advanced, the perspectives on innovation has taken different merits. Today innovation is not only limited to

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[1]Lundvall and Johnson (1994) classify knowledge into four: Know-what, Know-why, Know-how, Know-who. Know-what and know-why may be obtained through reading books, lectures and accessing data bases, the know how and know who depend on practical experience. Know-how will typically be learnt in apprenticeship relations where the apprentice follows the master, studies the master’s ‘body language’ as well as the master’s spoken language and relies upon her/his authority (Polanyi, 1958/1978, p. 53). Know-who is also learnt in social practice and some of it is learnt in specialized education environments.

“product and process innovation” or “radical innovation” or “technological and scientific innovation”.

Based on the above descriptions, the modes and types of innovation can be categorised based on three different pillars:

i) Business Processes: Product, process, marketing and organizational types of innovation (Schumpeter, 1946; OECD, 2005)

ii) Impact of Innovation: Radical and incremental types of innovation (Schumpeter, 1939)

iii) Knowledge and Learning Process: STI (Science, Technology and Innovation) and DUI (Doing, Using, Interacting) modes of innovation (Lundvall, 1994; Jensen et al., 2007)

Types and modes of innovation is summarized in Table 1.

The perspectives on the creation of the innovation have also changed; today - as the scientific and technological progress has led to highly specialised areas of knowledge (Tödtling and Grillitsch, 2014) which made knowledge sharing and relationships among the actors vital- innovation is not an isolated work; it is rather a result of collective processes (Lundvall, 1992; Nelson, 1992, Cooke, 1992,1997; Powell, 1998). Thus, knowledge has become a key factor for innovation and competitiveness in the new economy- so called- knowledge economy or learning economy. Knowledge sourcing has become an important research topic, as well as its spatial levels.

Table 1: Classification of Innovation

Classification Based On	Type	Definition
Business Processes (Schumpeter, 1946; OECD, 2005)	Product	a new or significantly improved product (good or service)
	Process	a new or significantly improved process
	Marketing	a new marketing method
	Organizational	a new organisational method in business practices, workplace organisation or external relations
Impact of innovation (Schumpeter, 1939)	Radical (Disruptive)	a significant impact on a market and on the economic activity of firms in that market such as change the structure of the market, create new markets or render existing products obsolete.
	Incremental	The performance has been significantly enhanced or upgraded such as lower cost, better performance, so on.
Knowledge and Learning (Lundvall, 1994; Jensen et al., 2007)	STI Mode (Science, Technology, Innovation)	Generation of advanced scientific and technological knowledge, through analytical processes to identify natural principles and mechanisms (especially in technology based industries)
	DUI Mode (Doing, Using, Interacting)	Innovation by application or novel combination of existing knowledge

1.3. INNOVATION FIGURES AND TRENDS IN THE WORLD

Innovation is highly affected by the number of external factors, as these factors change the innovative performance of the countries, the main players and so on are also subject to change. The main factors affecting innovative performance are the developments in ICT, investments in knowledge-based capital and globalisation, social and environmental challenges, and economic slowdowns.

Advances in ICT have been triggering innovation. By the use of ICT, access to inventions and innovations is faster, cheaper and better, and technology has become the part of mass culture. Cloud computing has decreased ICT barriers for SMEs, thus providing them the advantage to innovate. Besides ICT, there pharmaceuticals and biotechnology, technology hardware and equipment, andautomobiles are sectors in which innovation and R&D expenditures is highly observed (OECD, 2014). On the other hand, especially the economic downturnstarting in 2008 and weak demand caused a negative trend of the innovationindicators in OECD countries. The major R&D performers are USA, EU 28, Korea, China, BRIICS, Japan; however the share of the OECD countries have fallen from 90% to 70% over the past decade whereas the share of the countries outside the OECD isincreasing.More than one-third of the world's public research concentrated in non-OECD economies where Asia in particular set to play an increasinglyprominent role. Besides China; Korea, Slovenia, Czech Republic, Poland, the Slovak Republic and Turkey has increased their R&D spending strongly (OECD, 2017a). Figure 3 illustrates the R&D expenditures at the global level and major R&D performers. Figure 4 and 6 illustrate the Gross Domestic Expenditure on R&D (GERD) and Business Enterprise Expenditure on R&D (BERD).

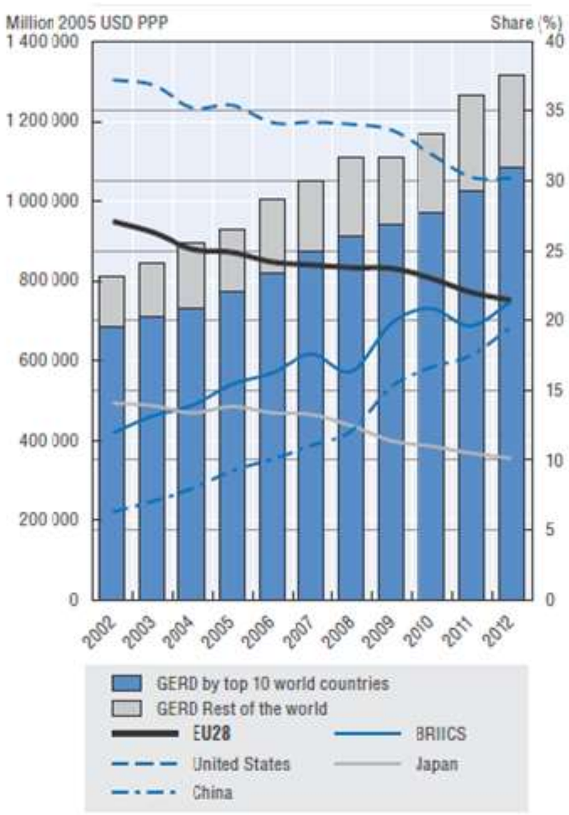
Average R&D intensity of OECD economies has continued to increase, however, very slowly, under 2% of gross domestic product (GDP) in 1995 to 2.4% of GDP in 2013. Korea is the most R&D intensive country, followed by Japan and the USA. Figure 5 and 7 illustrate the BERD and GERD, % of GDP.

Total patent applications in 2015 has reached to around 2.9 million worldwide, up 7.8% from 2014 (Figure 8). This growth is considerably higher than the growth rate in 2014, but slightly lower than the annual growth rates between 2011 and 2013, which are 8% and 9% respectively (World Intellectual Property Organization, 2016). In 2015, the growth is by mainly due to the growth in the application filings in China, which accounted for 84% of total growth. The rest of the world grew by only 1.9% in 2015. As per the numbers of the applications, thecountries which made higher R&D investments are to dominate the top of the list. The State Intellectual Property Office of the People's Republic of China (SIPO) which received the most applications in 2015 is followed by the United States Patent and Trademark Office (USPTO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO) and the European Patent Office (EPO) (Figure

9). The four BRIC countries – Brazil, China, India and the Russian Federation – rank among the top 10 offices. The Republic of Korea has had the highest number of patent applications per unit of GDP since 2004 (WIPO, 2016).

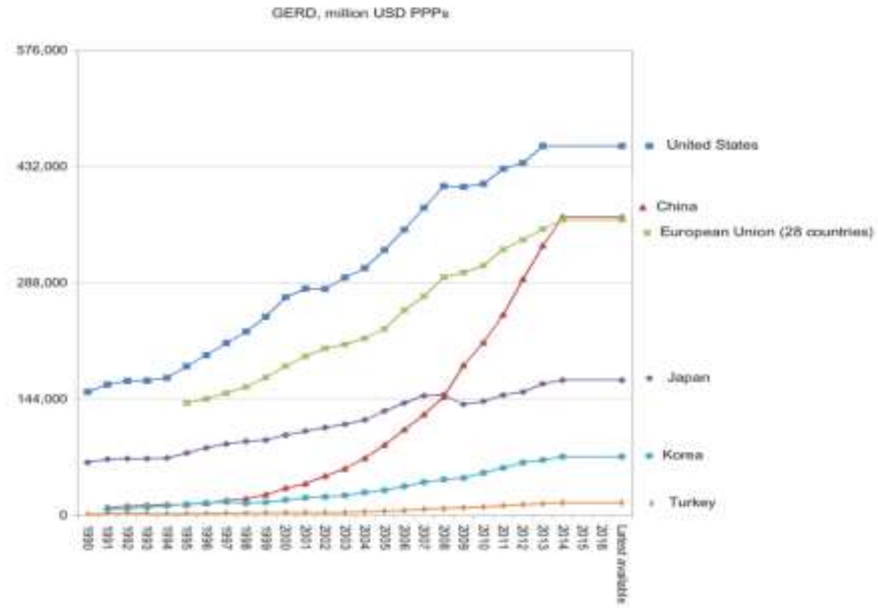
Today innovation is regarded as an important factor for competitiveness. There is a positive relationship between R&D, innovation, and productivity at the firm level (Griffith et al., 2004; Griffith et.al, 2006; Mairesse et al., 2006; OECD, 2009; Mairesse and Mohnen, 2010). Innovation promotes technological or active price competitiveness to the firms (Pianta, 2001).Global Competitiveness Index which has been used as one of the key assessments of global competitiveness since 2005, has included bothtechnologicaland non-technological innovation capacity as well astechnological readiness in the Global Competitiveness Index (GCI) (World Economic Forum, 2012)

Figure 3: Total R&D Expenditure and the Share of Major R&D Performers



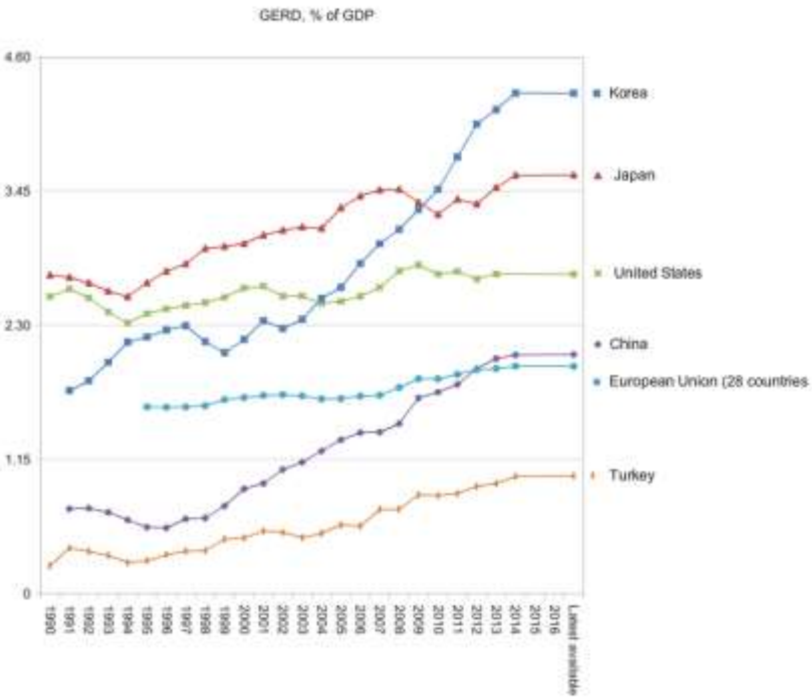
Source: OECD, 2014

Figure 4: Gross Domestic Expenditures on R&D (GERD)



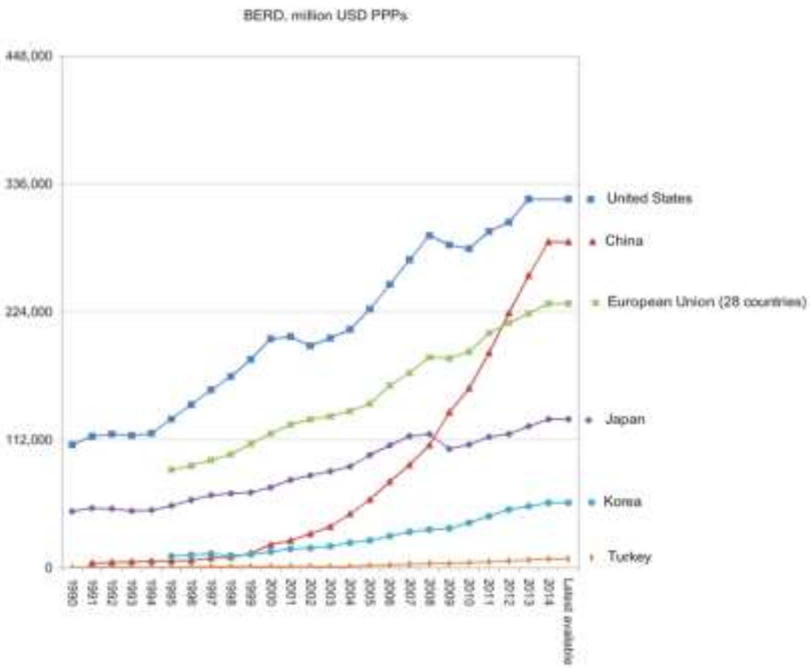
Source:OECD (2017)

Figure 5: Gross Domestic Expenditures on R&D (GERD), % of GDP



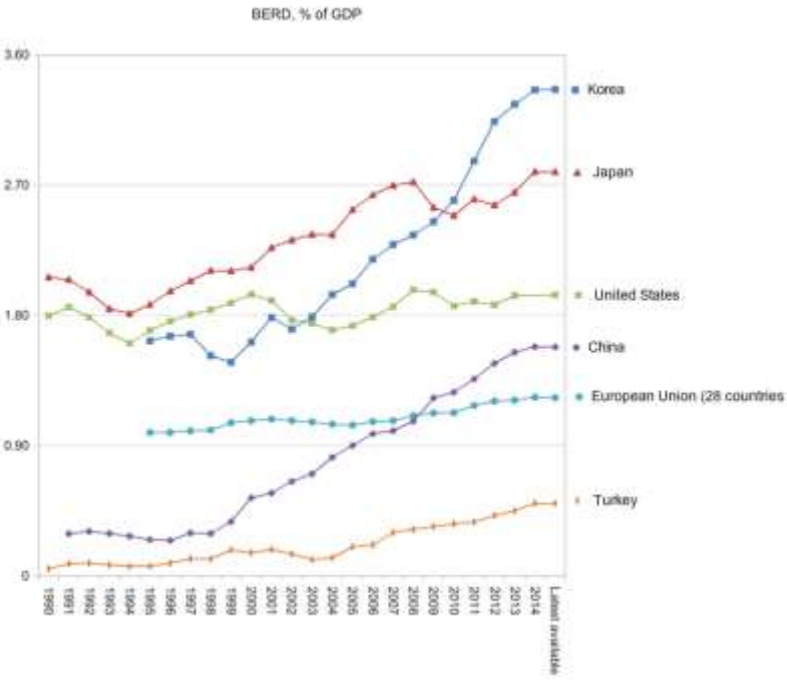
Source:OECD,2017

Figure 6: Business Enterprise Expenditure on R&D (BERD)



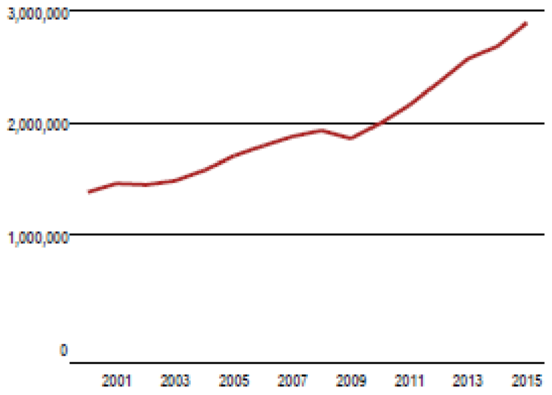
Source: OECD, 2017

Figure 7: Business Enterprise Expenditure on R&D (BERD), % of GDP



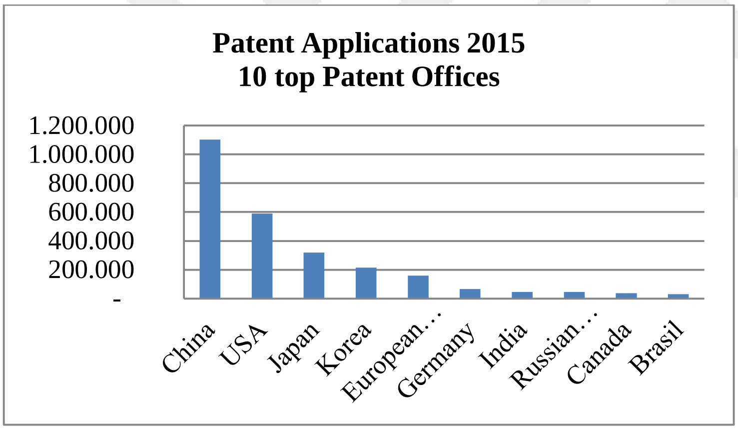
Source: OECD, 2017

Figure 8: Patent Applications Worldwide



Source: WIPO, 2016 : 21

Figure 9: Patent Applications 2015 in Top 10 Patent Offices



Source: WIPO, 2016

According to World Economic Forum global competitiveness ranking 2016-2017, Switzerland is the most competitive country for the eighth consecutive year. Its top-notch academic institutions, high spending on R&D, and strong cooperation between the academic and business worlds contribute to making it a top innovator. Singapore, USA, Netherlands and Germany come after Switzerland, their top positions are also related to –among other factors- innovation and business sophistication (World Economic Forum, 2014). GCI also includes business sophistication factor, since sophisticated business practices are conducive to higher efficiency in the production of goods and services. Business sophistication factor assesses the quality of a country's overall business networks and individual firms' operations and strategies. The indicators include –among others- local supplier quantity and quality, state of cluster development, nature of competitive advantage, production process sophistication. At this point, it is important to note that GCI's indicators and assessment is highly inspired by Michael Porter's diamond framework and clusters concept. In his book Competitive Advantage of Nations, Michael Porter suggests that the only meaningful concept of competitiveness at the national level is productivity and companies achieve competitive advantage through acts of innovation which can be manifested in a new product design, a new production process, a new marketing approach, or a new way of conducting training (Porter, 1990). He explains the competitive advantage of nations by the diamond framework which consists of "Factor Conditions", "Demand Conditions", "Related and Supporting Industries" and "Firm Strategy, Structure, and Rivalry". The quality of a country's business networks and supporting industries, i.e the quantity and quality of local suppliers and the extent of their interaction is crucial for competitiveness since co-location and clustering increases efficiency, provides an environment in which learning, innovation, operating productivity. Individual firms' advanced operations and strategies (branding, marketing, distribution, advanced production processes, and the production of unique and sophisticated products) spill over into the economy and lead to sophisticated and modern business processes across the country's business sectors. The lack of clusters limits productivity growth as seen in the developing countries (Porter, 1998c; 2001). Clusters and co-location as a source of innovation will be discussed in detail in the later chapters.

Turkey has industrialised rapidly in recent years, although growth has slowed in the last two years. Although its Gross Domestic Expenditure on R&D (GERD) grew by 8.2% annually over 2007-12 significantly above the OECD average and has reached to 1.007% in 2014; it is still at below the OECD total (2.403%). (OECD, 2017)

The country's Business Enterprise Expenditure on R&D (BERD)it is also well below the OECD median (0,1544%) (Figure 6). BERD has increasingly concentrated on knowledge services at the expense of high-technology manufacturing. Public support to business R&D as a percentage of GDP has risen from 0,04% in 2008 to 0,08% in 2014(OECD, 2016b). In addition to the public support, firms in Technology Development Zones benefit from a range of tax incentives andare required to establish an incubation centre and a technology transfer office. Turkey introduced corporate tax exemptions for incomederived from the use of intellectual property. Financial support has also been granted to encourage the participation of small firmsin international market-oriented R&D projects. Legislation and national strategies were introduced tofurther promote both the commercialisation of R&D and collaboration between academiaand industry. As in many countries, Turkey also have revised their governance arrangements for using public procurement to stimulate innovation. Public procurement has become a major feature of industrial plans, legal frameworks and procedures have been revised to simplify access to procurement markets (OECD, 2016b).The government is committed to sustained investment in STI and sets the targets for GERD 1.8% of GDP by 2018.

The number of patent applications has reached to 5841 in 2015. The applications are mainly in pharmaceuticals. Turkey has achieved a growth compared to 2014 with 14.6%; however exhibit low numbers of applications per unit of GDP (WIPO, 2016).

According to GCI 2016-2017, Turkey has dropped for the third consecutive year to 55th in the overall ranking 65th ve 71th in business sophistication and innovation factors ranking, respectively in 2014 and 2015. The innovation factor breakdown shows that the country is at the higher rank with regards to government procurement of advanced technology products; however, the “company spending on R&D”, “capacity for innovation”, “quality of scientific research institutions”, “university-industry collaboration in R&D” is rather low. Turkey’s grade in each indicator is shown in Table2 and 3.

Table 2: Innovation Factor Ranking of Turkey

Indicator	Rank
Capacity for innovation	75
Quality of scientific research institutions	103
Company spending on R&D	70
University-industry collaboration in R&D	63
Government procurement of advanced technology product	62
Availability of scientists and engineers	49
PCT patents, applications/million pop.	42

Source: World Economic Forum, 2017

Table 3: Business Sophistication Factor Indicator Ranking of Turkey

Indicator	Rank
Local supplier quantity	41
Local supplier quality	48
State of cluster development	57
Nature of competitive advantage	106
Value chain breadth	64
Control of international distribution	55
Production process sophistication	48
Extent of marketing	92
Willingness to delegate authority	86

Source: -World Economic Forum, 2017

Turkey's research system is still small; however it is undergoing major reforms to improve its quality and relevance, to increase collaboration with the private sector, and to leverage private funding. New programmes and awards were introduced to improve the efficiency of public research in universities. It has increased the number of full-time equivalent researchers three-fold since 2002 from a very low human resource base.

Until 2017, Turkey deployed the National Science, Technology and Innovation Strategy (UBTYS) 2011-2016, approved by the Supreme Council for

Science and Technology which has a sectoral focus, with nine national priority sectors: automotive, machinery and manufacturing technologies, energy, ICT, water, food, defence, aerospace, and health. A high-level prioritisation meeting was established for each priority sector to determine technological needs through a consultative and consensus-building process. The Scientific and Technological Research Council of Turkey (TÜBİTAK) has provided funds to projects. Landmark projects, such as the domestic electric vehicles, are also part of Turkey's target-oriented support system. As cross-cutting technologies, biotechnology and nanotechnology, as well as ICT software R&D and innovation strategy and action plans are being prepared by the Ministry of Science, Industry and Technology, in support of the priority areas of UBTYS 2011-16 (innovation policy platform website).Turkey's Tenth Five-Year Development Plan (2014-18) is similarinitiative aimed to raise national competitiveness through R&D and innovation (OECD, 2016b). The objectives include increasing the collaboration of private sector and research centers within the universities and public institutions, design initatives to help develop internationally competitive and high value added new sectors, products and brands, a cluster oriented and entrepreneurship focused innovation system, supporting R&D activities towards producing clean technologiesand green products, improving the structure and operation of technologydevelopment zones in order to foster university-industrycooperation, inter-firm joint R&Dactivities and innovative entrepreneurship, improvement of public procurement system to encourage innovation,domestic production, environmental awareness, technology transfer, improving regional and global cooperation in R&D activities, researchinfrastructures and research labor force issues (Turkey's Tenth Five-Year Development Plan 2014-18). Development through 2006-2013 and the 2018 targets are illustrated in Table 4.

Table 4: 2006-2013 Development Figures and 2018 Targets

	2006	2011	2013	2018
Share of R&D Expenditures in GDP (%)	0.60	0.86	0.92	1.80
Share of Private Sector in R&D Expenditures (%)	37.0	43.2	46.0	60.0
Number of Full Time Employed R&D Personnel	54,444	92,801	100,000	220,000
Share of Private Sector in R&D personnel (%)	33.1	48.9	52.0	60.0

Source: Turkey's 10th Development Plan, 2014

1.4. TERRITORIAL MODELS OF INNOVATION

1.4.1. Innovation And Regional/Local Growth

Aspreviously discussed, Schumpeter (1946) was the first economist to claim that innovation was the major driving forcing of the economy; he explained it by the creative destruction process. He suggested that innovation was in the form of product, process, market, and organizational. After Schumpeter, until 80's, innovation studies rather took a different approach where innovation was only taken as a technological process and its impact on the economy as exogenous. From 80's on, innovation's major role on economic growth hasstarted to be accepted as endogenous, and scientific studies provided evidence for the role of innovation on economic growth. These studies led innovation to become a priority topic also for the policy makers aiming the growth of the economy. Innovation's impact on the economy was elaborated not only from the nations' overall economy, these studies has affected all branches of economics -industrial, regional, traditional macroeconomic economics- (Capello, 2011).

Also, the perspectives on innovation process has changed. Innovation studies left the linear approach towards the dynamic, and it was argued that it was a collective approach rather than an isolated one. In this collective approach, knowledge and learning were the conducive for innovation. These Neo-Schumpeterian approaches which will be discussed in the following sections have put efforts on explaining the dynamics of the innovation at the national, sectoral, technological and regional/local levels. The national, sectoral and technological approaches- although contributed the literature by”innovation systems”concept, and emphasized the role of the national institutional structure, sectoral and technological conditions- failed to explain the regional differences of innovative performance in a nation or within a same sector and/or technology. Clusters (Porter, 1990; 1998b; Swann and Prevezer, 1996; Baptista and Swann, 1998) based on industrial districts (Marshall, 1920), innovative milieu (Camagni, 1991; Crevoisier, 2004), learning regions (Morgan, 1997) and regional innovation systems (RIS) (Cooke,1992), networks of innovation (Giuliani, 2011) are amongst the main views to explain the dynamics of regional innovation. The role of geographical proximity on innovation is discussed by economic geography and innovation geography; however, the externalities or the environment to foster innovation is not limited to clustering or geographical proximity. While some of these views were based on the geographical proximity-being in the same location or in other words co-location-, others argued that altough localised characteristics were crucial, knowledge flows which was at the heart of the innovation process should not be limited to the local sources. The fundamental debate in economic geography has been whether it was a matter of being in the right location or being in the right network (Castells, 1996).

Innovation is studied from various perspectives, at the national, sectoral, technological, and regional/ local levels and from network perspectives. The systems, dynamics, and the driving forces of these approaches will be discussed in detail in the following sections.

Innovativeness has been seen as an important factor supporting the regional development and increasing the competitive capacity of regions (Armatlı, 2005) since the systemic interactions and the knowledge flows of the regions foster the innovativeness. Specific regional resources such as a stock of ‘sticky’ knowledge, learning ability, entrepreneurial attitudes etc. are seen to be of great importance in firms’ efforts to be at global competitive level (Isaksen and Hauge, 2002, p.9). In the economic growth models sections introduced in the previous sections of this dissertation, the role of innovation and technological advances on productivity was discussed at the overall economy side. In literature the relationship between innovation and local growth was also discussed at the regional level. Capello (2011) suggests that there are three main approaches that explain the relationship between innovation and local growth: i)Functional/Sectoral; ii)Structural and iii) Cognitive Approach.

i) Functional/Sectoral Approach: It foresees innovation as the result of the presence of innovative sectors or functions. In pure sectoral approach it was assumed that science-based or high-technology sectors are the main source for economic growth. Innovation is science based and radical type. However, as research shows that innovation is not limited to 'scientific regions', knowledge based innovations are possible and comes from traditional sectors during their rejuvenation period (Asheim and Gertler, 2005). Therefore a functional approach was taken which emphasizes the importance of R&D and high-tech educational institutions such as universities. This approach sees productivity in innovation activities, and there is a short-cut between invention and innovation. The advantage comes from agglomeration, specialisation and proximity economies where physical/geographical proximity among actors facilitates the exchange of tacit knowledge. A more modern view of this approach is knowledge-filter theory which explains that investment in knowledge by incumbents and research organisations generate an entrepreneurial environment which leads to economic growth (Acs and Plummer, 2005)

ii) Structural Approach: The second view foresees regional innovation as the result of the presence of structural elements in a region. Innovation is incremental and productivity gains from the pervasive and rapid knowledge–innovation recombinations that are proximate and systemic. Regional economic growth depends on only increasing return to productive resources. There is a shortcut between knowledge and innovation. Productivity gains are achieved from the rapid recombination of innovation and its commercial exploitation which are regional innovation system processes (Cooke, 2011). It benefits from proximization economies.

iii)Cognitive Approach: It includes cognitive proximity in addition to the spatial proximity. Innovation is regarded as the result of the presence of collective learning processes and territorialized relations among subjects operating in geographical and social proximity and of the existence of rules, codes and norms of behaviour. These factors facilitate cooperation among actors and therefore the socialization of knowledge and help develop organizational forms which support interactive learning processes. Amongst the three approaches, cognitive approach is the most modern one, since it highlights the socio-economic preconditions for knowledge creation in the territory. This way of learning leads to collective learning, i.e. a process that spills over the boundaries of the firm and affects all actors of the local economy in a collective way. It explains the economic growth by factor productivity generated by innovation (Capello, 2011). Attention is focused on mainly the regional or local level at the construction of knowledge through cooperative learning processes, nourished by spatial proximity (atmosphere effect), network relations (including long-distance, selective relationships), interaction, creativity and recombination capability (Capello, 2011, p.112).

Table 5: Main Approaches on the Relationship between Innovation and Local Growth

Approach	**Elements/Processes that Create Innovation**	**Type of Proximity**
Functional/Sectoral	Innovation as an output of science based or high-technology sectors or functions (universities,etc.)	Physical/geographical proximity (It facilitates the exchange of tacit knowledge among actors).
Structural	Innovation as an outcome of the presence of structural elements	Spatial proximity (It provides knowledge which is unique to the region not only to spillover but also to form).
Cognitive	Innovation as the output of the presence of collective learning processes.	Not only spatial but also social proximity (the existence of rules, codes and norms of behavior).

1.4.2. Marshallian Industrial Districts

Marshall was one of the first economists to analyse the role of innovation in a local or regional context. Based on the spatial clustering of small manufacturing companies in northern England in 19th century, Marshall argued that although internal economies of scale provided advantages to the large firms, it was still possible for small firms to be efficient and to compete with larger firms by agglomerations, namely industrial districts (Marshall, 1920). He defines an industrial district as "the concentration of large numbers of small businesses of a similar kind in the same locality" (ibid, p. 277). He suggests that agglomeration enables small firms to profit by external economies of scale which are mainly market for skilled labor, availability of specialized related industries, use of highly specialised machinery, and industrial atmosphere (Marshall, 1920).

Skilled labor: Agglomeration of the firms in the same industry causes 'a constant market for skill'(Marshall, 1920, p. 271); while employers enjoy finding skilled labor which they require, employees can also find larger job alternatives compared to isolated firms.

Specialized related industries:When the number of firms agglomerate in an area, subsidiary firms 'grow up in the neighbourhood, supplying it with implements and materials, organizing its traffic, and in many ways conducing to the economy of its material' (ibid, p. 271). The agglomeration in a specific industry also causes a "growth in the same neighbourhood of industries of a supplementary character" (ibid, p. 272) that will lead to extensive division of labor. Firms in districts not only enjoy the specialised production factors but also the cost advantage. Suppliers can operate at higher capacity which allows economies of scale and specialise in skills and work. This in turn provides economic advantage to the final producers.

Industrial Atmosphere: Marshall suggests that "the broadest and in some respects most efficient forms of cooperation are seen in a great industrial district where numerous specialized branches of industry have been welded almost automatically into an organic whole" (Marshall, 1920, p. 599). This industrial atmosphere facilitates the flow of knowledge among skilled workers and specialized suppliers, knowledge is as Marshall puts it "in the air". Marshall's work were extended by economists Arrow (1962) and Romer (1986) and named MAR spillover by Glaeser et al. (1992). According to MAR model, knowledge transfer and exchange among firms facilitate innovation and growth, and the closer the firms are to one another, the greater the MAR spillover. Furthermore, Marshall argues that local monopoly restricts the flow of ideas to others and maximizes the innovating firm's capability (Glaeser et al., 1992).

The Marshallian industrial districts were a combination of competition and cooperation. As for Marshall, this is a necessary condition for the market to work at best, but here it is also the main feature of modern industry, not only localised industries, it is the result of the evolution of industry (Belussi and Caldari, 2009, p.346).

Industrial districts also bring some disadvantages to the firms. First, specialised and skilled labor force will demand higher wages. Second, as the district becomes a centre of attraction by time, the demand for the district will increase and the rental costs will rise. And third, especially the districts which only one sector dominates, are exposed to the economic decline risk, in case of a decline in that industry will have big impact on the district and the related industries (Marshall, 1920)

Marshall's work was seminal not only for exploring that small companies can compete with large companies by the economic externalities but also for bringing about the industrial atmosphere of agglomeration.

1.4.3. Neo Marshallian Industrial Districts

Marshall's industrial district model was revisited in late 70's by scholars (Bagnasco, 1977; Becattini, 1978; Brusco, 1982) when they examined the economic success of central and north east Italian regions (also called Third Italy) dominated by large number SMEs. These SMEs were both successful in mass (food and clothing) and specialized markets what Piore and Sable (1984) labeled as flexible specialization. The firms were concentrated in industrial districts (Bagnasco, 1977; Brusco, 1982). The main cause of this success was stemming from the territory (Becattini, 1978). This socio-territorial entity in one naturally and historically bounded area consisting of both a community of people and a population of firms (Becattini, 1990) formed an industrial atmosphere as Marshall put it. Becattini (1990) explains the impact of social relations on the production systems of the regions, and suggests that social and institutional characteristics improves industrial atmosphere. He defines industrial district as “a socio-territorial entity which is characterized by the active presence of both a community of people and a population of firms in one naturally and historically bounded area.”(ibid, p.38).

Main characteristics of these type of districts are; extensive division of labor, skilled workforce (as an outcome of transfer of knowledge and formal training) and a network which enables exchange of knowledge and collective efforts.

The network was formed by the common culture and it did not only consisted of firms but also worker associations, technical schools, related financial institutions and so on (Brusco, 1992). Inclusion of institutions as network members was the main feature that differentiates these types of industrial districts from Marshallian type.

Another important contribution of this concept was suggesting that the specific characteristic, the shared norms, values, routines -which were formed due to spatial proximity-and the institutional dimension which varied in different regions was the underlying reason of succesful regions(Becattini, 1978).

However, the drawback of this concept was that, it focused on the specific example of Italian regions where traditional sectors in which mainly SMEs had been operating. Storper (1997) criticized this view for taking a specific country as an example and that it could not form a general context for other economies, for example for innovative and high-tech industries.

1.4.4. The Innovative Milieu

The Innovative Milieu concept was introduced by the GREMI Group (the European Research Group into Innovative Milieus). GREMI I (Aydalot, 1986) and GREMI II (Maillat and Perrin, 1992) revealed what companies found in the region or beyond it during innovation processes. GREMI III (Maillat, Quévit, and Senn, 1993) explored innovative networks and showed their spatial, local, and extralocal functionings. GREMI IV (Ratti, Bramanti, and Gordon, 1997) was centered on comparing the trajectories of regions that are active in identical sectors and identical technological and market environments, took different types of evolution, ranging from disappearance to strong growth (Crevoisier, 2004.p.368). Like the Neo-Marshallian industrial district concept, this view also suggested that it is the territorial differences that cause differences in the innovative performances of the firms in a region. A territory includes not only manufacturing and related service firms but also industry and trade associations, research and training centres, policy actors, and so on. These territories form a common culture, norms and routines which facilitate collective learning and the territories together with the networks, interacting agents and these social norms provide an innovative milieu (Cova et al., 1996, p. 654). Bramanti and Ratti (1997) define it as "a territorialized whole, in which the interactions of economic and local agents develop, by learning, from multilateral transactions which generate externalities specific to innovation, by the convergence of learning on more and more advanced forms of common resource management." (Bramanti and Ratti, 1997, p. 29).

Crevoisier (2004) argues that innovative milieus build on three paradigms:

i) the technological paradigm which stresses innovation, learning and know-how as the most important competitive advantages;

ii) the organizational paradigm which emphasizes the role of networks, competition and rules of cooperation as well as relational capital; and

iii) the territorial paradigm which accounts for the role of proximity and distance and stresses the idea that competition occurs between regions (Crevoisier, 2004, p.370)

Firm's innovation process is collective and takes the following steps: "First, there is an apprenticeship process in which a certain type of know-how, a competence is developed. This process requires technical competencies but also relations with a clientele, organizational processes, and so on. This know-how is one of the basics behind the differentiation of spaces. The second phase of this cognitive process involves the capacity to perceive constraints on and opportunities in the markets and within the evolution of techniques and then, on the basis of the resources within the region, to imagine and formulate innovative projects. The innovative milieu is characterized by a capacity, shared by a certain number of actors, to construct a joint representation of a possible project, to go through the necessary learning process, and to implement the new competencies thus developed in an effective way" (Crevoisier, 2004, p.374).

1.4.5. Learning Regions

Learning regions concept introduced by Florida (1995) builds on three main pillars: the region, knowledge and continuous learning. Based on the "knowledge revolution" which suggests that capitalism has entered a new stage of knowledge creation and continuous learning (Drucker, 1993; Nonaka, 1991); Florida (1995) argues that as opposed to globalisation, regions are "focal points for knowledge-creation and learning in the new age of capitalism"; hence are "increasingly important sources of innovation and economic growth and are vehicles for globalization" (Florida, 1995, p.530). Innovation is an interactive process, is shaped by institutional routines and social conventions (Morgan, 1997, p.149). Therefore it suggest that regions must become learning regions which provide related infrastructures of

i) manufacturing infrastructure of interconnected vendors and suppliers;

ii) human infrastructure that can produce knowledge workers, facilitates the development of a team orientation, and which is organized around life-long learning;

iii) a physical and communication infrastructure which facilitates and supports constant sharing of information, electronic exchange of data and information, just-in-time delivery of goods and services, and integration into the global economy; and capital allocation and industrial governance systems attuned to the needs of knowledge-intensive organizations.

which can facilitate the flow of knowledge, ideas and learning; and the industrial government system will be mutually dependent relationships, network organization and flexible regulatory framework. (Florida, 1995,p. 532-533)

1.4.6. New Economic Geography

Krugman (1991a, 1991b, 1998) suggests that concentration is important; he explains it through exploration of linkages between centripetal and centrifugal forces. He argues that centripetal factors –economies of scale, economies of specialization, reduced transportation costs, market size effects and labor markets affects the geographical concentration positively. Transport costs motivate producers to locate near the demand and supply markets. When the region develops a comparative advantage over other regions, favorable conditions lead to uneven, self-reinforcing patterns of economic activity, market dominance, and specialization (Krugman, 1991b,p.98), and it is the increasing returns that push companies to locate in that advantageous region. Centrifugal factors, on the other hand, such as differences in factor endowments, increased land rents, and congestion costs affect the location decisions, thus agglomeration negatively. Krugman's contribution was not only the transport costs, but also he introduced a mathematical model to explain the relationship with production and labor in particular (clustered) regions. Krugman underestimates the role of social relations by his own words "knowledge flows are invisible; they leave no paper trail by which they may be measured and tracked"(Krugman, 1998, p.53).

1.4.7. Clusters

Clusters have become a key concept in economic geography, urban studies, regional economics and related disciplines; and for policy-makers as a tool for promoting regional growth and competitiveness (Martin and Sunley, 2003). The "cluster" concept was introduced by Michael Porter in the 1990s (Porter, 1990, 1998) which built on Marshallian industrial districts. Porter argues that

"In a global economy – which boasts rapid transportation, high speed communications and accessible markets – one would expect location to diminish in importance. But ….the enduring competitive advantages in a global economy are often heavily localised, arising from concentrations of highly specialised skills and knowledge, institutions, rivalry, related businesses, and sophisticated customers."(Porter, 1998c, p. 90)

Porter explaines the competitiveness of firms and nations by industrial clusters and regional clusters (Isaksen and Hauge, 2002). Porter (1990) originally defines clusters as firms and industries linked through vertical (buyer/supplier) or horizontal (common customers, technology etc.) relationships, and with the main players located in a single nation or state. Although in the same book he mentiones that geographic concentration in a region fosters innovation and competitiveness in a cluster, he does not include it in the first version of the definition. In his later work (Porter, 1998a), he includes the agglomeration aspect to the definition. He suggests that ‘the enduring competitive advantages in a global economy are often heavily local, arising from concentrations of highly specialized skills and knowledge, institutions, rivals, related businesses, and sophisticated customers’ (Porter 1998a: 90). His revised definition emphasizes the interaction with the institutions. In 1998, he defines clusters as

“Geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions …. in a particular field that compete but also cooperate” (Porter, 1998a, p.197)

In his latest version of cluster definition, he addes the geographic boundaires:

A cluster is a geographic concentration of related companies, organizations, and institutions in a particular field that can be present in a region, state, or nation (Harvard Business School, Institute for Strategy and Competitiveness, 2017)

Regional clusters are foreseen as “the best environment for stimulating innovation and competitiveness of firms” (Asheim and Isaksen, 2000). The concept was soon became prominent amongst the scholars, bringing various definitions to the literature. While in some definitions the focus is on the spatial proximity, some approaches described it by including knowledge and network concepts (Maskell, 2001).

In the literature, clusters have been confused and/or interchangeably used as IDs and regions (Martin and Sunley, 2003; Lazzeretti et al., 2014). Various definitions of the cluster concepts with different perspectives are given in Table 6 and Table 7.

In later approaches, as well as spatial proximity and particular types of similar and related firms; their associated institutions, interrelatedness of capabilities/activities, institutional and endowment structure, interaction between agents were the key elements of clusters (Martin and Sunley, 2003; Cruz and Teixeira, 2010). The key relationships are the various network interactions, interdependencies, inputs, outputs, spillovers, and emergent external economies that connect the co-located firms and associations and which turn them into a functioning system, that is a cluster (Martin and Sunley, 2003, p.1304). A competitive cluster should have local knowledge and collective learning (ibid). As a remedy, Gordon and McCann (2000) distinguish three main cluster models, i) Pure agglomeration economies ii) industrial complexes iii) social network models and suggest that the dominant structure of clusters should be identified when discussing their performances. Porter also suggests that 'the strength of ‘‘spillovers’’, and their importance to productivity and innovation determine the ultimate boundaries'; that 'cluster boundaries should encompass all firms, industries and institutions with strong linkages', and 'those with weak and non-existent linkages can safely be left out' (Porter, 1998a, p. 202); relating the clusters more to the network concept.

Cluster Mapping US Project (led by Harvard Business School in which Porter is the Professor) classifies clusters as “local” and “traded” which are defined as:

“A local cluster is composed of local industries, which are present in most (if not all) geographic areas, and primarily sell locally.

A traded cluster is composed of traded industries, which are concentrated in a subset of geographic areas and sell to other regions and nations. Sets of traded industries are organized into traded clusters based on an overall measure ofrelatedness between individual industries across a range of linkages, including input-output measures, use of labor occupations, and co-location patterns of employment and establishments.” (Source: Cluster Mapping Project)

1.4.7.1. Clusters and Competition

Modern competition depends on productivity, and productivity rests on *how* companies compete, not on the particular fields they compete in. Companies can be highly productive in any industry if they employ sophisticated methods, use advanced technology, and offer unique products and services. The sophistication is strongly influenced by the quality of the local business environment through the determinants which constitutes a “diamond” model (Figure 10). These determinants are (Porter, 1990);

Table 6: Cluster Definitions Emphasizing Only Spatial Proximity Aspect

Cluster definition	**Reference**
Groups of firms within one industry based in one geographical area	Swann and Prevezer (1996, p. 1139)
a large group of firms in related industries at a particular location	Swann, Prevezer, Stout (1998), p. 1
Cluster and agglomeration will be judged to be synonymous since they both define geographical areas where an industry (or industries) is concentrated to produce localized economic advantages	Oakey et al. (2001, p. 401)
A tendency for firms in similar types of businesses to locate close together, though without having a particularly important presence in an area.”	Crouch and Farrell (2001), p. 163
Spatial and sectoral concentration of firms	Bresnahan et al. (2001, p. 836)
Referred to as ‘locational economies’ and embraces those economies that arise from geographical agglomeration of related economic activities. The territorial configuration most likely to enhance the learning process.	Maskell (2001, p. 922)
Concentration of related activities in a particular area	Van Klink and De Langen (2001, p. 450)
Industrial districts as examples of advantage generating ‘superfirm’ groups inside industries, within each member, and within each member firm simultaneously shares and differentiates sources of competitive advantage	Tallman et al. (2004, p. 259)
“A cluster is defined as a group of enterprises spatially close, and specialized in the development of a similar or the same product.”	Pietrobelli/Barrera (2002), p.542.

Adopted from Cruz and Teixeira, 2010, new definitions added)

Table 7: Cluster Definitions Emphasizing Knowledge and Network Aspect

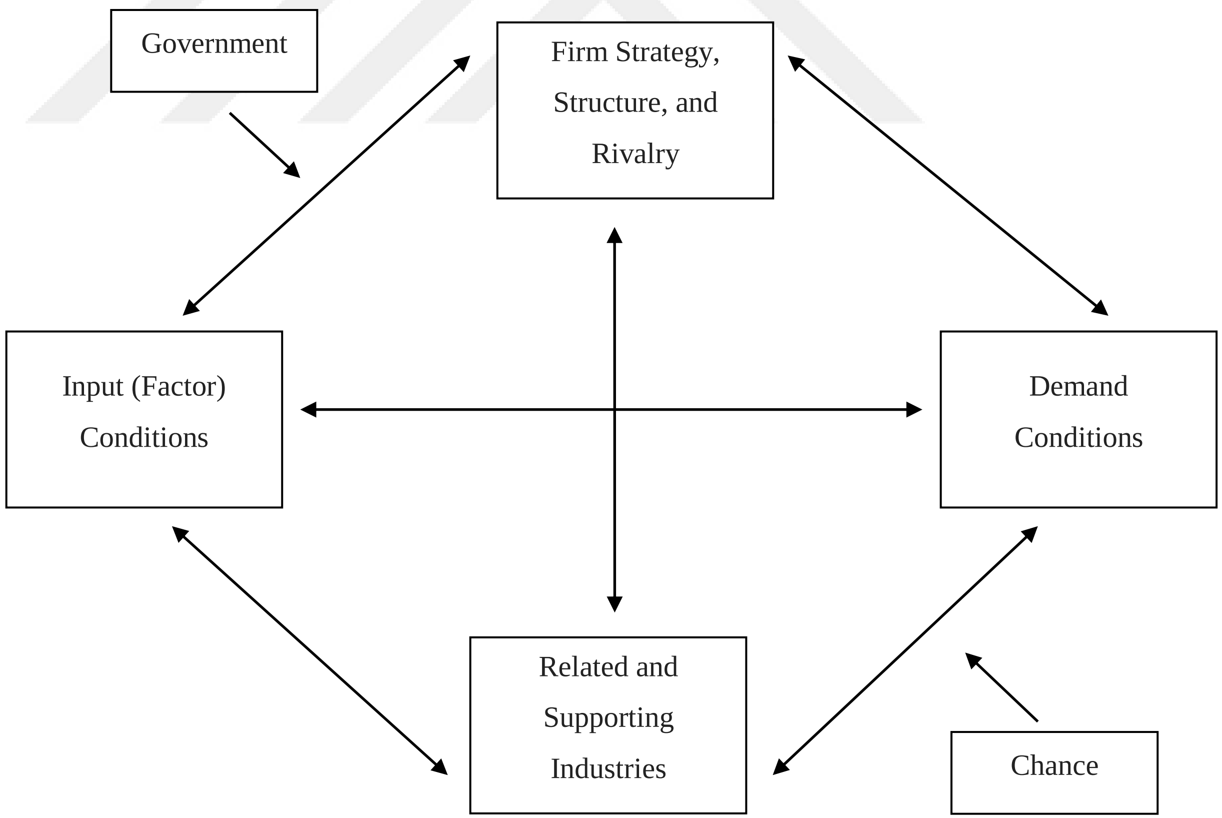
Cluster definition	**Reference**
Inter-industry level, underlying networks of interrelated cooperating businesses	Debresson (1996, p. 161)
geographically bounded concentrations of *interdependent* firms (which have active channels for business transactions, dialogue and communication)	Rosenfeld (1997, p.10); OECD, (2001)
Strong collection of related companies located in a small geographical area, sometimes centred on a strong part of a country's science base	Baptista and Swann (1998, p. 525)
Geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions …. in a particular field that compete but also cooperate	Porter (1998, p. 197)
"Economic clusters are not just related and supporting industries and institutions, but rather related and supporting institutions that are more competitive by virtue of their relationship."	Feser (1998), p. 26
Networks of production of strongly interdependent firms (including specialized suppliers), knowledge-producing agents (universities, research institutes), bridging institutions (brokers, consultants), and consumers related to each other in a value-adding production chain	Hertog and Maltha (1999, p.193)
(innovative cluster): a large number of interconnected industrial and/or service companies having a high degree of collaboration, typically through a supply chain, and operating under the same market condition."	Simmie and Sennett (1999), p. 51
Localized sectoral agglomerations of symbiotic organizations that can achieve superior business performance because of their club-like interaction	Steinle and Schiele (2002, p.850)
Homogenous knowledge communities	Dahl and Pedersen (2003, p.7)
Specific spatial configuration of the economy suitable for the creation, transfer, and usage of knowledge	Maskell and Lorenzen (2004, p.991)
a concentration of "inter-dependent" firms within the same or adjacent [or integrated] industrial sectors in a small geographic area	Asheim and Coenen (2005, p. 1174)
Non-random geographical agglomerations of firms with similar or closely complementary capabilities	Maskell and Kebir (2005, p.1)

Table 7 continued

Cluster definition	**Reference**
Group of firms, related economic actors, and institutions that are located near each other and have reached a sufficient scale to develop specialized expertise, services resources, suppliers and skills	Commission of the European Communities (2008, p. 5)
A regional concentration of related industries that arise out of the various types of linkages or externalities that span across industries in a particular location	Cluster Mapping Project website 16.03.2017
A cluster is a geographic concentration of related companies, organizations, and institutions in a particular field that can be present in a region, state, or nation	Harvard Business School, Institute for Strategy website

Source: Adopted from Cruz and Teixeira, 2010, new definitions added

Figure 10: The Diamond Model-Determinants of the National Competitive Advantage



Source: Porter (1990), p. 127

i) Factor Conditions: Cost and quality of factors of production, such as skilled labor, natural resources or infrastructure, necessary to compete in a given industry. The presence, quality, and specialization of these factors results in improved productivity.

ii) Demand Conditions: The nature of home-market demand for the industry's product or service, sophistication of local customers. Demand conditions are characterized by local presence of sophisticated and advanced buyers who continuously stimulate innovations.

*iii) Related and Supporting Industries:*The local extent and sophistication of suppliers and related industries Innovative related and supporting industries facilitate transfer of knowledge between firms and also positively influence productivity.

*iv) Firm Strategy, Structure, and Rivalry:*The nature and intensity of local competition force companies to produce innovations and improve their productivity.

In addition to these, chance events and government also influence the environment for competitive advantage. These determinants create the national environment; and a cluster is the manifestation of the diamond at work. Co-location improves these affects and force firms to innovate and upgrade (Porter, 1998b, p.90).

Clusters affect competition in three ways:

i) Productivity: by increasing the productivity of companies based in the area;

ii) Innovation: by driving the direction and pace of innovation, which underpins future productivity growth;

iii)Formation of new businesses: by stimulating the formation of new businesses, which expands and strengthens the cluster itself (Porter, 1998b, p.80)

1.4.7.2. Clusters and Productivity

Being part of a cluster allows companies to operate more productively in sourcing inputs; accessing information, technology, and needed institutions; coordinating with related companies; and measuring and motivating improvement.

a) <u>Better Access to Employees and Suppliers</u>: Like in Marshallian districts, co-location creates a market for skilled labor and specialized suppliers. Specialist suppliers are more cost effective. Sourcing locally instead of from distant suppliers lowers transaction costs. It also minimizes the need for inventory, eliminates importing costs and delays. Proximity improves communications and makes it easier for suppliers to provide ancillary or support services (Porter, 1998c: 13-14).

b) Access to Specialized Information: Extensive market, technical, and competitive information accumulates within a cluster, personal relationships and community ties foster trust and facilitate the flow of information (Porter, 1998c: 14-15).

c) Complementarities:A host of linkages among cluster members results in a whole greater than the sum of its parts. Because members of the cluster are mutually dependent, good performance by one can boost the success of the others. Complementarities such as products, coordination of activities across companies to optimize their collective productivity, marketing (such as reputation of a cluster will turn buyers to a vendor of related sectors, and joint marketing efforts) and attraction of customers for buying from a cluster (Porter, 1998c: 15).

d) Access to Institutions and Public Goods: Investments made by government or other public institutions—such as public spending for specialized infrastructure or educational programs—can enhance a company's productivity. The ability to recruit employees trained at local programs, for example, lowers the cost of internal training. Other quasi-public goods, such as the cluster's information and technology pools and its reputation, arise as natural by-products of competition. In addition to the government, investments by companies—in training programs, infrastructure, quality centers, testing laboratories, and so on—also contribute to increased productivity. Such private investments are often made collectively because cluster participants recognize the potential for collective benefits (Porter, 1998c: 15-16).

e) Better Motivation and Measurement: Local rivalry is highly motivating; peer pressure amplifies competitive pressure within a cluster, even among noncompeting or indirectly competing companies. Clusters also often make it easier to measure and compare performances because local rivalsshare general circumstances—for example, labor costs and local market access—and they perform similar activities. Companies within clusters typically have intimate knowledge of their suppliers' costs. Managers are able to compare costs and employees' performance with other local companies. Additionally, financial institutions can accumulate knowledge about the cluster that can be used to monitor performance (Porter, 1998c: 16).

1.4.7.3. Clusters and Innovation

Companies in clusters experience stronger growth and faster innovation than those outside clusters in certain phases (Audretsch and Feldman, 1996; Pouder and St. John, 1996; Baptista and Swann, 1998; Swann et al., 1998). A company within a cluster often can source what it needs to implement innovations more quickly, local suppliers and partners can and get closely involved in the innovation process, thus ensuring a better match with customers' requirements (Porter, 1998c). Other advantages are companies within a cluster can experiment at lower cost and can delay large commitments until they are more assured that a given innovation will pan out and the competitive pressure, peer pressure, constant comparison that occurs in a cluster (ibid).

More important than those, because sophisticated buyers are often part of a cluster, companies inside clusters usually have a better window on the market than isolated competitors do. The ongoing relationships with other entities within the cluster also help companies to learn early about evolving technology, component and machinery availability, service and marketing concepts, and so on. Such learning is facilitated by the ease of making site visits and frequent face-to-face contact (ibid) The spatial proximity facilitating knowledge spillovers and the localized learning processes are the main underlying reasons for clusters that foster innovation.

1.4.7.4. Clusters and New Business Formation

Many new companies grow up within an existing cluster rather than at isolated locations. New suppliers, for example, proliferate within a cluster because a concentrated customer base lowers their risks and makes it easier for them to spot market opportunities. Moreover, because developed clusters comprise related industries that normally draw on common or very similar inputs, suppliers enjoy expanded opportunities (Porter, 1998c).

Clusters are conducive to new business formation for a variety of reasons. Individuals working within a cluster can more easily perceive gaps in products or services around which they can build businesses. Beyond that, barriers to entry are lower than elsewhere. Needed assets, skills, inputs, and staff are often readily available at the cluster location, waiting to be assembled into a new enterprise. Local financial institutions and investors, already familiar with the cluster, may require a lower risk premium on capital. In addition, the cluster often presents a significant local market, and an entrepreneur may benefit from established relationships. All of these factors reduce the perceived risks of entry—and of exit, should the enterprise fail (ibid).

The study conducted covering 41 "traded" clusters incorporating 589 "traded" industries show that clusters are positively associated with multiple dimensions of regional economic performance. Results suggest that the effect of spillovers across related economic activity is a fundamental driver of growth and job creation across a broad range of industries and regions. Industries located in regions with strong clusters (i.e. a large presence of other related industries) experience higher growth in new business formation and start-up employment. Besides, the positive impact of clusters on employment growth does not come at the expense of wages, investment, or innovation, but enhances them. Strong clusters also contribute to start-up firm survival. Strong clusters are also associated with the formation of new establishments of existing firms (Delgado et al., 2010). This empirical study also shed light on the discussion of relatedness-unrelatedness issue on agglomeration by suggesting that large presence of other related industries fosters growth.

Spencer et al. (2010) also find evidence for clusters positive impact on industry level. When industries are located in an urban region with a critical mass of related industries, they tend to have both higher incomes and rates of growth compared with when they are situated in non-clustered settings (Spencer et al., 2010, p.712). By triggering the creation of firms not only in existing industries but also in new ones (Delgado et al., 2010), clusters play a crucial role in the path of regional economic development (Porter 1990, 1998, 2000; Swann, 1992)

1.4.7.5. Criticism to the Porter's Conceptualization of Clusters

As many scholars argue, the cluster concept does build on previous theories. Externalities stemming from agglomeration of firms in an industry such as pool of skilled labor, specialised related suppliers, cost advantages and knowledge spillovers overlap with Marshall's externalities. As opposed to Marshall, Porter builds on local market competition; however this is also discussed in urbanization economies (Jacobs, 1969). In the revised definition and explanation of clusters, the network aspect and institutions are included, which is inherited from Neo-Marshallian districts concept and the network theory.

In addition, the definition and boundaries, theorisation, claimed impacts on local innovation and productivity of the clusters are not precisely identified (Martin and Sunley, 2003; Asheim, et al., 2006; Martin and Sunley, 2011). The drawbacks in the conceptualization causes ambiguities in identifying a cluster, empirical measurement and policy making (Asheim et al., 2006; Isaksen and Hauge, 2002). Spencer et al. (2010) argues that "Porter's approach assumes that any 'traded' industry constitutes a cluster, no matter where it is found, it also fails to accept that natural resource-based industries could constitute the basis of a cluster" (Spencer et al., 2010, p.712) Thus he proposes an alternative model in which the cluster criteria are; specialization, non-ubiquity, related co-location, scale, and scope (Spencer et al., 2010).

The lack of a precise definition applies to the identification of the geographical boundaries of a cluster which prevents to design appropriate policies. Different types of industrial agglomerations are grouped under the same heading, which may lead one to overrate the quantitative importance of regional clusters in the economy. Poorly clarified concepts also make it somewhat difficult to compare different case studies and discuss policy implications (Isaksen and Hauge, 2002, p.9-10). Against these criticisms Delgado, Porter and Stern (2015) proposed a new algorithm where in which measures of inter-industry linkages were based on co-location patterns, input-output links, and similarities in labor occupations.

Last but not the least, the birth, growth and decline of clusters are discussed briefly by Porter (1998, pp. 237-245); however it is not based on a coherent theoretical base (Martin and Sunley, 2003). The diamond model presumes 'chance events' (which is ambiguous) as a reason for emergence of clusters; however recent empirical studies on cluster evolution provide evidence that rather than chance, there are determinants of clusters emergence and evolution.

These ambuguities in explaining the cluster concept has made scholars to abandon Porter's concepts such as five forces, competition and clustering and so on. Today many clustering studies only use the definition of the clusters by Porter. Especially in the EU countries the research on clusters have taken new merits. The studies aim to explore and scientifically explain how the clusters emerge, what trajectories they take after the emergence, how does the knowledge spillovers and network structures affect the innovative performance, how it affects competition and so on.

1.4.7.6. Clustering in the World

Clustering has been widely used by many governments including developing and developed countries as a main policy tool for innovation and growth. It has been a top priority for policy makers throughout the world. National and regional/local supporting schemes and policies are being designed with different aims and by various actions. The internationalisation of clusters is another key channel for SMEs to connect to global knowledge networks, and this has received particular policy attention (OECD, 2016b). Table 8 categorizes the policies of the selected countries.

According to Global Competitiveness Report 2015-2016, with respect to "state of cluster development" top 10 ranking countries are United States of America, United Arab Emirates, Taiwan (China), Germany, Italy, United Kingdom, Netherlands, Japan, Norway and Qatar, respectively (Table 9) (World Economic Forum, 2017). In the early stages of clustering policies, in many countries a unified model was applied for supporting the cluster development; however the one-size-fits-all model (Tödtling and Trippl, 2005) did not provide with the same benefits or targeted developments. Thestudies on regional development and clustering projects have shown that each cluster has its own attributes; the trajectory that they had taken, network structures and the characteristics of the sectors -which heavily influence the knowledge base- vary among clusters. Therefore, many countries especially in the EU have abandoned the unified policies and have tailored their clustering measures by to the needs of the specific cluster.

As the internationalization of the clusters are getting more and more important there are several networks and platforms in the world which aim to boost collaboration among the clusters and the related parties. Good examples of this type of initiative are TCI network and Innovation Policy Platform.

TCI Network: TCI Network is a global network of organisations and practitioners with extensive expertise in clusters and competitiveness. TCI reaches 9000 practitioners from development agencies, government departments, cluster organisations, academic institutions, companies and multilateral organisations in over 110 countries. Founded in 1998, TCI is a non-profit, non-governmental organisation with a global scope (http://www.tci-network.org/).

The Innovation Policy Platform (IPP): IPP is a joint initiative developed by the OECD and the World Bank. The aim of the platform is to provide policy practitioners around the world with a simple and easy-to-use tool, supporting them in the innovation policy-making process. This is done by facilitating collective learning about innovation policy, both as relates to conceptual and practical aspects, and tailoring this to the needs of developing and developed countries. Although the platform is about innovation policy in general, it also deals with cluster policy specifically (https://innovationpolicyplatform.org/content/clusterpolicies?topicfilters =12067).

Table 8: Clustering Policies in the Selected Countries

Policy Goal	**Actions**	**Countries**
Creating and Consolidating Clusters	Creation of new clusters through co-ordinated action for R&D activities	Argentina, Chile, Norway
	Promotion of network structures, service support for entrepreneurs, cluster co-ordination	Argentina, Austria, Australia, Belgium, Canada, China, Colombia, Denmark, France, Germany, Greece, Ireland, Japan, New Zealand, Norway, Sweden
Internationali-zation	Cluster competition and cluster excellence programmes	Austria, Belgium, Germany, France, Ireland, Japan, Netherlands, European Commision
Networking Platforms	Science-Science (e.g. promotion of collective research centres, centres of excellence)	Belgium, Canada, Denmark, France, Norway, South Africa, Spain, Switzerland, Turkey
	Industry-Science (e.g.promotion of public-private networks, science parks)	Argentina, Australia, Belgium, Canada, Colombia, Denmark, Finland, France, Germany, Italy, Norway, Poland, Portugal, United Kingdom
	Industry-industry (e.g. promotion of sectoral networks)	Belgium, Colombia, Denmark, Germany, Poland, Portugal, Spain, United Kingdom
Technology specialisation	Relative specialisation in biotechnology and nanotechnology	Australia, Belgium, Canada, Denmark, Ireland, Israel, Netherlands, New Zealand, Poland, Spain, Switzerland, United States, Singapore
	Relative specialisation in environment-related technologies	Australia, Austria, Canada, Czech Republic, Denmark, France, Germany, Hungary, Japan, Norway, Poland, Russian Federation, Singapore and Spain
	Relative specialisation in ICTs	Canada, China, Finland, Ireland, Israel, Japan, Korea, Malaysia Singapore and Sweden
(Towards) smart specialization	Australia, Austria, Belgium, Czech Republic, Estonia, Finland, Germany, Ireland, Israel, Poland, Russian Federation, Spain, Turkey, United Kingdom	

Source: Country responses to the OECD Science, Technology and Industry Outlook 2012 policy questionnaire and OECD (2010), OECD Science, Technology and Industry Outlook 2010, OECD, Paris.

Table 9: Top 10 Ranking in Cluster Development

Country	Rank
United States of America	1
United Arab Emirates	2
Taiwan,China	3
Germany	4
Italy	5
United Kingdom	6
Netherlands	7
Japan	8
Norway	9
Qatar	10

Source: 2016-2017 Global Competitiveness Report, 2017

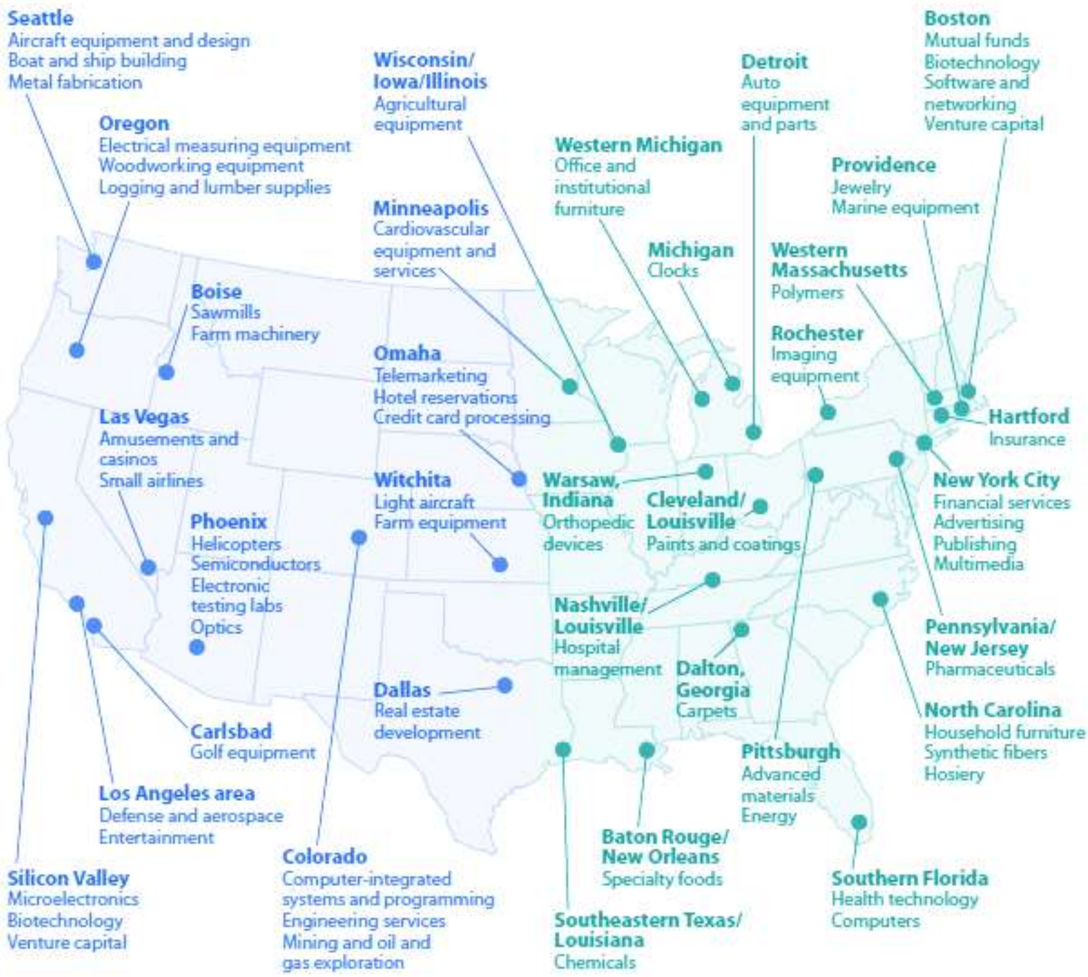
1.4.7.6.1. United States of America

Traded industries located in clusters have more than 87% of all patents in the USA (Delgado et al., 2014). Research in the US has shown that new business formation is higher in strong clusters, and that new firms are more likely to succeed and grow if located in strongclusters (Delgado et al., 2013)and the regionsthat have a higher proportion of their employment in strong clusters havehigher overall levels of prosperity (Delgado et al., 2014)

USA clustering studies are conducted through The U.S. Cluster Mapping Project which is led by Harvard Business School's Institute for Strategy and Competitiveness in partnership with the U.S. Department of Commerce and U.S. Economic Development Administration. Porter pioneered the mapping of clusters in the U.S. economy in the early 2000s. The research team from Harvard Business School, MIT Sloan, and Temple Fox School of Business used the latest Census and industry data and developed an algorithm that defines cluster categories. The project website provides data about clusters, regional economic performance, business environment quality, and regional characteristics and a platform for public and private sector. Research on the presence of regional clusters has recently oriented economic policy toward addressing the needs of clusters and mobilizing their potential. The U.S. Cluster Mapping Project has identified 67 types of clusters in the

U.S. economy. Examples of prominent clusters in the United States are illustrated in Figure 11. The project study compared the innovative performances of the clusters by taking the share of the patents as indicator between 1998-2003 period. Information Technology and Analytical Instruments cluster leads the list in terms of both growth rate of share and the share within the total; with 10.4% and 33.5% respectively, whereas Communications Equipment and Services is the second with 3.42% and 12,1%. Although Production Technology and Heavy Machinery ranks third with 9%, its share has decreased by 2.54%; whereas Aerospace Vehicles and Defense comes after with 8%, it increased its share by 1.53% (Harvard Business School website).

Figure 11: Prominent Clusters in the United States



Source: US Cluster Mapping Project website

1.4.7.6.2. European Union

Europe is home to 2500 strong clusters (European Cluster Observatory,2015) which are statistically defined regional concentrations of related traded industries that achieve above average performance for employees, firms, and regions. Figure 12illustrates the European Regional Hotspots for Sectoral Clusters Stars are given with respect to size, specialization and focusand Table 10 illustrates the leading regions and the top 3 clusters in the region.

The studies show that clusters have an important share in the European economy. Economic activities that are located in clusters account for about 39% of European jobs and 55% of European wages and clusters report much higher productivity, wages, and productivity growth (Köcker and Müller, 2015). 45 % of all employment in traded industries is located in strong clusters. Employees in strong clusters earn on average 11 % higher wages than their colleagues in the same industries but located outside of clusters. This reflects the higher productivity that companies can achieve inclusters. Strong clusters have reported job growth of 0.2 % annually in the period after the crisis (2008-2014), while traded industries outside of strong clusters have lost 1.7 % on average. The regions that have a higher proportion of their employment in strong clusters havehigher level of prosperity (Ketels and Protsiv, 2013).

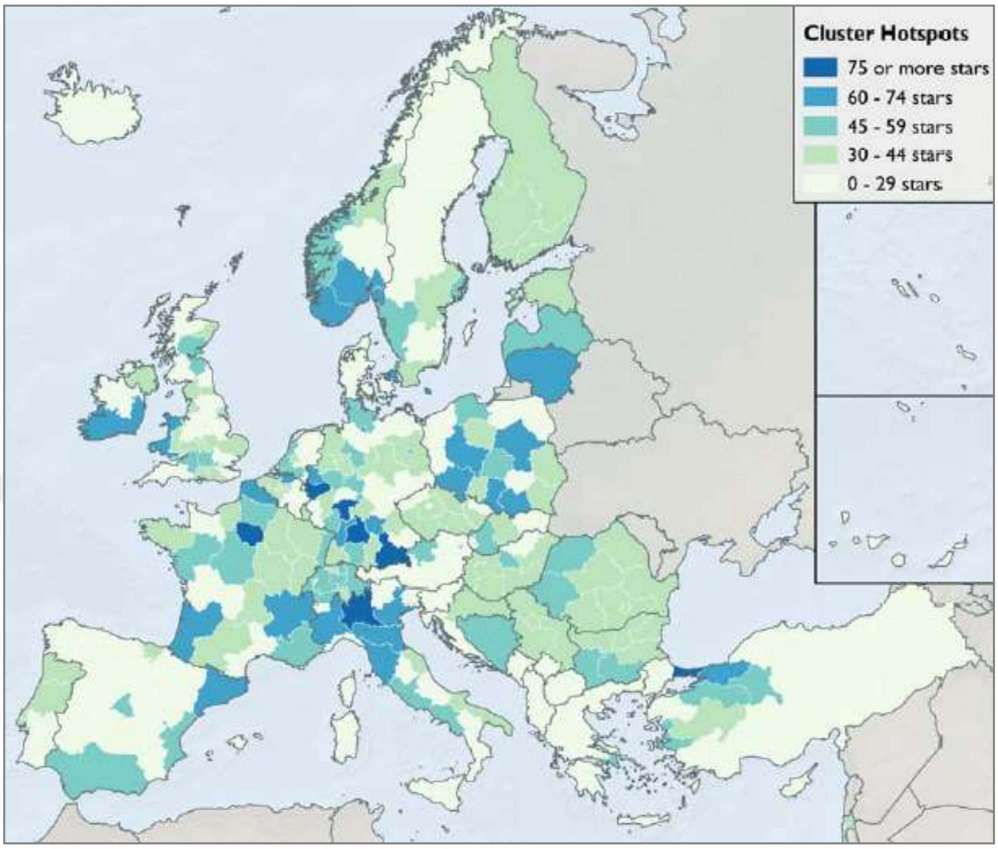
Cluster policies and smart specialisation strategieshave become focal to the implementation ofEurope's growth strategy; many Member States have national/regional policies and programmes insupport of clusters. Survey carried out in2015 by the European Cluster Observatoryidentified 16 national cluster programmes in15 EU countries, with other countries being inthe process of revising their national clusterpolicies and programmes and a small numbernot having cluster policies as such in place at national level (Ketels and Protziv, 2016). Recent evaluation programmes showed that the cluster support policies and programmes have created positive outputs in terms of innovation and employment. Thus, the EC and the national governments have been continuing their support on clusters with some modifications to increase the effectiveness. In many countries, the focus is on

Table 10: Leading Regions and the Top 3 Clusters in the Region

Country	Region Name	Top 3 Clusters by Location Quotient
Turkey	İstanbul	Appliances Textile Manufacturing Biopharmaceuticals
Germany	Ober-bayern	Aerospace Vehicles and Defense Biopharmaceuticals Video Production and Distribution
	Stuttgart	Production Technology and Heavy Machinery Automotive Metalworking Technology
	Köln	Video Production and Distribution Metalworking Technology Insurance Services
	Darmstadt	Biopharmaceuticals Financial Services Insurance Services
	Hamburg	Water Transportation Metal Mining Medical Devices
	Düsseldorf	Production Technologyand Heavy Machinery Communications Equipmentand Services Upstream ChemicalProducts
France	Île de France	Performing Arts Video Production andDistribution Marketing, Design, andPublishing
Italy	Lombardia	Textile Manufacturing Insurance Services Financial Services
Polonya	Slaskie	Coal Mining Lighting and Electrical Equipment Furniture
	Wielkopolskie	Appliances Furniture Livestock Processing

Source: Ketels and Prodziv, 2016

Figure 12: European Regional Hotspots for Sectoral Clusters (by number of stars)



Source: Ketels and Prodziv, 2016 p.16

supporting mature clusters and developing emerging industries whereas previously the support was mainly for the creation of new clusters. Furthermore, in addition to the grant funding, new programmes include a technical assistance component for training and coaching cluster organisations (European Commission, 2016)

Beyond the supporting programmes, the EU has developed various platforms and initiatives:

a) European Cluster Collaboration Platform (ECCP): ECCP promote more European Strategic Cluster Partnerships, by strengthening crossregional collaboration. As a core element of the EU's support of cluster internationalisation, the ECCP facilitates cluster cooperation within the EU and helps clusters access international markets. The ECCP organises International Cluster Matchmaking Events to provide cooperation opportunities for European cluster organisations with partners within and beyond Europe.

b) European Cluster Observatory: the European Cluster Observatory is a single access point for statistical information, analysis and mapping of clusters and cluster policy in Europe and is primarily aimed at European, national, regional and local policymakers, cluster managers and representatives of SME intermediaries. It is an initiative of the European Commission's Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs.

c) European Enterprise Network: the European Enterprise Network brings together around 600 business support organisations from more than 50 countries, with the aim of helping cluster organisations develop business opportunities in the EU single market, and also for the promotion of SME internationalisation on the global market.

d) Cluster PoliSEE: Cluster PoliSEE is an initiative funded under the European Territorial Cooperation South Eastern Europe programme. Its objective is to improve the capacity of regional policy-makers to promote cluster development and to develop their smart specialisation strategies.

1.4.7.6.3. Japan

Cluster promotion efforts were conducted by Ministry of Economy, Trade and Industry (METI) through "industrial cluster project" during the period of 2001-2010. The project aimed to enhance the competitiveness of Japan through industrial clusters. After this period the clusters are expected to be lead by their local government, collaborating with their local academia and industry for further advancement. In Japan, major clusters identified in various regions are as follows:

- Pharmaceutical, Biotechnology, Healthcare, and Welfare clusters
- Environment, Energy clusters
- IT clusters
- Automobile Related Industry clusters
- Electronic components, Devices and semiconductors clusters
- Precision machinery cluster (Robotics, optics, nanotechnology, textile, fabric)

- Knowledge clusters (Health Science, Nano cluster, Smart Device cluster) (Industrial Cluster project, 2009)

METI also encourages international collaboration of clusters. Within this scope, information, helpdesk and matchmaking activities have been carried out and thematic missions have been organized (EU-Japan Centre for Industrial Cooperation Cluster Mapping Japan, 2013)

1.4.7.6.4. Turkey

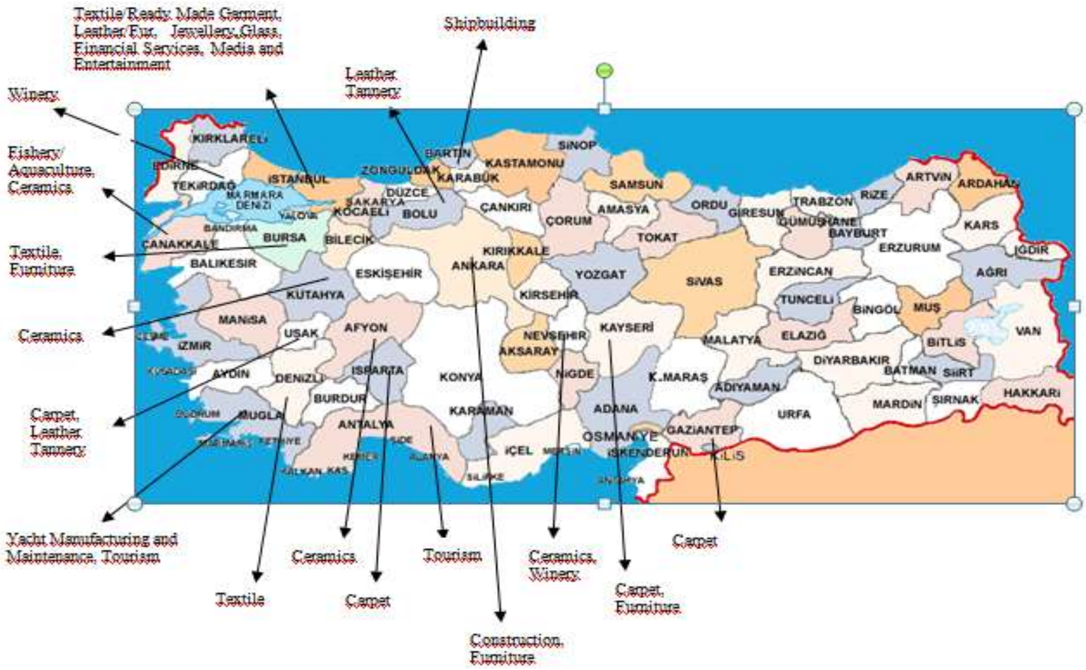
The clustering efforts in Turkey starts at end 1990s; however, its foundations date back to1960's by the State Planning Organization (SPO) (Cansız, 2011). The initial approach to clustering was in the form of Organized Industrial Zones (OSB) and Small Industrial Sites in the 1960s; in the 1990's, the Technology Development Centers (TEKMER) were established within universities under the guidance of KOSGEB (Small and Medium Enterprises Development Organization). The technology centers played a significant role in the formation of clusterrelated policies in Turkey(Akgüngör et al., 2013.

In end 1990s, "Competitive Advantage of Turkey" (CAT) was started as the first organized initiative. The cluster mapping projects were run by National Competitiveness Research Agency (URAK) established by CAT team. From 1999 on, URAK has identified and carried out mapping and roadmapping activites of the Sultanahment tourism cluster, Bolu tourism cluster, Bartın tourism cluster (sports tourism, food tourism, spa tourism), Ostim Organized Industrial Zone (Ankara) Defense Industry Cluster, Zeytinburnu Leather Cluster, Textile and Ready Made Garment Cluster, Metalware Cluster, Ankara Information Technologies cluster (www.urak.org).

Several academic studies highlighted Turkey's highpoint clusters. Öz (2004) identified the top industries by using location quotients (LQs) to measure geographic concentration (Figure 13).

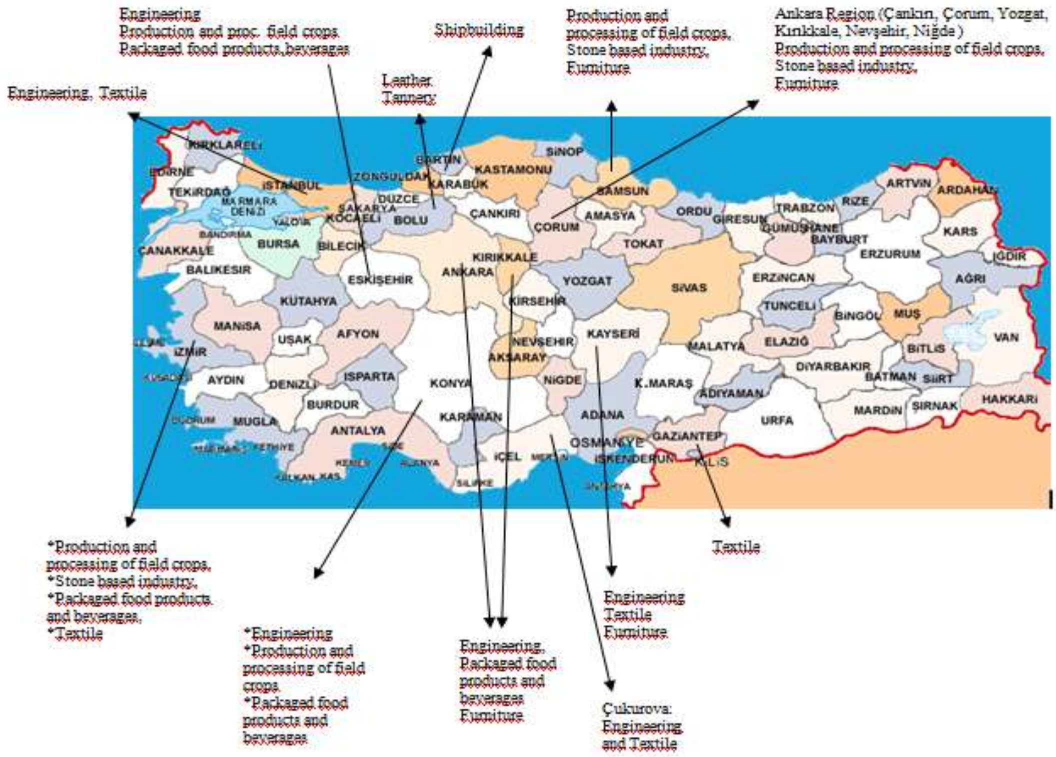
Akgüngör (2006) identified clusters by meso-level application by using input/output based methodology. Identified highpoint clusters are illustrated in Figure 14.

Figure 13: Highpoint Clusters of Turkey



Source: Öz, 2004

Figure 14: Highpoint Clusters of Turkey



Source: Akgüngör, 2006

Identification of clusters were also carried out by national clustering projects started in early 2000s. The projects were funded by the Turkish government, EU, UNDP and the development agencies. Especially after including clustering as a priority area in development policies, many projects are submitted and funded by the regional development agencies. The main clustering projects conducted in Turkey are;

i) Establishment of Fashion and Textile Cluster (2005-2006): The project was run by The General Secretariat of Istanbul Textile and Apparel Association (İTKİB), it aimed to increase networking among SMEs in the textile and clothing sector, at local, national and European levels.

ii) Development of Clustering Policy Project (2007-2011): The project focused on "Development of National Clusters Policy and Building Capacity for Execution", "Development of National Clusters Policy" and "Clusters Mapping and Analysis". Clusters Strategy Document (White Paper) was prepared to form a basis form a basis for the National Clusters Policy. As a result of mapping activities at the national level, 32 Clusters categories were identified for Turkey and roadmaps of 10 pilot clusters are prepared. These clusters are Mersin processed food, Ankara machinery, Konya automotive parts, Eskişehir-Bilecik-Kütahya ceramic, Manisa electronic, Ankara software, Denizli-Uşak home textile, Muğla yacht building, İzmir organic food and Marmara automotive parts. In addition, within the scope of Regional Competitiveness Operational Programme (RCOP) cluster analysis were conducted for 11 pilot clusters and the current situation and needs of these clusters were identified. These clusters are listedin Table 11.

iii) SME Networking Project (2011-2013): SME networking project was run in five areas, namely Gaziantep, Çorum (Agriculture Products Processing Machines), Kahramanmaraş (Metal Kitchenware), Samsun (Health appliances) and Trabzon (Ship building) with the aim of improving networking and cooperation between the developed and the under-developed regions of Turkey.

iv) GAP (Southeastern Anatolia Project) Regional Clusters Activities: In addition to the above, UNDP funded GAP-GIDEM project carried out clustering activities, Adıyaman textile, Şanlıurfa organic agriculture and Diyarbakır marble clusters are the prominent cluster initiatives of this project.

Table 11: Outstanding Pilot Clusters of RCOP

Province	Sector
Kayseri	Furniture
Gaziantep	Machinery–made Carpet
Kahramanmaraş	Textile
Sivas	Natural Stones
Yozgat	Furniture
Trabzon	Wood Procesing
Samsun	Foreign Trade Operations
Malatya	Apricot
Erzurum-Kars	Winter Tourism
Mardin	Tourism
Çorum	Machinery

Source: Regional Competitiveness Operational Programme

v) Izmir Development Agency (IZKA) clustering projects: IZKA has identified clusters in Izmir. Mapping and roadmapping activities of two most potential clusters namely Industrial Ventilation, Air Conditioning and Refrigeration and Processed Vegetable and Fruit clusters were carried out. In addition, Izmir Development Agency and other development agencies in Turkey have been supporting clusters with various funds. Although several clustering projects have been carried out, not all of them continue its operations. A list of clusters in Turkey which is being coordinated by a management body is given in Table 12.

Currently, clustering policies in Turkey are run by Ministry of Science, Industry and Technology. The ministry has started Cluster Support Programme in 2015. The programme provides grants for 50% of the cluster business plan activities. It is highly related with Turkey's R&D and innovation strategies. Activities in specific technologies such as biotechnology, nanotechnology and ICT are getting bonus points in evaluation process (Clustering Support Programme)

Table 12: Clusters in Turkey

Cluster Name
Aegean Apparel Cluster
Aegean Dried Fruits Cluster
Aegean Livestock and Aqua Products Cluster
Aegean Textile and Raw Materials Cluster
Aegean Ventilation, Refrigeration, Air Conditioning Cluster
Automotive parts and components cluster
Egeplasder - Aegean Plastics Industry Cluster
Eskisehir Bilecik Kutahya Ceramics Cluster
Furniture cluster
Inegol Furniture Cluster
Istanbul Apparel Cluster
İAOSB Metal Casting Cluster
İstanbul Chemical Materials cluster
İzmir Aviation and Space Cluster
Konya Agricultural Machinery Cluster
Konya Automotive Spare Parts Industry Cluster
Konya Foundry Cluster
METU Software Cluster
Organic Agriculture Cluster
OSSA Defence & Aviation Cluster
OSTIM Medical Industry Cluster
Packing Manufacturing Cluster
Plastics Industry Cluster
Port Operators Cluster
Sakarya Machinery Manufacturing Cluster
Samsun Medical Industry Cluster (Mediküm)
Transport Cluster of East Marmara
Transport Cluster of East Marmara
White Goods Cluster

Prepared by compiling the list of sources Cansız, (2011), European Secreteriat Cluster List (2011) and the websites of the cluster organizations.

1.4.8. Systems of Innovation

The relationship between innovation and the evolution of industries was discussed by Schumpeter and in his seminal works, in "Business Cycles" (Schumpeter, 1939), and "Capitalism Socialism and Democracy" (Schumpeter, 1950). Schumpeter's models and concepts inspired many of innovation research studies; however, the studies which conducted between 1950s and 1960s had a static view which neglected Schumpeter's evolutionary view (Malerba, 2004). In the late 70's the research focus had turned its direction towards a dynamic approach. This stream was called neo-Schumpeterian perspective of evolutionary economics since it has the evolutionary view and put innovation at the center of the economy as Schumpeter; however, these views were far away from the collective learning or network perspectives; in other words innovation was only examined at the firm level ignoring their relationships and interactions with the others (Cooke, 2011)

In 1990's, "the systems of innovation" concept was developed. It had a Schumpeterian view in the sense that it was evolutionary; it departed from the Neo-Schumpeterian view since it emphasized the interactive nature of innovation processes. The innovation systems approach stressed that the innovation process was evolutionary and interactive; innovation resulted from the interaction between the components of the system (Lundvall, 1992; Edquist,1997). The systems concept refers to the set of institutions and the interactions among these institutions determine the innovative performance (Nelson and Rosenberg, 1993). Within this approach, three main concepts were introduced at different levels: a.National b.Technological and Sectoral c. Regional

a. *National Innovation Systems (NIS)* (Freeman,1987; Lundvall,1992, 1997, 1998) was built on List's concept of national systems of production. Both Freeman and Lundvall described the system having interaction between the actors (both public and private sector) within the national boundaries. However Freeman focused on the importance of the social and political institutions whereas Lundvall's main focus was on learning processes for innovation. Nelson (1992) contributed to the concept by identifying a key set of institutional actors and identifying that the supporting institutional structures vary across countries. His study was important also in the sense of assessing the national innovation systems, he evaluated the consequences of innovation processes in terms of growth and employment.

b. *Technological InnovationSystems (TIS)* focuses on adoption and utilization of technology; it was introduced by Carlsson et al. (1991, 1997). It was defined as:

"A network or networks of agents interacting in a specific technology area under a particular institutional infrastructure to generate, diffuse and utilize technology. Technological systems are defined in terms of knowledge or competence flows rather than flows of ordinary goods and services. They consist of dynamic knowledge and competence networks" (Carlson and Stankiewicz, 1991, p.111; Carlsson and Jacobson, 1997, p.268).

Technological systems can be analysed at different levels. The first level is the technology application area or the range of products that the technology and the related specific knowledge is used. Second one is the markets that the product is used. The third one is the set of interrelated products that are complementary or substitutes for each other and operate under the institutional arrangements (Carlsson and Jacobsson, 1997).

The main difference of a national innovation system and a technological innovation system is that the former one is at the national level, whereas a technological systems can be at regional, national level, or it may exceed the national boundaries. In addition, the latter form of system focuses on the adoption and utilization of technology whereas national innovation system emphasizes the generation and distribution of knowledge (Carlsson and Stankiewicz, 1991).

c. *Sectoral Innovation Systems (SIS)* was developed by Breschi and Malerba (1997)*:*In his study on the Italian NIS, Malerba (1993) found that the innovative firms were not the large companies on which the formal NIS focused, but they were rather SMEs who were in interaction in local clusters; therefore NIS concept was not always effective for innovation and also it did not have to have national boundaries. These findings shed light to a new concept of "Sectoral Innovation Systems" (Breschi and Malerba, 1997). SIS was defined as:

"The system (group) of firms active in developing and making a sector's products and in generating and utilising a sector's technologies, such a system of firms is related in two different ways through processes of interaction and

cooperation in the artefact-technology development and through processes of competition and selection in innovative and market activities (Breschi and Malerba, 1997, p.131).

As the definition reveals, sectoral innovation system concept- as well as the other systems- emphasizes the importance of interaction and cooperation, however it also includes the competition among the firms. Where it departed from the former innovation system concepts is that; unlike national and technological innovation systems concepts, the sectoral innovation system had no geographical boundaries.

1.4.9. Regional Innovation Systems

Regional innovation system (RIS) concept was introduced by Cooke (1992), was later developed by Cooke and Morgan (1994, 1998), Cooke et al (1997), Braczyk et al (1997), Asheim and Isaksen (1997); Cooke et al., (2000); Cooke (2001); Asheim and Gertler, 2005). RIS is defined as

"The set of **economic, political and institutional relationships** occuring in a given **geographical area** which generates a **collective learning process** leading to the rapid diffusion of knowledge and practice" (Cooke, 1998).

RIS concept finds its roots partially on the economic geography which were discussed previously in this thesis, and partially on the systems of innovation concept. While the systems of innovation concepts were being introduced, innovation research and the studies on the competitiveness were discussing the role of the proximity; it was suggested that the agglomerations and clusters provided competitive advantages to the firms, in terms of -among others- innovation. Including the geographical proximity dimension to the systems of innovation concept, Cooke (1992) proposed that the innovation processes were systemic at the regional level. He introduced the concept of Regional Innovation Systems, and the concept was later developed by Cooke and Morgan (1994, 1998), Cooke et al (1997), Braczyk et al (1997), Asheim and Isaksen (1997); Cooke et al.,(2000); Cooke (2001); Asheim and Gertler, 2005). It is defined as

“The set of **economic, political and institutional relationships** occuring in a given **geographical area** which generates a **collective learning process** leading to the rapid diffusion of knowledge and practice” (Cooke, 1998).

RIS builds on five main suggestions introduced by both neo-Schumpeterian economics and economic geography (Cooke, 2005):

- Taking the region with some capacity to support economic development;
- The definition of the innovation as not only the product or process but also the forms of business organisations,
- The network concept,
- The concept of (interactive) learning, and
- The role of institutional context on learning and innovation.

RIS concept suggests that the region is a network (Cooke 1997; Cooke and Morgan, 1998), and this network is composed of firms and supporting institutional context (supporting organisations) and that the learning takes place through the interaction of the actors. RIS also suggests thatthe economic growth and innovation is based on the knowledge, skills and capabilities, infrastructures -shortly- on local characteristics of the region, and thedistinctiveness of these characteristics (Cooke, 2008). Based on these statements, an RIS can be defined as a framework in which intensive communication and collaboration occur between the components of the system which are; companies, knowledge generating organizations, policy support infrastructures and the other institutional setting(Cooke, 1998).

An RIS consists of two main subsytems;

a) knowledge exploitation and application subsytem and

b)knowledge generation and diffusion subsystem (Cooke at al, 1997).

In the knowledge exploitation and application subsytem, firms, their customers, collaborators, suppliers and competitors take place. These actors network horizontally and vertically.

The second subsystem knowledge generation and diffusion subsystem forms a part of this institutional setting where knowledge and skills are produced by public research organisations, educational institutions (e.g. universities, vocational training institutions and so on), workforce mediating organizations and technology mediating organizations (e.g. technology licensing offices, innovation centres, and so on)

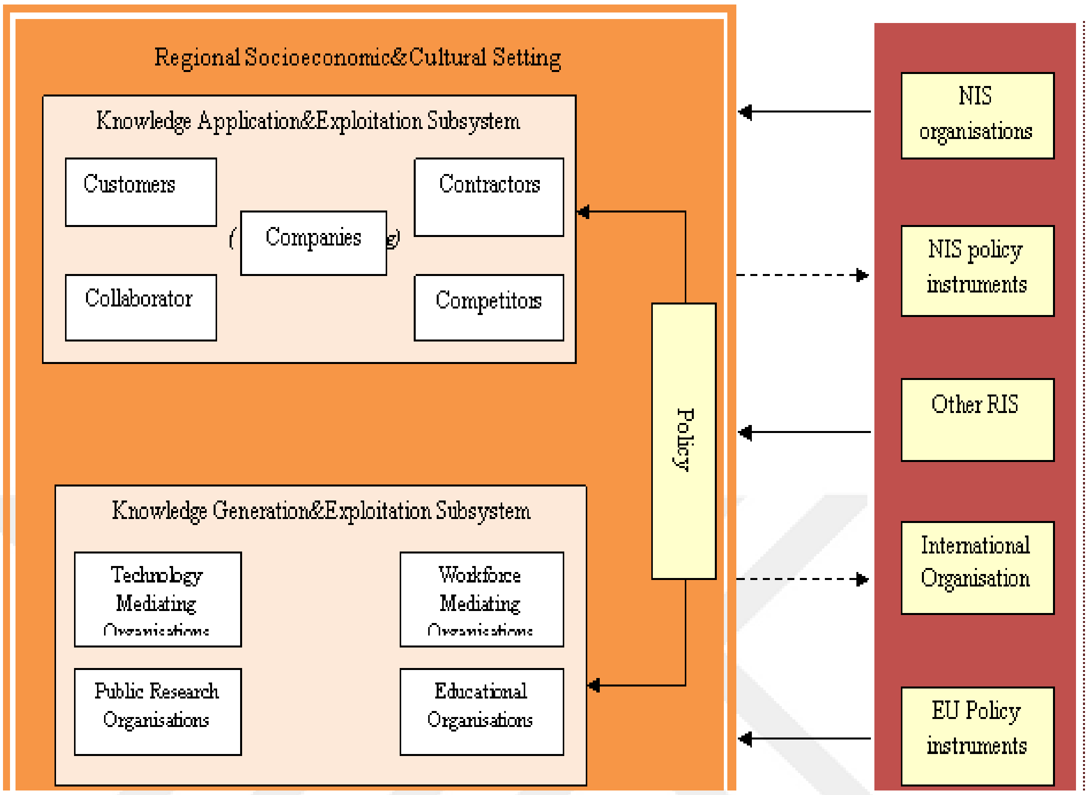
(Tödtling and Trippl, 2005). In an RIS ideally the two subsystems should have intensive interaction which will facilitate the exchange of knowledge, resources and human capital.

Besides the two subsytems, there are policy actors at the regional level to design and implement the innovation policies (Cooke et al, 2000). RIS is not a closed system which only interacts the actors within the region, it is also in interaction with the outer region. The RIS highly communicates, collaborates and interacts with other RISs as well as NIS organizations, international organizations, EU policy actors (applicable for the related RISs) which describes its national, international and supranational levels. Policies have impact on innovation. As Cooke et al (1997) puts it:

"Learning represents a strategic element in any innovative process. It can be concluded that learning has important specific and local characteristics and that it can be improved through certain institutional changes and properly oriented active policies" (Cooke et al, 1997, p.490)

The main structure of an RIS is illustrated in Figure 15. What is not illustrated in the figure but constitute important elements of RIS are the regional norms and routines and the social capital. Social capital is defined as 'social networks and relations held together by common norms and values (of which trust is one)' (Westlund and Kobayshi 2013,p.5). The networks that constitute social capital comprise a rich and dense social community in which the business relationships of the local economy are embedded (Wolfe, 2002). RIS suggests that the informal societal norms and characteristic of the region is as important as the firms, supporting/educational/research organisations, policy makers and the laws and regulations. In a regional innovation system, trust-building is of the essence (Cooke et al, 1997, p.489) and without embeddedness, there is no milieu (Maillat, 1997). Cooke et al. (1997) argues that "regional innovation systems were conceptualised in terms of a collective order based on microconstitutional regulation conditioned by trust, reliability, exchange and cooperative interaction" (ibid, p.490).

Figure 15: Main Structure of RISs



Source: Tödtling and Trippl;2005

At this point, it is important to note the difference between clusters and the RISs. Clusters are included as an important component of an RIS. An RIS may host several sectors and clusters (Asheim and Coenen, 2005). In RISs institutions play a larger role (Tödtling and Trippl,2005). Clusters are important, but so too are a range of other factors, agents and institutions that combine to promote and diffuse innovation within a region (Asheim et al., 2011, p.880). "The RIS approach emphasizes networking, social and institutional interactions and associated collective learning that is analysed within an evolutionary framework", …… "with its more complete theoretical and policy analysis, it offers a broader framework for regional innovation theory and policy (Asheim et al.,2011, p.879).

As mentioned above, RIS finds its roots partly in other innovation systems concept. Just like in sectoral and technological innovation systems, RIS also considers that the innovation systems could be in the subnational level, as well as the international and global levels. It departs from these approaches in the sense that it takes the “region” as a focus. The reasons for taking the region as the focus is the different industrial specialization patterns and innovation performances of the regions (Cooke, 2008). Furthermore, regional economies are also formed by the cultural traditions and institutional structures that shape the economic behavior (Wolfe, 1997) and knowledge exchanges and collective learning process which play a key role on innovation is facilitated by geographical proximity. Proximity at the spatial level facilitates trust-based, intensive personal contacts; and by these relationships tacit knowledge is transferred and exchanged among the actors. Therefore, RIS argues that learning has important specific and local characteristics, sectors and even clusters are in interaction with regional governance and innovation support infrastructures. This locality does not mean that it is closed to the outer world, on the contrary it is also in intensive interaction with other institutions and RISs at the national and global levels. RIS gives great importance to the institutions since learning, thus innovative performance can be improved through certain institutional changes and properly designed active policies (Cooke et al.1997; Cooke, 2001). In this respect, the system dimension was inspired by the NIS concept and the rationale of having territorially based innovation systems (national and regional) is the same (Asheim and Coenen,2005).

Different regional cultures and regulations at various spatial levels can also explain the differences between the RISs. These are important issues since they play a key role in regions dynamics and related issues such as learning, knowledge exchange, network structure and so on. These differences lead to the conclusion that for a sound cluster analysis it is essential to identify the type of the RIS that the cluster is in. By this way it is aimed to explain why the differences with respect to their functioning and innovative performance can occur.

1.4.9.1. Types of RISs

RISs are classified from different aspects: Capacity to develop high-tech sector, governance, knowledge base and dominant industries and RIS problems and barriers (Tödtling and Trippl, 2011). The first two classifications were formed by Cooke whereas the latter two classification which were developed by Asheim and

Coenen (2005) and Tödtling and Trippl (2005) respectively. Classification based on the knowledge bases and RIS problems and barriers are today widely used to analyse and to design policies for the clusters.

1.4.9.1.1. Capacity of Developing High-Technology

Cooke (2001, 2004) differentiates RISs with respect to their capacity two develop high-technology as Institutional RIS (IRIS) and Entrepreneurial RIS (ERIS). IRISs depend on state and institutional support more, it is suitable for development of traditional sectors. On the other hand, ERIS rely on local venture capital, entrepreneurship, scientific excellence, market demand and incubators and suitable for high-tech sectors development.

1.4.9.1.2. Governance Dimension

This classificiation is based on the argument that the key actors, institutions of coordination and policy processes differ between RISs. Cooke (1992) introduced the three terms of RISs: Grass Roots, Networked and Dirigiste.

i) Grass-roots RISs: In this type of RIS, initiation of technology transfer action is locally organized. Funding will be diffuse in origin, the market demand directs innovation, level of technical specialiazation is low and rather than technological expertise, generic problem solving is prominent. The localized nature causes low level of coordination. Japanese kohketsushi system where SME technology centres are coordinated by regional and local bodies, industrial district systems of Northern Italy and South California can be the examples of this type (Asheim,2007). Asheim (2007) calls it territorially embedded regional innovation systems, where firms primarily those employ synthetic knowledge base.

ii) Network RIS: In this type of RIS, initiation of technology transfer is not at local level but it is at multi-levels. The research competence is mix of pure and applied. Because of the many stakeholders, coordination is high. This regionally networked innovation system is a result of policy intervention to increase innovation capacity and collaboration. Asheim calls this type of RIS regionally networked innovation system. The network approach is most typical of Baden-Württemberg Germany, North-Rhine Westphalia Austria and the regions of Denmark countries. The interaction with the outer region more intensely than the grassroots RIS protect the Network RISs from the risk of cognitive lock-in (Asheim,2007).

iii) Dirigiste RIS: Technology transfer action starts by outer region generally by central government policies. The research is at fundamental level and serves the needs of higher bodies, such as government. Coordination is high and the specialization is expected to be high. Asheim calls this type of RIS as the regionalized national innovation system since the RIS is more integrated into the national and international innovation systems (Asheim, 2007). Examples of this type of RISs are French Regions, Singapore and Slovenia (Heidenreich and Koschatzky, 2011).

1.4.9.2. RIS Problems and Barriers

Tödtling and Trippl (2005) criticised the innovation policies as they generally took the best practices as example and offered the same remedy for each region. This one-size-fits-all approach was far from addressing the problems and failures thus specific needs of the regions (Tödtling, Trippl, 2005). In their analysis, they focused on the weak innovation capabilities of less favoured regions. The findings showed that the underlying reasons for an RIS failure included

- inadequate organisational and institutional set up,
- communication problems between the actors,
- limited innovative capabilities of the firms,
- lack of clusters (or having a few clusters),
- overspecialization in traditional industries and outdated technologies,
- missing interaction (since it causes lack of knowledge exchange)
- too strong ties (since it causes a lock-in risk)
- lack of external links (since external knowledge complement the knowledge that is not already in the region)

According to their problems and deficiencies, they identified three types of RISs[2];

- Fragmented (metropolitan)
- Locked-in (old industrial regions)
- Thin (peripheral)

The model takes the problems which predominate the region, meaning that the regions might have other problems as well, however one type will most dominantly be observed.

i) Peripheral regions

The main problem observed in the peripheral regions is the "organisational thinness" which means the lack of dynamic clusters and supporting institutions. The clusters are often in traditional industries, the innovation and R&D activities are at the low level. Although supporting institutions exist, they are ineffective, and networks with these institutions are weakly developed. The knowledge suppliers and educational institutions are far from being specialised, and also networks with the specialised knowledge suppliers such as universities and research organisations is often weak (Tödtling and Trippl, 2005).

ii) Old industrial regions

This type of regions are specialised in often mature industries which are in the phase of decline, the R&D acitivities have an incremental nature. Like the peripheral regions, they have insufficient learning and innovation. Where they set apart from the peripheral regions is that, they have a well developed subsystems and clustering is too strong; however these brings the RIS failures since it causes lock-ins. The lock-ins can be functional; as too rigid inter-firm networks, cognitive; as

[2]The model was based on the previous typologies of Isaksen (2001)

their views are more often the same and political; as they have symbiotic relationships between public organisations and private sectors (Tödtling and Trippl, 2005).

iii) Fragmented metropolitan regions

Although metropolitan regions have an advantage of highly developed structures both at knowledge generation and knowledge application subsystems sides and R&D activities, patenting and major product innovations are at better levels than the other regions (Feldman and Audretsch, 1999; Simmie, 2003), some metropolitans lack dynamic cluster due to lack of networks and of interactive learning (which is a must for a high innovative performance in RISs).In other words, the two subsystems operate separately. The lack of networks and communication may not only be between the subsystems but also within them(Tödtling and Trippl, 2005).

The relationship of the problems and the regions is illustrated in Table 13.

1.4.9.3. Transformation Capacity of RIS

Isaksen and Trippl (2014) discuss RISs with respect to their path renewal and new path creation –transformation– capability. They distinguish between i) organisationally thick and diversified RISs (often found in advanced core regions) ii) organisationally thick and specialised RISs (commonly found in old industrial areas and industrial districts), and iii) organisationally thin RISs (often found in peripheral areas).

Table 13: Problem Areas and RIS Deficiencies

Type of Regions / Problem Areas	Peripheral Regions	Old Industrial Regions	Fragmented Metropolitan Regions
Knowledge application subsystem	SME Dominance Traditional Industries Clusters too weak or missing	Large firms' dominance Mature industries High level of clustering	Many firms Various industries/Services High profile or knowledge based clusters missing
Knowledge exploitation subsystem	Underdeveloped	Specialised; however too much focus on traditional industries and technology fields.	Well developed and have a large variety
R&D and Innovation activities	Low level, emphasis on incremental and process innovation	Mature traditional trajectories, dominance of incremental and process innovation	R&D at large firms' own R&D departments, product innovation and new firm formation below expectations
Networks	Lack of networks due to underdeveloped institutional structure (Organisational Thinness)	Too strong ties between and within the subsystems (Lock-ins)	Market links are strong, (innovation related) networking missing

Source: Tödtling and Trippl,2005

i) Organisationally thick and diversified RISs

In this type of RISs there are a large number of different industries and many knowledge and supporting organizations they are often found in large, well-performing core regions such as metropolitan areas and advanced technology regions (Tödtling and Trippl 2005). The wide range of heterogeneous (but related) industries located in this type of region offer good potential for cross-sector knowledge flows and new re-combinations of knowledge (Boschma and Frenken 2011; Boschma 2014a) and wide range of knowledge and supporting organisations foster innovation and development. Knowledge networks are diverse and geographically open which prevents the lock-in risk. Social capital in these RISs are both bonding and bridging networks (Malecki 2012). Diversity of local industries, technologies and organisations foster innovation and economic reconfiguration (Martin and Sunley, 2006) therefore the organizationally thick and diversified areas are likely to offer favourable conditions for path renewal and new path creation (Isaksen and Trippl, 2014).

ii) Organizationally thick and specialized regional innovation systems

Differently from the first type of RISs, in this type of RISs, there are strong clusters in one or a few industries. The support structure and institutional set-up is highly specialized. These RISs lack the diversity to foster innovation and industry and thus suffer from developing new regional paths (Boschma and Frenken 2011, Boschma, 2014b). They mainly experience innovation along existing regional industrial development paths, hence path extension is most likely to happen (Isaksen and Trippl, 2014). Bonding social capital is high, however this positive lock-in can result in a negative lock-in if the region cannot adapt to changes, leading to decline (among others, Tödtling and Trippl 2005; Hassink 2010; Simmie and Martin 2010).

iii) Organizationally thin regions

This type of regions suffer from having a weak institutional set-up (e.g few institutions of higher education or R&D-institutes), none or only weakly developed clusters. The regions are often dominated by SMEs operating in traditional and resource-based industries, but also larger, externally owned firms (Tödtling and Trippl 2005). The type of innovation is mainly Doing, Using, Interacting (DUI) (Jensen et al. 2007, Isaksen and Karlsen 2013). They mostly have bonding social capital therefore just like the former type of RISs they face the risk of lock-in. Weak institutional infrastructures, weakly developed clusters –if not none- and DUI type of innovation leads to incremental innovation within existing industries, therefore the evolution is mostly path extension with a high risk of decline.

So far, three related concepts of geography of innovation–agglomerations, clusters and regional innovation systems- were discussed. As the definitions and the typologies of RISs show, RISs are wider contexts than agglomerations and clusters. In an RIS there can be few or none clusters. Moreover, RIS suggests that institutional set-up affects regional economies. The emphasis of the RIS is on the interaction which has a great impact on learning, and thus innovation processes as in the other systems of innovation suggest. Therefore in this study the clusters will be analysed with a wider approach taking the knowledge sources and institutions into consideration.

Based on the above discussion about RISs, Table 14 suggests the conditions for high and low RIS potential of a region.

Table 14: Conditions for Higher and Lower RSI potential

Higher RSI Potential	**Lower RSI Potential**
Informal institutional setting	
Cooperative culture	Competitive culture
Interactive learning Networking Trust-based	Individualistic Isolation Low level of/none trust based relations
Firms	
Externalisation	Internalisation
Interactive innovation	Stand-alone R&D
Formal institutional setting	
i)*Policy dimension*	
Inclusive	Exclusive
Consultative	Authoritative
Networking	Hierarchical
ii)*Educational/Training/Research organisations*	
Up to date knowledge and technology	Out to date knowledge and technology
Links with outer world(firms and other institutions	Too much focus on one topic, mostly introvert

(Lower-higher potential idea and some concepts cited from the table in Cooke, 2001, new dimensions and concepts added)

1.4.9.4. Knowledge Bases

Knowledge base concept is mainly based on the fact that innovation process of firms in various industries and sectors differ; an innovation process is extremely different between the biomedical and advertising sectors. The reason of this difference is due to the requirement of specific knowledge base(s) (Asheim and Gertler, 2005; Asheim and Coenen, 2005). In other words, they depend on the knowledge bases of the industries and sectors. Knowledge bases concept suggests that knowledge bases can have different mixes of tacit and codified knowledge (Asheim and Coenen, 2005). Codified knowledge can be easily transferred and brought into a region from outside whereas tacit knowledge is a based on experience and can be transferred by face-to-face contacts. However, the relationship between the tacit and codified knowledge is complex, there is a continous process of transformation of these types of knowledge (Nonaka and Takeuchi, 1995; Lundvall andBorras,1997. Therefore, a knowledge base does not only have one type of knowledge but a combination of them (Asheim and Coenen,2005).

According to the innovation processes, they identified three types of knowledge bases. Analytical (science-based), Synthetic (engineering-based) (Laestadius, 1998) and Symbolic (creativity-based)

i) Analytical Knowledge Base

In analytical knowledge bases scientific knowledge is highly important, knowledge creation is often based on cognitive and rational processes, or on formal models (Asheim,2008, pg.225). Asheim and Coenen (2005, p.1176) explains it as:

"Knowledge generation is based on the application of scientific principles and methods, knowledge processes are more formally organised (e.g. in R&D Departments); knowledge inputs and outputs are frequently codified both basic and applied research is conducted. The relationships between research organizations and the companies is intense. The research activities require specific analytical skills such as abstraction, theory building and testing.The analytical knowledge base is more likely than other types to lead to scientific discoveries and technological

inventions are observed more prominently than other knowledge bases (Asheim and Coenen, 2005). Innovations are in radical nature and more often have patents and licenses. These innovations are applied by the establishment of new firms and spin-off companies. Analytical knowledge base is more close to natural science; examples of this type of RISs having this type of knowledge base is biotechnology and nanotechnology."

ii) Synthetic Knowledge Base

Synthetic knowledge base is described as:

"In synthetic knowledge base, innovation is more based on existing knowledge and the aim is to solve specific problems. R&D is generally less important; it is done for product or process development. Due to the rare case of R&D, and its applied nature, the links between the firms and the research institutes are not as dense as in the analytical base.

Knowledge embodied in the respective technical solution or engineering work is at least partially codified. Insofar as knowledge results from experience gained at the workplace and through learning by doing, tacit knowledge is more important here as compared with the analytical knowledge base. The knowledge depends on know-how, craft and practical skill. These are often provided by professional and polytechnic schools, or through on-the-job training.

The innovation is more incremental in nature, such as the modification of existing products and processes. Most of the innovation take place in exisitng firms, spin-offs are less frquent compared to the analytical base. Synthetic knowledge base is observed in engineering science, examples of synthetic knowledge bases are plant engineering, specialized advanced industrial machinery and production systems and shipbuilding." (Asheim and Coenen, 2005,p.1176-1177)

iii) Symbolic Knowledge Base

This type of knowledge base is associated with the aesthetic attributes of products, the creation of designs and images and the economic use of various forms of cultural artefacts (Asheim,2011 pg.226) it is more dominant in the industries where aesthetic/design content of goods and services is high. Symbolic knowledge base is built on arts rather than science. This type of knowledge has a tacit component since it is highly related to everyday culture and norms and therefore may have a high degree of place specificity. The required skills are creative, imaginative and interpretive skills which more rely on practice rather than university degrees. Media (filmmaking, publishing, music), advertising, design and fashion are the examples of industries having symbolic knowledge base (Asheim, 2007)

Table 15 illustrates the main features of three knowledge bases. As will be seen from the above discussion, the concept takes innovation in broader sense; innovation is not only considered as radical type or product/process innovation, but also incremental type and marketing/organisational innovation is included.

Knowledge base concept shows that comparing clusters with different knowledge bases will lead to inaccurate findings. When analysing or assessing the cluster's innovative performance and designing policies, it will be misleading to use the same criteria such as number of patents, the novelty of the innovation, number of employees with university or graduate diploma. While in analytical knowledge base the innovation is more radical and patented, whereas in synthetic and the innovation type is more incremental; in analytical base the number of employees having university diploma would naturally be higher than the symbolic base. However; this does not necessarily mean that the cluster in the symbolic knowledge base is less innovative than the clusters in other knowledge bases.

1.4.9.5. Institutions

In Chapter 1 so far, innovation concept and the territorial models of innovation have been discussed. These models aim to explain in which ways the territorial model boost innovation. Marshall (1920) was the first to introduce "the industrial atmosphere", and Neo-Marshallian Industrial Districts (Bagnasco, 1977; Becattini, 1978; Brusco, 1982) added the specific characteristic, norms and values dimension. More recent views on the innovation territorial models consider that the

Table 15: Main Features of the Knowledge Bases

Knowledge-base / Criteria	Analytical (science-based)	Synthetic (engineering-based)	Symbolic (arts based)
Rationale for knowledge creation	Developing new knowledge about natural systems by applying scientific laws; *know why*	Applying or combining existing knowledge in new ways; *know how*	Creating meaning, desire, aesthetic qualities, affect, intangibles, symbols, images, *know who*
Development and use of knowledge	Scientific knowledge, models, deductive	Problem solving, custom production, inductive	Creative process
Actors involved	Collaboration within and between research units	Interactive learning with customers and suppliers	Experimentation in studios, Project teams
Knowledge types	Strong codified knowledge content, highly abstract, universal	Partially codified knowledge, strong tacit component, more context specific	Importance of interpretation, creativity, cultural knowledge, sign values; implies strong context specifity
Importance of spatial proximity	Meaning relatively constant between places	Meaning varies substantially between places	Meaning highly variable between place, class and gender
Outcome	Drug development	Mechanical engineering	Cultural production, design, brands

Source: Asheim and Gertler, 2005; Asheim et al., 2007; Asheim and Hansen, 2009; Gertler, 2008

innovation process is interactive in nature and innovation is an output of the interaction between the components of the system (Lundvall, 1992; Edquist,1997).

The "systems concept" refers to the set of institutions and the interactions among these institutions determine the innovative performance (among others; Nelson and Rosenberg, 1993; Freeman, 1987; Cooke, 1992). Also, in the revised definition of clusters (by Porter, 1998a), the interaction with the institutions is emphasized. Taking its roots from the systems of innovation concept, the definition of the RIS includes economical, political and institutional relationships (Cooke, 1998).

Institutional thickness is considered as one of the main success factors for innovation and development. Amin and Thrift (1994), in their seminal work, explains that the institutional thickness is associated with four factors:

i) a strong local institutional presence (existence of a variety of different organizations such as groups of firms, financial bodies, governance organizations, unions, associations, and business service organizations),

ii) high levels of interaction between local organizations which emphasizes the importance of formal and informal knowledge exchange and cooperation among those organizations,

iii) a structure of domination (relative power of organisations) and/or patterns of coalition, and

iv) a mutual awareness of being involved in a common enterprise which result in developing and dependingon a common agenda.

Amin and Thrift (1994) take both the physical presence of and the knowledge sharing-interaction with the institutions. Gertler (2004, p. 7) takes a different perspective and defines institutions as "formal regulations, legislation, and economic systems as well as informal societal norms that regulate the behavior of economic actors". This perspective takes institutions as the rules, norms, regulations, laws, etc. and, as opposed to Amin and Thrift (1994) it does not consider the physical presence of the institutions, scholars in this view uses the word "organisation" instead of "institution". In this study, Amin and Thrift's (1994) view will be used since it takes both physical presence of the institutions and the interaction dimension.

RIS gives great importance to the institutions since learning, thus innovative performance can be improved through certain institutional changes and properly designed active policies (Cooke et al.1997; Cooke, 2001). The vital importance of "knowledge generation and diffusion subsystem" stems from the fact that knowledge and skills are produced by public research organisations, educational institutions (e.g. universities, vocational training institutions and so on), workforce mediating organizations and technology mediating organizations (e.g. technology licensing offices, innovation centres, and so on) (Tödtling and Trippl, 2005). For innovative performance, it is at utmost importance that the two subsystems should have intensive interaction which will facilitate the exchange of knowledge, resources and human capital.

Besides these two subsytems, policy actors to design and implement the innovation policies at the regional, international or EU level are important actors since they have direct and indirect influence on clusters and regional development by means of policy actions and measures. All these suggestions emphasize that a cluster within an RIS is not an isolated formation from the institutional context of an RIS; it is deeply affected by the policies, rules and regulations both at regional and broader levels.

The studies examining the relationship between institutional context and innovative performance reveal that the clusters benefit from a stronger institutional context whereas a weak institutional context hampers the innovative performance. For large firms, collaboration with higher education or public research institutions is mainly an important source of knowledge transfer (OECD, 2013). The findings of a study which analysed the weak innovation capabilities of less favoured regions shows that the underlying reasons for an RIS failure include -among other things- inadequate organisational and institutional set up (Tödtling and Trippl, 2005). In the peripheral regions where the innovation and R&D activities are at the low level, the main problem is the “organisational thinness” - the lack of dynamic clusters and supporting institutions. In this type of regions, although supporting institutions exist, they are ineffective, and networks with these institutions are weakly developed. The knowledge suppliers and educational institutions are far from being specialised, and also networks with the specialised knowledge suppliers such as universities and research organisations is often weak (Tödtling and Trippl, 2005). Two clusters operating in the same sector and having the same knowledge base show differences in terms of innovative performance due to institutional contexts; poor institutional context causes low innovation performance (Kuştepeli et al., 2013). On the other hand, organizationally thick and diversified areas are likely to offer favourable conditions for path renewal and new path creation (Isaksen and Trippl, 2014). According to World Economic Forum global competitiveness ranking 2016-2017, Switzerland is the most competitive country for the eighth consecutive year and its top-notch academic institutions and strong cooperation between the academic and business worlds contribute to making it a top innovator.

In Chapter One, innovation, territorial models of innovation and their relationship were introduced. Table 16 presents a summary and comparison of the territorial models of innovation discussed so far. In this study, among these models, the most recent ones; clusters and RISs were discussed in detail. As seen in the above discussion, RIS has brought up two important concepts for innovation: a) Interaction and b) The components of the system which are not only the firms, and their suppliers, customers, competitors, and so on, but also the institutions- which is in line with the institutional thickness concept. The empirical studies on institutions in RISs support the theory, suggesting that the institutional context is a key factor to the innovative performance of the clusters and RISs. Therefore, one of the main focus of this research will be institutions and its relationship with innovation in clusters.

Table 16: Summary and Comparison of the Territorial Models of Innovation

Models of Innovation	**Main Emphasis of the Concept**	**The Novelty of the Concept**
Marshallian Industrial Districts (Marshall,1920)	External economies of scale (by pooling of skilled labor, availability of specialized related industries, use of highly specialised machinery, and industrial atmosphere) by agglomeration.	Benefits of agglomeration and industrial atmosphere concepts explained for the first time.
Neo-Marshallian Industrial Districts (Bagnasco, 1977; Becattini, 1978; Brusco, 1982)	The specific characteristic, the shared norms, values, routines -which was formed due to spatial proximity-, and the institutional dimension which varied in different regions was the underlying reason of succesful regions.	Industrial districts definition does not include same type of firms only, institutions are also included.
Innovative Milieu GREMI Group (the European Research Group into Innovative Milieus)	The territorial differences cause differences in the innovative performances of the firms in different regions. (Similar to the Neo-Marshallian industrial district concept)	• Spatial, local, and extralocal functionings of the innovative networks were explored. • The trajectories of regions that have identical sectors and identical technological and market environments were compared. (Shed light on cluster evolution concept)
Learning Regions (Florida,1995; Morgan,1997)	Regions must become learning regions which can facilitate the flow of knowledge, ideas and learning. The industrial government system be mutually dependent relationships, and have flexible regulatory framework.	It is not the globalization but the regions are the focal points for knowledge creation and learning; thus innovation and economic growth.

Table 16 continued

New Economic Geography (Krugman,1991a, 1991b, 1998)	• *Centripetal factors* –economies of scale, economies of specialization, reduced transportation costs, market size effects and labor markets- *affects the geographical concentration positively*. • *Centrifugal factors* -differences in factor endowments, increased land rents, and congestion costs- *affect the location decisions (thus agglomeration) negatively*. • It underestimates knowledge and the effect of social relations	Transport costs were added to the agglomeration concept and also a mathematical model was introduced to explain the relationship with production and labor in particular regions.
Clusters (Porter, 1990, 1998)	Mainly inherits the concepts of Marshallian Industrial Districts.	Five Forces –Diamond Model
National Innovation Systems Freeman (1987); Lundvall (1992, 1997, 1998), Nelson (1992)	Innovation systems have interaction between the actors (both public and private sector) within the national boundaries. Learning processes for innovation…..(generation and distribution of knowledge) For an effective NIS Social and political institutions are important, key set of institutional actors and identifying that the supporting institutional structures vary across countries,	Introduced the concept of "system" for innovation and this system has to be at national level.
Technological Systems of Innovation Carlsson et al. (1991, 1997)	Innovation systems are networks in a specific technology area. can be at regional, national level, or it may exceed the national boundaries.	Focus on adoption and utilization of technology

Table 16 continued

Sectoral Innovation Systems (Breschi and Malerba,1997)	The firm benefits from the sectoral technology. Firms relate by interaction and cooperation and also by competing with eachother. No geographical boundaries	Competition is added to the innovation systems concept
Regional Innovation Systems (Cooke, 1992-2001); Cooke and Morgan (1994, 1998), Cooke et al (1997,2000), Braczyk et al (1997), Asheim and Isaksen (1997), Asheim and Coenen (2005)	the innovation processes were systemic at the regional level. Two subsystems in the region (firms and institutions) form a network and interaction between these subsytems is a major determinant of the success. Knowledge bases	Introduced the concepts of • knowledge exploitation and application subsytem • knowledge generation and diffusion subsystems and • knowledge base

CHAPTER TWO
CLUSTERS AS NETWORKS AND KNOWLEDGE SOURCES IN CLUSTERS

As discussed in previous chapter, innovation is not an outcome of an isolated effort; it is rather an interactive process in which knowledge sharing and learning takes place. The sources of innovation- to a large extent- depend on the relationships among various actors (Powell, 1990, 1998). From Marshall's "industrial atmosphere" and "knowledge in the air" concepts on, the relationship between the knowledge flows, social capital and innovation have been studied in various suggested innovation models such as Neo-Marshallian Industrial Districts, Innovative Milieu, Learning Economies, Learning Regions, Innovation Systems and Clusters. RIS concept emphasizes the interaction between the components of the RIS.

The importance of interaction between actors, the informal institutional set-up -especially the social capital- have led to considering clusters as networks and raised attention to the "analysis of the networks" in regional economies (Grabher and Ibert, 2006; Ter Wal and Boschma, 2009). Understanding the interactions of the parties within that network is assumed a core requirement to understand networks (Ford and Håkansson, 2006). Not only to assess the current situation of the clusters but also, how the clusters emerge and the reasons underlying their different trajectories which will be discussed in the next chapter.

Clusters and RISs are analysed from different perspectives, their network, structures, how dense the relationships in a network are, the main actors and the brokers, etc. Under this topic, a body of literature focused on to which extent knowledge spillovers could be observed (Tödtling and Trippl, 2005). Knowledge sources –their types and spatial levels- and their relationship with innovation has gained considerable attention. Social Network Analysis (SNA) has become a useful tool for the economic geography scholars as it enabled to analyse the networks quantitatively. It did not only allow analysing the network structure but also investigating the variety of knowledge sources to which each node is linked, and how that affects their innovation performance (Broekel and Boschma, 2012).

In this chapter, networks, knowledge sources in the networks and their relationship with innovation will be discussed. The rest of the chapter is structured as follows: The first section gives an overall description of a network and related important concepts. Section two focuses on the knowledge sourcing in clusters and RISs.

2.1. DEFINITIONS

2.1.1. Definition of Network

A network consists of nodes connected by ties or linkages where nodes represent actors and ties represent relationships (Laumann et al., 1978; Fombrun, 1982; Brass et.al 2004).

Networks can have different types such as social networks, business networks, innovation networks and so on, depending on the context that they are in, the actors involved or the type of relationships that they have.

Laumann et.al describes a "social network" as a set of nodes (e.g. persons, organisations) linked by a set of social relationships (e.g. friendship, transfer of funds, overlapping membership) of a specified type (Laumann et al., 1978).

The business networks are defined by several scholars as

"a set of two or more connected business relationships, in which each exchange relation is between business firms that are conceptualized as collective actors" (Emerson, 1981).

'an integrated and co-ordinated set of ongoing economic and non-economic relations embedded within, among and outside business firms' (Keeble and Wilkinson, 1999).

"Relationships between economic actors are commonly described in terms of networks, which are in this context socioeconomic structures that connect people or firms to one another" (Powell and Grodal, 2005)

"Networks of innovating firms can have different types; supplier-user networks, networks of pioneers and adopters, regional inter-industrial networks, international strategic technological alliances, and professional inter-organizational networks (DeBresson and Amesse, 1991).

In the networks, the relationships can have different forms. According to Lave and Wenger, networks can have formal or informal relationships. Formal relationships can be agreements or contracts between companies, whereas informal linkages are joint membership of a business association or, belonging to the same epistemic community or community of practice (Lave and Wenger, 1991); and in a same network there can be different type of relationships.

Inkpen and Tsang (2005) the strategic networks with some form of formal agreement where members' roles and relationships are clearly defined, and members are well organized to achieve certain goals as structured networks; whereas the reverse was true for the unstructured networks.

The relationships are also classified with a vertical-horizontal dimension which represents the extent to which network members occupy different positions along the network's value chain. Ghauri et al. (2003) define horizontal networks as cooperative network relationships among manufacturers whereas vertical networks as cooperative relationships between suppliers, producers and buyers.

2.1.2. Main Network Theories

a) **Network Structure:** The network theory suggests that the structure of the network affects the access to information. There are two views arguing this suggestion. Network closure (Coleman, 1990) and structural hole (Burt,1992).

   i. **Network closure**: Network closure Coleman (1990) refers to the *positive effect of cohesive social ties*. In Coleman's (1990) definition of a closed network, members can trust each other to honor obligation, which diminishes the uncertainty of their exchanges and enhances their ability to cooperate in pursuit of their interests. Coordination is improved through repeated exchange among stable members to the group. It declares that the strength of strong ties holds the network together.

ii. **Strength of weak ties:** Granovetter (1973) argues that effective social coordination does not arise from densely and strongly interconnected networks but from the presence of occasional weak ties between individuals who frequently didn't know each other that well. Strong ties are sustainable and long lasting, such as ties of an individual to family members, whereas weak ties are distant and very infrequent (Granovetter, 1973).

iii. **Structural hole:** Structural hole concept is based on strength of weak ties (Granovetter, 1973). As opposed to the network closure, Burt (1992) suggests that it is the *diversity of information and the brokerage opportunities created by the lack of connection between separate cliques in a social network that provide benefits for the actors*. Actors who occupy brokerage positions between cliques have better access to information and enjoy comparative advantages in negotiating relationships, which allow them to know about more opportunities and secure more favorable positions. Conversely, an actor strongly tied to cohesive contacts has little autonomy to negotiate his role in the network.Allen (1977) defined firms with strong connections outside the cluster which contribute also to the diffusion and recombination of external knowledge within the local context as gatekeepers. Zaheer and Bell (2005) found that innovative firms that *also* bridge structural holes get a further performance boost.

Although structural holes and network closure seem contradictory, Zaheer et.al.(2004) found that they were both valuable, but different points in time. These two also can exist at the same time in a network called Small Worlds.

iv. **Small worlds (Milgram, 1967):** In small worlds, contradicting concepts of network closure and structural holes are both satisfied.In a small world network, one contact of a node in a sub-cluster is also the contact of another firm in the same sub-cluster, therefore the knowledge easily flows in the overall network (Watts, 1999). There are sub-clusters which are interconnected with relatively small number of intermediaries.

Therefore, small worlds benefit from both the cohesive ties existent in subclusters and structural holes since there are ties that connect these subclusters.

v. **Social Capital:** Social capital is defined as ‘social networks and relations held together by common norms and values (of which trust is one)’ (Westlund and Kobayshi 2013,p.5). The networks that constitute social capital comprise a rich and dense social community in which the business relationships of the local economy are embedded (Wolfe, 2002). The nature of the social capital can explain knowledge creation and transmission mechanisms (Uzzi, 1997). Maskell and Malmberg (1999: 17) define share-trust as a local capability.

The network structure concepts described above are analysed quantitatively by Social Network Analysis. The SNA measures will be described in the methodology section in Chapter 4.

While the network concepts described above enable to figure out the status of the knowledge flows and strength or weakness of the relationships in the overall network, following concepts rather aim to explain what factors are lying behind the formation and the changes throughout the time in the networks.

b) **Embeddedness:** Refers to the fact that the organizations and the economy is part of a larger institutional structure and the context of organizational action shapes rational choice (Granovetter, 1985). Relational, cognitive and structural embeddedness influence the decision of with whom to build relationships. Gulati and Gargiulo (1999) argue that in relational embeddedness prior direct ties build trust and reduce the uncertainty. In structural embeddedness, if two companies have a common contact, then they can get information about each other from that contact. In cognitive embeddedness, shared beliefs and mental models influence with whom to cooperate or to compete. Geographical embeddedness can also be a factor shaping this decision.

c) **Preferential Attachment:** Means that in scale-free networks nodes link with higher probability to those nodes that already have a larger number of links

(Barabasi and Albert, 1999). Barabasi-Albert also captures the network's time evolution, meaning that as a knowledge network grows, there is a higher probability that a new node connects to the best-connected node in the network.

d) Homophily: Refers to the tendency for nodes to share same attributes with other nodes. It also explains the patterns that the actors cooperate. It suggests that firms tend to cooperate with the actors that they have similar characteristics. (With respect to clusters, while homophily is required to form strong ties, when there is too much homogenity in the cluster such as the same way of thinking, using the same technologies, same products, same markets, and so on, the cluster faces the lock-in risk as explained in network closure.)

2.2. LITERATURE ON KNOWLEDGE SOURCING IN CLUSTERS

Parallel to network literature, cluster literature suggest that knowledge flows is a major factor since it affects learning and innovation. Knowledge flows have been analysed mainly with respect to its spatial levels and the types knowledge sources in innovation studies. The openness of cluster relations and active search for large external markets were one of the main reasons of the successful clusters (Bresnahan et al., 2001). Bathelt et al (2004) have introduced the local buzz and global pipelines concept which suggests that although local knowledge flows are important for the innovation process, in order to complement the knowledge that is not already in the region, extra local linkages play an important role for the innovation (Bathelt et al.,2004). In their concept, local buzz refers to the intra cluster exchange of knowledge wheras the global pipelines are the knowledge exchange with the extra local/regional linkages. A dense local system of interactions might lead to cognitive lock-in and external sources were crucial to avoid or overcome it (Camagni, 1991; Grabher,1993; Asheim and Isaksen,2002; Bathelt et al., 2004). Boschma and Ter Wal (2007) supported this as they found that a strong local network position as well as extra cluster linkages of a firm tended to increase the innovative performance in Italy footwear district.Tödtling et al., (2009) also showed that external and internal knowledge sources both positively related to the innovativeness of companies, durable interactive relationships are important. However, when it came to spatial levels, both regional and international levels of knowledge sources positively affected the innovativeness of firms, however there was no significant values for national sources (Tödtling et al, 2012). In a research (Tödtling et al, 2006) which examined clusters from five sectors in Austria with respect to the spatial levels and types of knowledge sources, the knowledge sources showed unsimilar characteristics in different sectors. For knowledge and innovation based firms, knowledge sources from the region, in particular universities and service firms, were clearly more important than manufacturing firms. High-tech firms combined knowledge sources from the region with those of national and international origin in their innovation process and more fundamental innovations rely on knowledge both from inside and from outside of the firms.

An OECD survey reveals interesting differences of habits of knowledge sourcing between large enterprises and SMEs. In developed countries, large firms are more likely to collaborate than SMEs. Among SMEs the rate of collaboration is between 20% and 40%, whereas for large innovative firms, this rate is more than 70% in the United Kingdom, Austria, Belgium, Finland, Denmark and Slovenia; however the rate was less than a third in Brazil, Mexico and Chile. R&D-active firms tend to collaborate more frequently on innovation than non-R&D-active firms (OECD, 2013). However, among large firms, suppliers played a key role as value chains has become increasingly integrated (OECD, 2013) and that market knowledge was valuable for all types of innovations (Tödtling and Grillitsch, 2012). Collaboration with foreign partners play an important role in the innovation process. This is due to reaching knowledge and resources at lower cost and sharing risks. This collaboration varies from ranging from one-way information flows to highly interactive and formal arrangements.

Cluster literature also reveals that the network knowledge flows change in different knowledge bases (Asheim and Coenen, 2005). Kratke (2010) analysed a synthetic knowledge base and found that that the degree of a firm’s connectivity to the ensemble of regional partners positively affected innovation and also supra-regional connectivity had a relevant impact on innovation output. Martin and

Moodysson (2010) first examined the moving media cluster which had a symbolic knowledge base. They found that geographical proximitywas important for the knowledge transfer. In their following study (2011), they compared the three clusters with different knowledge bases: the life science cluster (analytical knowledge base), the food cluster (synthetic knowledge base), and the moving media cluster (symbolic knowledge base) in the RIS of southern Sweden. Their study showed that knowledge exchange in geographical proximity was especially important for industries that relied on a symbolic or synthetic knowledge base, because the interpretation of the knowledge they dealed with tended to differ between places. This was less the case for industries drawing on an analytical knowledge base, which relied more on scientific knowledge that is codified, abstract and universal and were therefore less sensitive to geographical distance (Martin and Moodysson; 2011).Plum and Hassink (2011) focused on the emerging biotechnology industry in the Aachen Technology Region in Germany which had an analytical knowledge base; they found a relatively balanced local node–global network pattern of knowledge exchange relationships. In their later study (2013) they analysed the knowledge base configuration of automotive clusters by investigating the nature and geography of knowledge sourcing and interactive innovation processes of southwest Saxony's automotive firms. They found weak knowledge relations with universities and science, and international knowledge links which threatened the competitiveness of the companies in the long-term with a possible lock-in (Plum, Hassink; 2013).Kuştepeli et al. (2013) compared two textile related industries in two regions of Turkey (the more developed RIS of Denizli and the organizationally thin and peripheral RIS of Adiyaman). They examined the differences with regards to the knowledge generation and knowledge exploitation processes. Although the two regions hosted industries with identical knowledge bases (synthetic), they were different with respect to the institutional structure that made up their respective RISs. The findings showed that there were significant differences in knowledge-generation and knowledge-exploitation processes between regionally networked and organizationally thin regions, and having the same knowledge bases did not mean that the innovation activities, including knowledge generation, exploitation and sharing, would be similar which requires unique institutional arrangements and policy actions specific to each region.

The study at the EU level, "Constructing Regional Advantage" project covers seven countries from EU and examined the intra-extra knowledge sources and its relationship with innovativeness in these countries. The findings reveal that the sectors with an analytical knowledge bases tend to acquire knowledge also intensively from outside sources, particularly from knowledge organizations. For the sectors with a synthetic knowledge base, innovations were the incremental type, and suppliers and clients are important sources of external knowledge for innovation. Innovation and access to relevant information showed different patterns depending on the regional and country contexts and sector. Finally, different types of innovations are associated with different patterns of firm competencies and knowledge sourcing (Tödtling et al, 2014)

The study of the nature of innovation networks in 10 regional industries found in different parts of Europe demonstrates a multi-scalar nature of knowledge sourcing (Martin, 2013). The 10 regional industries are based on different types of knowledge. Firms in all clusters source knowledge from the regional, national and international levels. However, science-based clusters are dominated by globally configured knowledge networks. Firms in engineering-based clusters exchange knowledge mainly with national and regional partners, while clusters operating in creative industries are dominated by regionalized and localized knowledge networks.

Armatlı-Köroğlu (2005) studied three industrial nodes in Turkey. She found that firm networks differentiated according to the purpose of foundation of networks and there was a direct relationship between innovation activities and firm networks, as well as local networks the global networks were important in the innovation process. The customer and supplier networks were seen as the important knowledge source of innovations and these networks forced the firms to make innovation activities. In the innovation process, linkages with the university were extremely limited. The study exhibits the profile of three important industrial nodes in Turkey and shows how different the types of the relationships are; and the sources of innovation change in different networks.

Morrison (2008) showed that leader firms are well connected with knowledge sources in particular with research centres, laboratories, sectoral associations and universities, Giuliani and Bell (2005), Giuliani (2005,2007) examined the functioning of the intra-cluster knowledge system and its interconnection with extra-cluster knowledge in three wine clusters in Italy and Chile. The results showed that in spite of firms' geographical proximity and the pervasiveness of local business networks, innovation-related knowledge is diffused in a highly selective and uneven way; and it was related to the heterogeneous and asymmetric distribution of firm knowledge bases. Knowledge flowed within a core group of firms characterised by advanced absorptive capacities. This finding is supported by Morrison and Rabellotti (2009), Boschma and Ter Wal (2007) and Graf (2011). Ter Wal and Boschma (2007), examined a cluster from different sector-Italian footwear; Morrison and Rabellotti (2009) examined an Italian wine cluster and Graf (2011) studied the characteristics of gatekeepers in the innovation systems of four East German regions to analyse structural differences.These studies reached the same conclusion in terms of flow of knowledge; knowledge network was unevenly distributed and it was selective (Giuliani, 2005,2007; Ter Wal and Boschma,2007; Morrison and Rabellotti (2009), Graf, 2011). This conclusion was very important in the sense that they shed light to the discussion of whether being in the right place (as clustering literature suggets) or being in the right network matter more for the competitiveness of firms (Castells, 1996).

Studies show that the norms and culture affect the innovative performance; effectiveness of localized networks is related to social capital (Eraydın, Armatli-Köroğlu,2005) and that lack of trust among the firms created a major obstacle for networking activities, which resulted in a knowledge creation and transfer deficiencies (Gülcan et al.,2011).

The research on knowledge sources are illustrated in Table 17.These studies present valuable findings. First, the network structures of the clusters are different both at micro and macro levels. They show differences in terms of the types and spatial levels of knowledge sources depending on the knowledge bases, and the regional and country context including the institutional context.To be more specific, in sectors with a synthetic knowledge base tacit knowledge is more important as compared with the analytical knowledge base.(Asheim and Coenen, 2005; Tödtling et al, 2014), knowledge sourcing from suppliers and clients are important. Geographical proximity is important in knowledge transfer for symbolic and synthetic knowledge bases (Martin and Moodyson, 2011), they exchange knowledge mainly with national and regional partners (Martin, 2013) whereas international knowledge sources and research institutions are more observed in analytical knowledge base (Asheim and Coenen, 2005; Martin and Moodyson, 2011; Plum and Hassink, 2011). Therefore for a precise cluster analysis, it is crucial to identify the knowledge bases, knowledge-generation and knowledge-exploitation processes. Furthermore, as Tödtling and Trippl (2005) suggest, instead of transfer of best practices, the characteristic of the network be analysed. Comprehensive network analysis is essential for each cluster to provide cluster specific implications for policy development.

Second, during the emergence of the clusters, strong ties are important to reach a critical mass, however; too much homogeneity in the world views, technological applications etc. carries the risk of lock-in, therefore in the following stages, these ties had better fed with external linkages. A positive lock-in of strong ties can become negative which leads to decline (Martin and Sunley, 2003). This calls for -although intra cluster relationships are strong- clusters focus on strengthening their extra cluster relations in order to avoid cognitive lock-in (Camagni, 1991; Grabher,1993; Asheim and Isaksen,2002; Bathelt et al., 2004).

The network theories do not only serve cluster and RIS literature by bringing about the analysis knowledge sources but also by bring the dynamic view. The network theories suggest that the networks are dynamic (Barabasi and Albert, 1999), they are subject to change; different type of relationships are valuable, but different points in time (Zaheer et al., 2004), they emerge and go through different ways throughout the time. Network theories have caused research on clusters and RISs to shift towards evolutionary approach which is discussed in the next chapter.

Table 17: Literature on Knowledge Sourcing

Author	**Country**	**Sector**	**Focus of Analysis**	**Main Findings**
Giuliani and Bell (2005), Giulani (2005,2007)	Italy Chile	Wine	Knowledge distribution	1. Uneven network structure (selective rather than pervasive) 2. Knowledge flowed within a core group of firms w/ high absorptive capacities
Morrison and Rabellotti, 2009	Italy	Wine	Knowledge distribution	1. Uneven knowledge distribution 2. Knowledge flows among firms w/high internal competencies
Graf (2011)	Germany	Networks of innovators	Knowledge distribution	Uneven network structure
Ter Wal, Boschma (2007)	Italy	Footwear	1. Knowledge distribution 2. Spatial levels	1. Uneven network structure (selective rather than pervasive), strong local network position of firms affect their innovative performance positively. 2. Spatial proximity is not enough, locally and also non-locally connected matters.
Morrison (2008)	Italy	Furniture	1. Leader firms 2. Spatial levels of knowledge sources (Information and knowledge network seperately)	Leader firms are well connected to knowledge sources (in particular with research centres, laboratories, sectoral associations and universities)
Owen-Smith and Powell (2004)	USA	Biotech.	Characteristics of key members	Geographic propinquity and the institutional characteristics of key members alter the flow of information through a network.

Author	Country	Sector	Focus of Analysis	Main Findings
Kuştepeli et.al (2012)	Turkey	Textile (Synthetic KB)	Effect of knowledge generation & exploitation systems on innovative performance (comparison of a developed RIS vs. organizationally thin& peripheral RIS)	1. Organizationally thin region has lower innovative performance than networked RIS. 2. Institutional frameworks affect innovativeness.
Plum and Hassink (2011)	Germany	Biotechnology (Analytical KB)	Spatial level and type of knowledge sources Spatial proximity	1. Local, regional, national and global sources matter at the same time 2. Spatial proximity has a crucial role in technological knowledge sharing
Plum and Hassink (2013)	Germany	Automotive (Synthetic KB)	Spatial level and type of knowledge sources	1. Multiplicity of knowledge transfers within the region, vertically orientated interactions. 2. Weak relations w/research inst.&international links(lock-in threat)
Martin and Moodysson (2010)	Sweden	Moving media cluster (Symbolic KB)	Spatial level and types of knowledge sources	Geographical proximity is important for knowledge transfer

Author	Country	Sector	Focus of Analysis	Main Findings
Martin and Moodysson (2011)	Sweden	Life sciences (Analytical KB) Food (Synthetic KB) Moving media cluster (Symbolic KB)	Spatial level and types of knowledge sources (Comparison of three knowledge bases)	Geographical proximity is important in knowledge transfer for symbolic and synthetic knowledge bases.
Kratke (2010)	Germany	7 Sectors medium high-medium high technology (Synthtetic & Analytical KBs)	Effect of spatial level of knowledge sources on innovation	1. Regional connectivity decisively matters for innovative capacity, also supra-regional connectivity has impact on innovation. 2. 'Medium-high tech' subsectors showed highest density and cohesion whereas 'high technology'subsectors weak.
Tödtling et al.(2011)	Czech Austria	Software	Knowledge Sourcing patterns Spatial level and type of contacts Innovation Activities Institutional Background Characteristics of RISs (Comparison of two regions)	The RIS with higher density of knowledge and educational organizations, more technology-intensive firms and denser networks perform better in product innovation, the share of new products in turnover and R&D intensity, whereas other RIS focus more on innovations in strategy, organizational structure and marketing.

Author	Country	Sector	Focus of Analysis	Main Findings
Tödtling et al.(2006)	Austria	1. high-tech (HT) 2. Knowledge& innovation based services(KIBS 3. Research firms (R) 4. Traditional 5. Manufacturing (MT)	Spatial levels and types of knowledge sources	1. Knowledge sources from the region, in particular universities and service firms, are clearly more important for KIBS than MT firms. 2. HT firms combine knowledge sources from the region with those of national and international origin in their innovation process. 3. More fundamental innovations, rely on knowledge both from inside and from outside of the firms.
Tödtling et al.(2009)	Austria	Various	Relationship between innovation and external knowledge links of companies	Firms w/ advanced innovating are cooperating more often with universities and research organizations, w/ less advanced innovations rely more on knowledge links with business services.
Tödtling et al.(2012)	Austria	ICT	Spatial levels and intra-extra knowledge sources	1. External and internal knowledge sources both positively related to the innovativeness of companies, durable interactive relationships are important. 2. Both regional and international levels of knowledge sources are positively affect the innovativeness of firms, no significant values for national sources.

Author	Country	Sector	Focus of Analysis	Main Findings
Tödtling et al. (2014)	Germany Czech Sweden Austria Nederlands Norway Turkey	1. Biotech 2. Life Sciences 3. ICT 4. Electronics 5. Space industry 6. Aviation 7. Automotive 8. Mechanical Engineering 9. Food 10. Textile 11. Moving Media (Analytical, Synthetic, and Symbolic KBs)	Spatial levels and intra-extra knowledge sources and its relationship with innovativeness.	1. Sectors with an analytical KB tend to acquire knowledge also intensively from outside sources, particularly from knowledge organizations. 2. Sectors with a synthetic KB external knowledge sourcing from suppliers and clients are important, incremental innovations. 3. Regional and country contexts and sector matter for innovation and access to relevant information. 4. Different types of innovations are associated with different patterns of firm competencies and knowledge sourcing.

CHAPTER THREE
EVOLUTION OF CLUSTERS

Schumpeter suggested that innovation was the reason for the economic change and emergence as well as growth and decline of the industries, he explained it with concepts of creative destruction and the business life cycles (Schumpeter, 1939; 1950). Schumpeter's work inspired many scholars after him, however, the dynamic notion which considered the evolutionary side of the economy was lost until 1990's (Malerba, 2004). After 90's the neo-Schumpeterian view emerged; it left the static view and took the evolutionary approach.

3.1. EVOLUTIONARY ECONOMIC GEOGRAPHY

Evolutionary Economic Geography (EEG) takes the regions and clusters as dynamic structures and suggests that the emergence of certain types of networks is a function of specific knowledge, industrial settings, demand and institutions, and their evolution is the result of the interplay between firms' internal capabilities and technological, social and institutional factors (Kogut, 2000). It suggests that the past influences the future and it aims to explain the changes and its underlying reasons (Boschma and Martin, 2010).

As discussed previously, institutional dimension is an important component of the regional innovation systems. EEG also argues that institutions influence innovation and claims that institutions co-evolve with technologies and industrial dynamics over time; the implementation and diffusion of novelty is mostly dependent on the restructuring of old institutions and the establishment of new institutions (Freeman and Perez, 1988). EEG also aims to explain how networks evolve and -besides other factors- to what extent regional and national institutions influence the network evolution (Bathelt and Glückler, 2003).

EEG reveals that the cluster analysis should take a holistic approach, meaning that instead of taking a snapshot, the periods that the clusters have gone through, the changes occured during these periods and the factors lying behind these changes should be analysed (among others Boschma and Frenken, 2006; Martin and Sunley, 2006).Economic factors that cause a cluster to emerge are not the same as the ones at the later stages (Bresnahan et al., 2001).

In the next section the studies on cluster evolution will be discussed in terms of their findings. In the following section, two approaches on cluster evolution; the life cycle approach and the adaptive cycle approach will be discussed.

3.2. STUDIES ON CLUSTER EVOLUTION

Martin and Sunley (2011) discuss that there are mainly two approaches in cluster evolution literature. The first approach suggests that the cluster evolution depend on the external factors such as theindustry, technology, product or profit life cycle. The second approach, on the other hand suggests that the cluster evolution is driven by the internal characteristics. There is also a third body of literature that take both internal and external factors into consideration. These three views are introduced briefly in this section. In the following, in addition to those views, in this dissertation the cluster evolution studies are examined as the two important factors for innovation: Knowledge sourcing and the network structure and the institutions.

3.2.1. Studies Taking only External Factors into Consideration

This view argues that the life cycle of a cluster is related to the factors outside the cluster, it is in parallel with the industry, technology, product or profit life cycle. Studies in this view showed that clusters were providing economic advantages in the early stages of an industry’s evolution (Audretsch and Feldman, 1996; Van Klink and De Langen, 2001), and as the technology–industry life-cycle matures, cluster advantages have become disadvantages (Baptista and Swann,1998). However, this view was not sufficient to explain the cases where two clusters in the same sector and economy had different paths. Saxenian (1994) showed that while Silicon Valley grew, Route 128 cluster declined due to their cluster specific characteristics (Martin and Sunley, 2011), namely the network structure.

3.2.2. Studies Taking only Internal Factors into Consideration

Cluster evolution studies taking cluster's characteristics into consideration showed that internal characteristics were the determinants of the life cycle, therefore different clusters might go through different life cycles (Pouder and St. John, 1996; Iammarino and McCann, 2006; Maskell and Malmberg, 2007; Bergman, 2007). One strand of this view focused on the firm-level learning, firm heterogeneity and firm capabilities. They showed that firm heterogenity and as well as capability of exploiting the heterogenity was an important factor for cluster growth and transformation (Klepper, 2007; Shin and Hassink, 2011; Elola et al., 2012; Hervas-Oliver and Albors-Garrigos, 2014, Potter and Watts, 2011).

3.2.3. Studies Taking Both Factors into Consideration

In addition to Martin and Sunley's (2011) categorisation, there is also a third body literature which argues that both internal and external factors affect cluster evolution. Cluster evolution is affected by knowledge and history (cluster specific) and policies, demand and competition (external factors) (Brenner, 2004), localised learning, high-heterogeneity of the clusters as well as technological differences and different market environments can impose different challenges on clusters (Mossig and Schieber, 2016), the interrelationships between the dynamics (at technological, market and structural level) should be analysed in combination with strategic decision making (Popp and Wilson, 2007).

3.2.4. Studies on Cluster Evolution and Knowledge Sourcing

As an important cluster specific feature; the network characteristics, their effect on cluster evolution and how they changed through time were also analysed. In summary, literature in this category studied how the networks emerged, affect of proximity on the network's emergence, how the relations in the networks changed in time, the role of specific actors in a specific stage. Owen-Smith and Powell (2004) investigated network structures consisting of biotechnology firms, pharmaceutical corporations, venture capitals, and public research organizations in the United States in time. They analyzed intra-cluster and inter-cluster linkages, and showed that geographic proximity and the institutional characteristics of key members alter the flow of information through a network. Balland (2012) also examined the influence of proximity on the evolution of collaboration networks in the global navigation satellite system industry through 2004-2007. The results of this empirical study showed that geographical, organizational and institutional proximity favoured collaborations, while cognitive and social proximity did not play a significant role. Owen-Smith and Powell's (2004) study was also important to show that the network structure and the actors that are in relation might change throughout cluster evolution. In their case, in the early stages, the firms had more dense relations with public research institutions, however; in the later stages, the relations between the firms got stronger. A more recent study also showed how the structure of a network might change through the cluster's evolution (Li et al., 2011). They examined the aluminium extrusion industry cluster in Dali, Guangdong province, which has developed over a period of 30 years. The early growth was led by few pioneering entrepreneurs and a strong local network which carried the risk of cognitive lock-in. With the change of the political–economic context and the succession of a new generation of entrepreneurs, the cluster experienced deep structural transformations resulting with a new path formation. However, the new structure was different from the beginning phase, close networks among new entrepreneurs were rare. Giuliani (2011) analysed what types of organizational models applied to clusters as they grew by comparing two periods in time of a wine cluster in Chile. The study showed that during the early growth phase of a successful cluster, leading firms working as TG became progressively more popular sources of local learning; they acquired knowledge outside cluster boundaries and contribute to diffusing knowledge to other local firms. This study was very important to show that how the external knowledge was absorbed in the cluster; since external knowledge had a key role on clusters' evolution. This important role is explained by lock-in risk. If the knowledge transfer is only within the intra cluster boundaries, the cluster may have a cognitive lock-in risk; external sources are crucial to avoid or overcome it (Camagni, 1991; Grabher,1993; Asheim and Isaksen,2002; Bathelt et al., 2004). It is argued by many scholars that local buzz and localized learning was important for the emergence of the clusters; and that extra cluster linkages at supra regional, national and at global levels were important. (One exception for this view is that Isaksen's (2009) study in Norwegian clusters. It shows that the national research institutions triggered the knowledge flows in the cluster and supported the emergence of the clusters). Shin and Hassink (2011) analysed the spatial levels of knowledge sources in different life stages of the South Korean shipbuilding cluster. They found that although the intra linkages were more dominant, in the later stages extra-local linkages both at national and international level were strengthened. While linkages at the national level was for expanding the production scales, international linkages were established for acquiring advanced skills, knowledge and technology.

3.2.5. Studies on Cluster Evolution and Institutions

The research provides evidence that institutions and cluster's evolution are related. Inadequate or underdeveloped institutional structure can affect the learning process negatively which causes low innovative performance compared to other clusters in the same sector, hence tackles cluster's development (Kuştepeli et al, 2013); and negatively affects the transformation of the clusters (Hassink, 2010). In these type of structures emergence of high tech clusters is rare and it is with deliberate policy actions (Leibovitz,2004) whereas in RISs with developed structures new cluster emergence is more frequently and spontaneously (Prevezer, 2001). In Norway, research institutions played the main role for the emergence of the six globally-competitive clusters by triggering the knowledge flows (Isaksen, 2009). Another research which is on San Diego Technology cluster, found out that networking and communication opportunities provided by trade associations and research institutions critically enhanced individuals' learning processes by facilitating the formation of learning communities, enabling individuals to participate in communities and promoting interactions of individuals across multiple communities (Kim;2015). It was local authorities who supported the Sophia Antipolis technology cluster in France by an effective advertising strategy at the international level (Ter Wal, 2013) and the emergence of the cluster was due to the policy actors efforts (Longhi, 1999). Other empirical studies support that the governmental institutional context (i.e supporting organisations, policies, regulations, measures and so on) affects the cluster evolution. In Sweden, biogas cluster emerged by the national government's supporting legislation on green technology (Martin and Coenen, 2015). In Korean shipbuilding cluster, government supported the cluster by investing in this sector and also providing information on know-how (Shin and Hassink, 2011). In Norway, the clusters in maritime and gas industries were established by the support of government on these sectors (Isaksen, 2009). As opposed to the examples of positive effect, there can be examples where government's negative attitude affects a cluster's decline (Grabher, 1993). There is interesting example in which government's negative attitude caused a positive outcome. The Seoul film and TV cluster emerged as a reaction towards the national government's regulations on censors against media (Berg, 2014). Having that important role on clusters (directly or indirectly), cluster policies should be designed tailor-made (Tödtling and Tripll, 2005) and by taking a evolutionary view (Boschma and Frenken, 2009). This means, as well as the functioning of the clusters, the stages should be identified and policies and measures should be designed according to the specific needs of the clusters as the profile of a declining cluster is more likely to be different than an emerging cluster's as many cluster evolution studies suggest.

As the above literature suggests, institutional context intensively interacts with the clusters, hence closely related to cluster evolution. Some studies show that cluster evolution affects institutional change, wheras others show that it is the institutional efforts which triggers the clusters evolution either positively or negatively. In fact this cycle goes on, showing that they both influence each other (Martin and Sunley, 2012; Berg and Hassink,2014) and they co-evolve (Maskell and Malmberg, 2007).

Table 18 and 19 summarizes the literature on cluster evolution with respect to knowledge sources, institutions.

Table 18: Literature on Knowledge Sources and Evolution

Author	**Country**	**Sector**	**Finding**
Owen-Smith and Powell (2004)	USA	biotechnology	• Geographic proximity& institutional characteristics of key members alter the flow of information through a network. • Network structure and the actors that are in relation might change throughout cluster evolution
Balland (2012)	France	global navigation satellite system industry	Geographical, organizational and institutional proximity favoured collaborations, while cognitive and social proximity did not play a significant role
Li et al. (2011)	China	aluminium extrusion industry	Network structure changed overtime
Giuliani (2011)	Chile	types of organizational models	In the early growth phase of a successful cluster, TGs became popular sources of local learning
Isaksen (2009)	Norway	Shipbuilding	National research institutions triggered the knowledge flows in the cluster and supported the emergence of the clusters
Shin and Hassink (2011)	South Korea	shipbuilding	İn later stages extra-local linkages both at national and international level were strengthened

Table 19: Literature on Institutions and Evolution

Author	**Country**	**Clusters**	**Finding**
Kuştepeli et al. (2013)	Turkey	İstanbul and Adıyaman Textile Clusters	Inadequate or underdeveloped institutional structure causes low innovative performance, tackles cluster's development
Leibovitz (2004)	Scotland	Biotechnology	In RISs w/ underdeveloped institutional structures emergence of high tech clusters is rare and it is with deliberate policy actions
Prevezer (2001)	USA	Biotechnology	In RISs w/ developed structures new cluster emergence is more frequently and spontaneously
Isaksen (2009)	Norway	6 globally competitive clusters in various sectors	research institutions played the main role for the emergence of the six globally-competitive clusters by triggering the knowledge flows
Kim (2015)	USA	San Diego Technology cluster	Trade associations and research institutions promoted interactions of individuals across multiple communities
Ter Wal (2013)	France	Sophia Antipolis technology cluster	Local authorities supported
Martin and Coenen (2015)	Sweden	Biogas cluster	cluster emerged by the national government's supporting legislation
Shin and Hassink (2011)	South Korea	Shipbuilding cluster	Government supported the cluster by investing in this sector and also providing information on know-how
Isaksen (2009)	Norway	Clusters in maritime and gas industries	Clusters emerged by the support of government on these sectors
Grabher (1993)	Germany	Coal industry	Government policies led to cluster's decline
Berg (2014)	South Korea	Seoul film and TV cluster	Government's negative attitude towards media caused the cluster to emerge

3.2.6. Comments on the Cluster Evolution Studies

Cluster evolution literature is criticized for giving too much focus on the firm heterogeneity and knowledge networks (Martin and Sunley, 2006) and not examining the place-specific factors, the role of human agency, and other factors at regional and higher spatial scales (Trippl, 2015) although these play an important role in the emergence of new clusters (Boschma, 2014a). Malerba (2004) suggests that knowledge bases of an industry also affect the evolution by influencing the specific characteristics of the actors, the type of organization of R&D, the features of the innovative process and of networks, the specific role of the institutions and these in turn might affect the technology, the knowledge base and so on. In addition, the effect of knowledge bases can be applied to the clusters, however; to the best of our knowledge there is no empirical study on how the knowledge base affects clusters' evolution.

3.3. METHODS USED TO ANALYSE THE CLUSTER EVOLUTION

The studies on cluster evolution mainly analysed the clusters by the life cycle approach; however, more recent view of adaptive cycle approach which criticizes the "aging" term and the "same trajectory for all clusters" views suggested in life cycle approach is also gaining attention (Martin and Sunley,2012). In this section, these two approaches will be discussed. By the discussion and comparison of the two methods it is aimed not only to give a comprehensive outlook to the cluster evolution but also to form a ground for this study to identify the stages of the selected clusters.

3.3.1. Life Cycle Approach

This approach defines the stages of the cluster by its age and growth. It finds its roots on previous cyclical approaches such as spatial product life-cycle approach (Vernon, 1966; Cox, 1967, Thompson, 1968; Utterback & Abernathy, 1975), the profit cycle approach (Markusen, 1985), and the industry life-cycle approach

(Audretsch and Feldman, 1996; Klepper, 1997, 2007). Based on this literature, the life cycle approach suggests that the clusters go through the stages; however the names and the number of stages described differ in various studies.These names mostly used in the literature are;

Phase I: Emergence
Phase II: Growth
Phase III: Maturity / Sustainment
Phase IV: Decline
and in some cases;
Phase V: Transformation / Renewal / Rejuvenation

To explain the life cycles of the clusters, in this study the model introduced by Menzel And Fornahl (2010) will be taken as a basis since it is the most organised style of life cycles.

Based on these stages, Menzel and Fornahl (2010) characterize the clusters using the following stages of development:

1. Emergence
2. Growth
3. Sustainment
4. Decline

In their description, transformation and renewal are not defined as stages, they are rather described as the processes while moving from one stage to another.

Phase I: Emerging clusters

At this stage, clusters dymanics are not yet formed as there are only a few enterprises (which are mainly small sized) and despite its small size, there is too much technological heterogenity to form a common ground for local networks and customer-supplier relations. In other words, they don't reach the critical mass yet. It is difficult to identify an emerging cluster; however the clusters at this stage can be distinguished by the existence of one or more companies which have a lasting vision for a new local technology path; and having a strong scientific base or political support to lead the cluster to grow in size. An emerging cluster can either be succesful and go through the growth stage or it can be go towards the opposite direction and disappear.

Phase II: Growing clusters

Main characteristics of this stage is establishment of several specialised suppliers and service firms (mainly as a result of spin-offs or vertical disintegartion of firms), specialized local labor market, the emergence of knowledge spill-overs (Storper and Walker, 1998). At this stage, firms benefit from the knowledge networks. Specific cluster organisations are established and/or exisiting ones adapt themselves in accordance with the cluster needs. The growing stage ends when the growth of a cluster adjusts to the industry average and the cluster arrives at the sustaining stage (Pouder and St. John, 1996).

Phase III: Mature or Sustaining clusters

The main characteristic of this stage is the development of supporting informal institutions or social capital which are formed in time. Social capital facilitate the formation of the knowledge networks. Knowledge flows brings collective learning which is an important factor for innovativeness. At this stage, clusters are organizationally rich which means endowed with efficient and appropriate institutional structure (Tödtling and Trippl, 2005).

However, as the literature shows in case of dense networks, the linkages between the actors become inflexible (Grabher, 1993) which causes lock-ins. In this case, if there is no new technology or knowledge comes to the cluster from external sources, this stage leads to decline (Bathelt et al., 2004). In other case, clusters transform (renewal or rejuvenation) to survive. However, this causes a crisis in the cluster and therefore comes after a stage of decline (Martin and Sunley, 2006; Altenburg and Meyer-Stamer,1999).

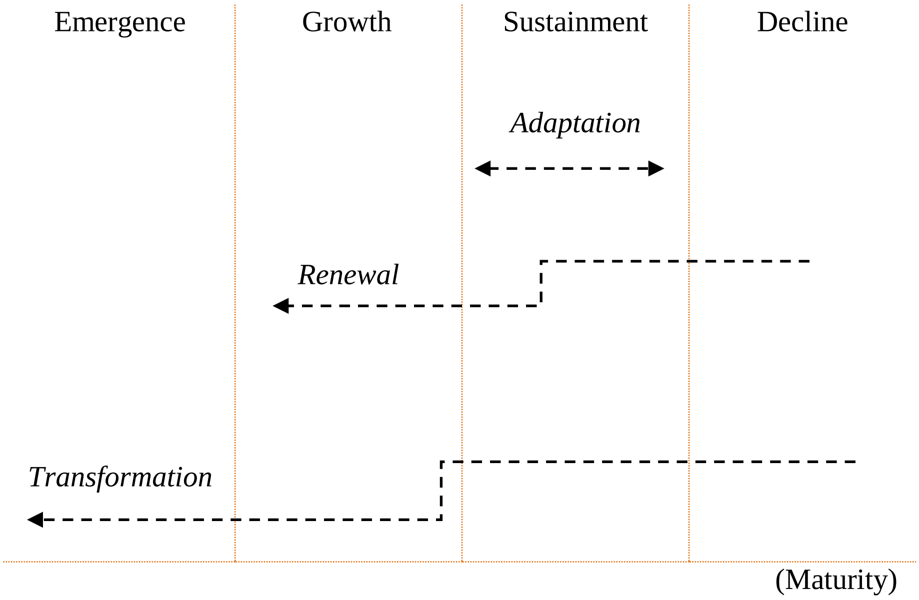
Phase IV: Declining clusters

Menzehl and Fornahl (2010) describe the declining clusters as the ones which has lost its ability to sustain its diversity, to adjust to changing conditions, the decrease in the number of companies and employees is mainly obeserved. They suggest that although they still have the potential, if they don't renew themselves, they diminish. However, they can also survive by turning their direction towards new but related technologies or by going into completely different fields by the integration of the new actors; therefore the life trajectory of a cluster is not a straight line from emergence to decline, there are different possible directions (among others, Pouder and St. John, 1996; Iammarino and McCann, 2006; Maskell and Malmberg, 2007, Bergman, 2007).

As can be seen in the description of the stages, like in other life-cycle studies, this classification of cluster evolution also the main focus is on the heterogenity of the firms and knowledge networks.

The trajectories that the clusters might take and the hetergoneoity of the accessible knowledge through the stages are illustrated in Figure 16.

Figure 16: Cluster Life Cycles



Source: Menzehl and Fornahl, 2010

Menzehl and Fornahl (2010) assess the life cycles from qualitative and quantiative aspects. Quantitative dimension includes the size (i.e. number of actors, organizations and employees) and the utilization of the size (i.e. perception of the cluster, capacity for collective action), whereas qualitative dimension includes diversity (knowledge, competencies and organizational forms) and utilization of the diversity (exploitation of synergies, networks and value chains). Their argument can be criticised by one aspect that they argue that sustaining clusters have open networks and firms enjoy synergy and external knowledge. Although this is an ideal case, as discussed in literature, the networks in mature or sustaining clusters are often dense meaning that there are strong ties within the cluster which may cause cognitive homogeneity and hamper innovativeness. In some cases clusters feed themselves with external knowledge, however they might not achieve to do so (which will lead the cluster to decline). Therefore, in this study, the original table proposed by Menzel and Fornahl (2010) was revised accordingly. The main characteristic of each stage is summarized in Table 20.

Although it has brought a new dimension to cluster analysis and provided a ground for understanding the clusters;life-cycle analogy is criticised by Martin and Sunley (2011). They argue that life-cycle analogy itself is not the appropriate metaphor for clusters since it implies an aging process and it suggests that it limits the evolution of the clusters to only a set ofstages. By doing so, they introduce a new approach called Adaptive Cycle Model (Martin and Sunley, 2011).

Table 20: Main Characteristics of the Life Stages

Stages/Phases	Main Characteristics of the Clusters	
	Quantitative Aspect	**Qualitative Aspect**
Emergence	• *Size of the cluster*: Few companies and employees	• *Diversityof knowledge, competencies, organizational forms:* Quite heterogeneous
	• *Utilization of the cluster size*: Hardly perceivable as a cluster, few possibilities for collective action	• *Utilization of the diversity:* Scarce possibilities for interaction
Growth	• *Size of the cluster:* Increasing employment	• *Diversityof knowledge, competencies, organizational forms:* Focusing
	• *Utilization of the cluster size*: Growing perception, collective actions, institution building	• *Utilization of the diversity:* Open and flexible networks
Sustainment	• *Size of the cluster:* Stagnation	• *Diversityof knowledge, competencies, organizational forms:* Focused competencies, strong regional bias
	• *Utilization of the cluster size:* The cluster shapes the region	• *Utilization of the diversity:* Strong and dense network (In case of no external knowledge flow, head to decline)
Decline	• *Size of the cluster*: Decline in number of companies and in employment	• *Diversityof knowledge, competencies, organizational forms:* Strong focus on a narrow trajectory
	• *Utilization of the cluster size*: Negative sentiments regarding the cluster	• *Utilization of the diversity:* Closed networks impede adaptability of the cluster

Source: Menzel and Fornahl, 2010

3.3.2. Adaptive Cycle Model

Adaptive Cycle Model (Martin and Sunley, 2011) also argues that cluster evolution should not be separated from its components- firms and related organizations. The heterogeneity of firms and firm dynamics affect the developmentof the clusters (Popp and Wilson, 2007; Bergman, 2007). Furthermore, based on dynamic network theories, they suggest that clusters are complex systems whose population (therefore the behavior and acts of the cluster) as well as the technology, products might change in time. Hence the clusters are not deterministic, predictable and mechanistic (Folke, 2006); therefore it will be misleading to conclude that all the clusters will follow the same life-cycles. Such as life-cycle approach, this view also names the phases similarly (emergence, growth, maturity, decline, renewal, and so on). However where they depart from LCL approach is thatLCL suggests thatclusters go through stages emergence, growth, maturity/sustainment, (Menzehl and Fornahl suggest that if they can adapt to changes then they stay in sustainment) anddecline and they might take different routes after decline (such as transformation, renewal, rejuvenation) whereas adaptive cycle approach proposes that there are numerous possible routes that a cluster can go and classify the possible trajectories. They modify the classical adaptive cycle model (Holling, 1986) to explain these trajectories which are given below:

The first possible trajectory is the cluster full adaptive life cycle. In this trajectory, clusters follow the route of emergence, growth, maturation, decline and finally the replaced by a new cluster which was built on the resources and capabilities inherited from the old cluster.

Second alternative constant cluster mutation in which clusters go through the emergence and growth phases and constantly changes itself structurally (such as industrial specialization) and technologically. Cluster has high degree of resilience. Cluster firms are able to innovate continuously.

Third possible route is stabilisation. Clusters go through emergence, growth and maturation and stabilisation. Although cluster declines, the remaining firms will upgrade products or find niche market segments. However, the cluster will still be vulnerable to decline.

Cluster re-orientation is the fourth alternative route. It represents the renewal, replacement of the existing cluster or new cluster emergence. Nearing or after maturation or in the early cluster decline phases clusters can might take this route.

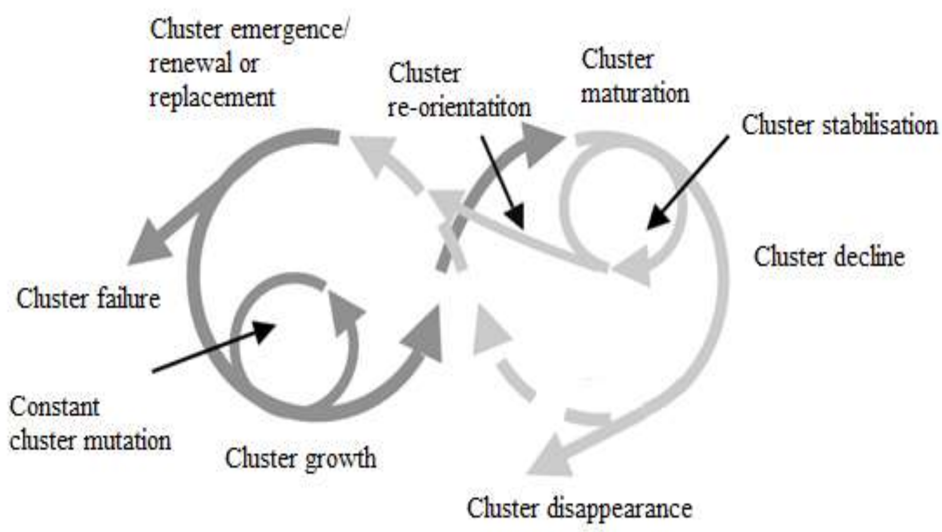
Fifth possibility is the cluster failure. When the emergent cluster fails to reach critical mass, externalities or market share in other words when it cannot achieve to grow, it disappears.

Finally, the clusters can take the route of cluster disappearance. Differently form the cluster failure, clusters decline after taking the routes of emergence, growth and maturation. This is also called the classical life-cycle.

Therefore its another distinction from the life cycle model is that it introduces the constant cluster mutation (where clusters mutate before they go into decline stage) and cluster stabilisation. Adaptive cycles is illustrated in Figure 17.

This model assumes that after maturity phase, clusters decline, only some firms can go to stabilisation stage, and after stabilisation and decline clusters go through re-orientation. However, as the authors suggest the trajectories can take numerous possibilities (Martin and Sunley, 2012), therefore cluster constant mutationcan also be observed in the maturity stage. (In their own argument they also state that they suspect whether there is one model that is applicable to all the clusters.)

Figure 17: Adaptive Cycles



Source: Martin and Sunley, 2011

Both models have their limitations. Life cycle approach proposes a few possible trajectories; however affected by too many factors and having a dynamic characteristics as the network theories suggest, there can be many possible alternatives as the adaptive life cycle models suggest. On the other hand, adaptive life cycle model does not describe the stages. Therefore in this study, the phases of the clusters were determined as the life cycle approach suggests (Table 20); however; in the conclusion part while making comments on the clusters future trajectory dynamic aspect of the adaptive cycle model was taken into consideration.

CHAPTER FOUR
AN APPLICATION ON THE KNOWLEDGE SOURCING, INSTITUTIONS AND INNOVATIVE PERFORMANCE OF CLUSTERS

4.1. CONCEPTUAL BACKGROUND

Innovation has become a priority topic both for governments and for the companies. This is mainly due to the effect of innovation and technological advances on the economic growth. From Schumpeter (1946) on the relationship of innovation and economic growth is explained by various models. Innovativeness has been seen as an important factor supporting the regional development and increasing the competitive capacity of regions also (Armatlı, 2005). Various territorial models of innovation are introduced in literature. Among these, clustering has become a key concept for policy-makers as a tool for promoting regional growth and competitiveness (Martin and Sunley, 2003). Regional Innovation Systems concept relates innovation with the regional context with a larger scope. Clusters are included as an important component of an RIS, an RIS may host several sectors and clusters (Asheim and Coenen, 2005). Embedded into the RIS, a cluster cannot be analysed isolatedly; the characteristic of specific RIS that the cluster locates in has to be included in the analysis.

RIS concept suggests that the innovation processes are systemic at the regional level (Cooke, 1992) and the region is a network (Cooke 1997; Cooke and Morgan, 1998) which is composed of firms, and supporting institutional context (supporting organisations) and that the learning takes place through the interaction of the actors. This suggestion emphasizes two important components in RISs: institutions and knowledge sources.

4.1.1. Institutions

Institutional thickness is considered as one of the main success factors for innovation and development. Amin and Thrift (1994), in their seminal work, explains that the institutional thickness is associated with four factors: a strong local institutional presence, high levels of interaction with and among these institutions, a structure of domination and a mutual awareness of being involved in a common enterprise which result in developing and dependingon a common agenda.

The “systems concept” where RIS has its roots refers to the set of institutions and the interactions among these institutions determine the innovative performance (among others; Nelson and Rosenberg, 1993; Freeman, 1987; Cooke, 1992). Also, in the revised definition of clusters (by Porter, 1998a), the interaction with the institutions is emphasized. Definition of the RIS includes economical, political and institutional relationships (Cooke, 1998). RIS gives great importance to the institutions since learning, thus innovative performance can be improved through certain institutional changes and properly designed active policies (Cooke et al.1997; Cooke, 2001). The vital importance of “knowledge generation and diffusion subsystem” stems from the fact that knowledge and skills are produced by public research organisations, educational institutions (e.g. universities, vocational training institutions and so on), workforce mediating organizations and technology mediating organizations (e.g. technology licensing offices, innovation centres, and so on) (Tödtling and Trippl, 2005). For innovative performance, it is at utmost importance that the two subsystems should have intensive interaction which will facilitate the exchange of knowledge, resources and human capital.

Besides these two subsytems, policy actors to design and implement the innovation policies at the regional, international or EU level are important actors since they have direct and indirect influence on clusters and regional development by means of policy actions and measures. All these suggestions emphasize that a cluster within an RIS is not an isolated formation from the institutional context of an RIS.

The studies examining the relationship between institutional context and innovative performance reveal that the clusters benefit from a stronger institutional context whereas a weak institutional context hampers the innovative performance (Tödtling and Trippl, 2005; Kuştepeli, 2013; Isaksen and Trippl, 2014).

In summary, over the last two decades, institutional context and its effect on innovation and regional development has been an important topic of study. Empirical studies support the theory, suggesting that the institutional context is a key factor to the innovative performance of the clusters and RISs. In this research, institutional context is included as a factor to predict innovation and have been analysed in the light of Amin and Thrift's (1994) institutional thickness concept which refers to presence of variety of organisations, levels of interaction, structure of dominance and a mutual awareness.

Evolutionary Economic Geography which brings time perspective to clusters and RISs argues that institutions influence innovation and claims that institutions co-evolve with technologies and industrial dynamics over time; the implementation and diffusion of novelty is mostly dependent on the restructuring of old institutions and the establishment of new institutions (Freeman and Perez, 1988). The research provides evidence that institutions and cluster's evolution are related. Inadequate or underdeveloped institutional structure can affect the learning process negatively which causes low innovative performance compared to other clusters in the same sector, hence tackles cluster's development (Kuştepeli et al, 2013); and negatively affects the transformation of the clusters (Hassink, 2010). Literature suggests that institutional context intensively interacts with the clusters, hence closely related to cluster evolution. Some studies show that cluster evolution affects institutional change, wheras others show that it is the institutional efforts which triggers the clusters evolution either positively or negatively. Cluster evolution and institutional context influence each other (Martin and Sunley, 2012; Berg and Hassink,2014) and they co-evolve (Maskell and Malmberg, 2007).

4.1.2. Knowledge Sources

In today's world, innovation is no longer seen as an isolated effort, it is rather a collective process where learning and knowledge takes place (Lundvall, 1992; Nelson, 1992, Cooke, 1992,1997; Powell et al., 1996). Companies form a network where they have linkages and share knowledge. Network theories suggest that the network structure affects access to information, this have caused knowledge sources in clusters and RISs and their relationship with innovation to be analysed from different perspectives such as their spatial levels and types.

Studies on specific knowledge bases revealed that both the types and spatial levels which influence innovation may differ depending on the knowledge bases. In analytical knowledge bases where scientific knowledge is more important (Asheim and Coenen, 2005; Tödtling et al, 2014) and innovation is in STI mode, more close ties with R&D related institutions are observed, furthermore external knowledge sources are more effective on innovation (Asheim and Coenen, 2005; Martin and Moodyson, 2011; Plum and Hassink, 2011). On the other hand, in synthtetic and symbolic knowledge bases where tacit knowledge is important and innovation is mostly in DUI mode, geographical proximity of knowledge sources is important (Martin and Moodyson, 2011), and customers and suppliers are more important knowledge sources.

Spatial levels and types of knowledge sources that are influential on innovation vary not only based on the knowledge bases but also different spatial levels of the knowledge can be required for different types of innovation (Tödtling, 2009).

Literature on knowledge sources also shows that knowledge networks are unevenly distributed and selective (Giuliani, 2005; 2007; Ter Wal and Boschma, 2007; Morrison and Rabellotti, 2009; Graf, 2011). This finding is very important for two reasons; first it reveals that it is not in the air –as Marshall put it- and second, for the innovative performance just being in the same location is not enough, it is important which sources the companies share knowledge (Castells, 1996).

Network theories also suggest that the networks are dynamic, they are subject to change; they emerge and go through different ways throughout time (Barabasi and Albert, 1999). In different cluster life stages different types and spatial levels of knowledge sources are required. Strong ties within a cluster is almost obligatory to form a cluster and for knowledge spillovers, however; when the cluster goes through further stages of growth and maturity, in case of too strong networks where knowledge sourcing is only within the cluster (closed networks), homophily (similarity of way of thinking, beliefs, etc. among the cluster members) causes negative lock-ins where no new ideas are formed. Homophily hampers innovation; for novelty, knowledge transfer from external sources becomes inevitable (Camagni, 1991; Grabher,1993; Asheim and Isaksen,2002; Bathelt et al., 2004). Especially clusters in maturity/sustainment stage are most likely to be under the lock-in threat.

This example shows that the knowledge sourcing provides clues on the evolution of the cluster (Martin and Sunley, 2003).

4.2. OBJECTIVE OF THE RESEARCH

Literature review on clusters and RISs shows that studies have analysed the knowledge sources, institutions and their relationship with innovation in different knowledge bases, however; these studies analyse only one point in time, The dynamic view suggests that the clusters change in time, they show different characteristics throughout their evolution. However there is no such study analysing how the knowledge sources and institutions change throughout the evolution of the clusters in a specific knowledge base.

This leads us to the research question of

What are the role of institutions and knowledge sources for cluster firms' innovation performances in different cluster life stages and how do they change throughout cluster evolution in specific knowledge bases?

Based on the above research question, this study aims to identify the types and spatial levels of knowledge sources and the types of institutions that influence innovation in different cluster life stages.

The study is original in the sense that it analyses and compares two cluster life stages in terms of knowledge sources and institutional context and their relation to innovative performance in a synthetic knowledge base and examine the differences between the two life stages. It includes different factors such as their network structure, knowledge sources (both spatial levels and types) and institutions to explain innovative performance throughout cluster's evolution.

4.3. HYPOTHESIS

Literature on clusters and RISs suggests that the type and spatial level of knowledge sources and institutions influence innovation. Therefore we draw the following hypothesis:

H_1: Knowledge sources influence innovative performance.

H_2: Institutions influence innovative performance.

Network theory suggests that the networks are dynamic and therefore they change in time (Barabasi and Albert, 1999) and different types of network ties are valuable at different different points in time (Zaheer et.al., 2004). This leads us to the second hypotheses:

H_3: The types and the spatial levels of the knowledge sources which influence cluster firms' innovative performance differ throughout evolution of the cluster.

Based on the dynamic feature of the networks, we argue that the characteristic of the cluster changes through different life stages, as the clusters evolve the needs of cluster firms and therefore the support for cluster development should also change. This leads us to the third hypotheses:

H_4: The type of institutions which influence the cluster firms' innovative performance differ throughout evolution of the cluster.

4.4. RESEARCH MODEL

Drawing on the first two hypothesis, to predict innovative performance with knowledge sources and institutions and identify what the type and spatial level of knowledge sources and type of institutions in different cluster life stages, a multivariate model is formed. In the model, the dependent variable is the innovative performance of the companies, knowledge sources and institutions are the independent variables whereas the cluster stage is the control variable. The variables of the model are explained below.

4.4.1. Dependent Variable

Innovation performance is the dependent variable. Four types of innovation are included in this research: a. new product b. new process, c. new marketing strategy d. new organisational strategy. While making the classification of innovative performance, two criteria were applied.

First criteria is the degree of the innovation. The companies are classified as “has created an innovation”, “applying an existing innovation to the company”, and finally “neither created nor applied innovation”. It would be misleading to classify the companies only in two categories such as innovative and not-innovative since a company as the one which has created innovation is more innovative than the one which applied an existing method.

In order to tackle these problems, three ordered category was used. These categories are;

1)High

2)Medium

3)Low innovative performance

Second criterion is the method of making an innovation. This criteria aims to distinguish whether the company makes R&D efforts. In some cases, a company which is a subcontractor might declare that it had a product or process new to the Turkish market but this firm might have not put any R&D effort for this product/process. This means that it received all the specs of the main contractor firm, the subcontracting company is only the manufacturer this new product. Therefore, firms were classified according to the main method that was used. These methods are;

1.Product specifications and know- how are received from the main contractor.

2.The firm makes R&D when we receive a demand from the customers.

3. The R&D efforts are made systematically in the light of the information received by R&D department/personnel or marketing-sales department.

Using the above mentioned criteria, the innovation categorisation is made as follows:

1) High innovation performance: If the company has patent or has applied for it in the last three years and/or made a technological innovation and/or non-technological innovation new to the market.

2) Medium innovation performance: If the firm has innovation new to the firm (in terms of technological or non technological innovation.) and has a R&D method 2 or 3.

3) Low innovation performance: If the firm has neither technological nor non-technological innovation or the firm uses R&D method 1.

4.4.2. Independent Variables

Independent variables of the model are; a) type of knowledge sources, b)spatial level of knowledge sources and c) types of institutions

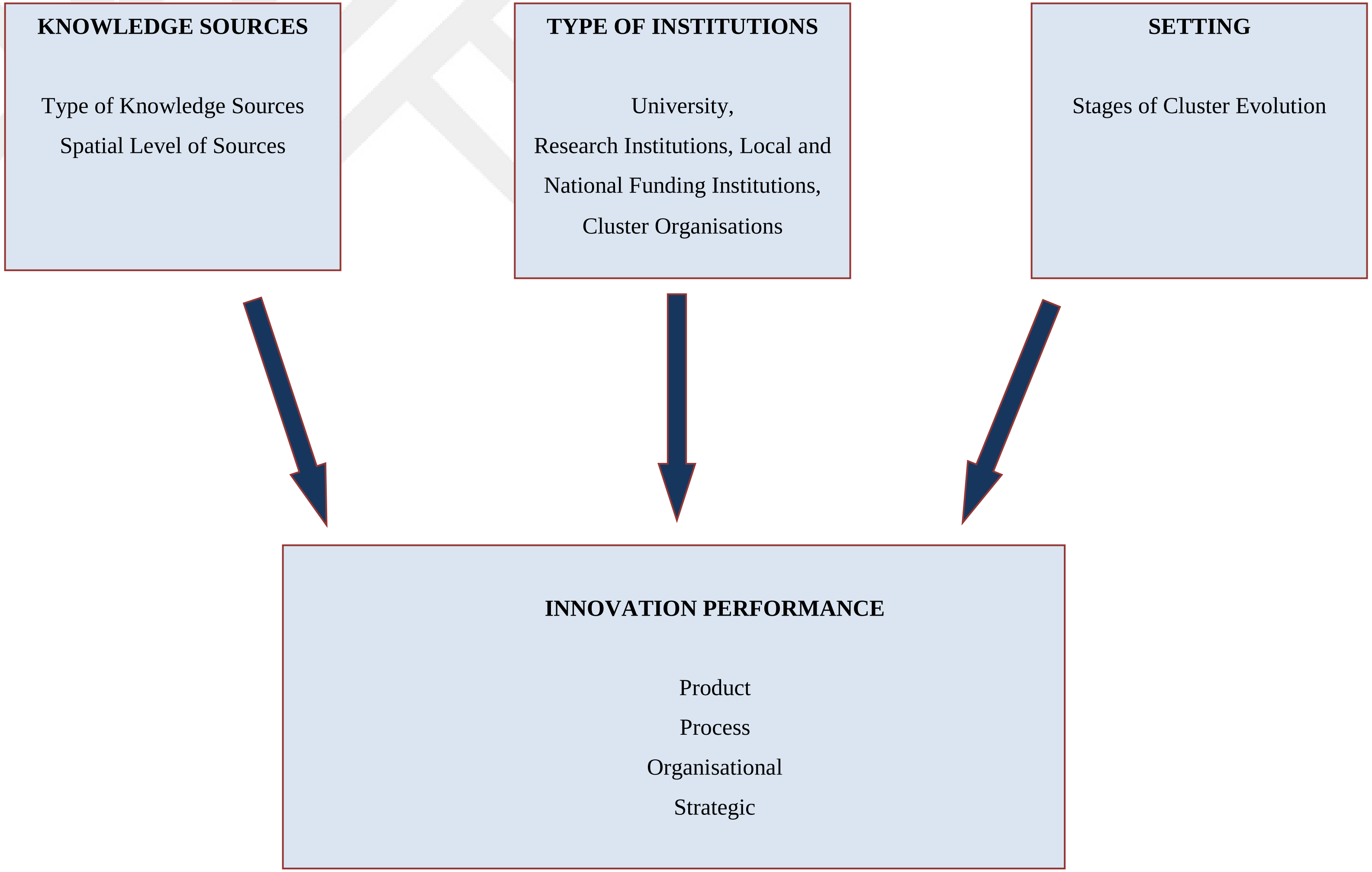
a) Type of knowledge sources: Type of knowledge sources were categorised as “customer”, “supplier” and “other” (competitor or other). (Institutions are not included here since it is assessed as a separate independent variable.) Three indicators were taken: average importance of each category, number of sources in each category and share of each category.

b) Spatial level of knowledge sources: Spatial level of knowledge sources were categorised as “local/regional”, “national” and “international”. As in the type of knowledge sources, the indicators of this variable are taken as average importance of each category, number of sources in each category and share of each category.

c) Types of institutions: Cooperation with university, research institutions, local and national funding institutions and cluster initiatives types of institutions is taken as the indicator of this variable.

The model is shown in the below figure 18:

Figure 18: The Research Model



4.5. RESEARCH METHODOLOGY

4.5.1. The Sample

Since the research aims to examine the differences or similarities in different cluster life stages in terms of knowledge sources and the institutions affecting the innovative performance, the research was applied on two clusters in different life stages. One of the clusters is Industrial Ventilating, Climatization and Refrigeration (IVAC-R) Cluster in İzmir. This cluster was chosen as it represents a good practice of clustering in Turkey. Although the clustering projects had officially started in 2008, the collective efforts date back to 1990s. Furthermore, the cluster is managed by the cluster organisation (ESSIAD) and roadmap drawn in the clustering project has being implemented actively by the cluster organisation. The cluster is in maturity (sustainment) stage and it has a synthetic knowledge base.

In choosing the other sample cluster, two criteria were considered. First, -since the knowledge base characteristic has a dominant effect on clusters' learning and innovation processes-, in order to avoid differences stemming from knowledge bases in the analysis, the cluster having the identical knowledge base with the IVAC-R cluster was chosen. The other criterion was having a different cluster life stage. Machinery Cluster in Denizli was chosen as the second sample cluster since it meets both criteria; the cluster has a synthetic knowledge base and it is in emergence stage.

Profiles of the clusters are described below in more detail.

4.5.1.1. Industrial Ventilating, Climatization and Refrigeration Cluster

Izmir where IVAC-R Cluster is located in ranks 4th with a share of 5% in terms of number of industrial companies in Turkey, and has the largest share of 37% in Aegean Region. HVAC-R sector has an important share in Izmir's economy and the same sector in Turkey (IZKA, 2010). As of 2008, Izmir HVAC-R sector has 2050 companies. Total employment of the companies is 16.550; and its export totals to USD 94,697,754. In the same period, the share of Izmir HVAC-R sector in the

HVAC-R sector in Turkey in terms of number of companies, employment, export is 17%, 12.33%, 6.88% respectively (IZKA,2010).

The Development of Clustering Strategy Project in Izmir conducted by IZKA shows that the HVAC-R sector in Izmir has a sectoral concentration with respect to the rest of the sector in Turkey (see Table 21); there is a sectoral specialization (IZKA, 2010). Within the scope of same project, HVAC-R sector was identified by Izmir Development Agency as having the highest clustering potential. In parallel to this project, in 2009 the roadmap of HVAC-R sector has been set with the field study and workshops performed and the cluster was named as Industrial Ventilating, Climatization and Refrigeration Cluster (IVAC-R).

Table 21: Main Figures of Izmir HVAC-R sector and its share in the Overall Sector in Turkey

	HVAC-R Izmir	Share in HVAC-R Turkey
Number of companies	2.050	17,00%
Employment	16.550	12,33%
Export (USD)	94.697.754	6,88%

Source: İZKA, 2010.

The cluster organization[3] is Association of The Aegean Industrialists and Businessman of Refrigeration (ESSIAD). The association was established in 1990; this shows that the cluster initiatives[4] has started long before the IZKA clustering project. There are 85 members of the association.

Cluster members act together to achieve the activities in the roadmap and pursue common goals. The roadmap drawn in 2010 has being implemented with several projects. One of these activities is the National Accredited Test and Analysis Laboratory. The laboratory which is the first one in Turkey in its sector is in the preparation phase. The cluster also participates in a common UR-GE Project funded by T.R. Ministry of Economy to increase the export capacity of the cluster members.

[3]Cluster organisations are the legal entities that support the strengthening of collaboration, networking and learning in innovation clusters and act as innovation support providers by providing or channelling specialised and customised business support services to stimulate innovation activities (EC, 2016).
[4]Cluster initiatives are organised efforts to support the competitiveness of a cluster and thus consist of practical actions related to the capacity of these clusters to self-organise and increasingly to pro-actively shape the future of the cluster (EC, 2016).

44 companies has joined the project. Within this project, following a thorough needs analysis, technical and commercial training and consultancy activities were carried out, which aim the development of the technical capacity of the companies, ensuring the penetration to the new markets and managing the common infrastructure. In addition a new project is run by IZKA for the development of the cluster. The project aims to benchmark the world leader Italian HVAC-R sector and discuss the cooperation possibilities.

The cluster consists of mainly 6 subsectors namely, Central Airconditioning, Ventilation Manufacturers, Industrial Refrigeration Manufacturers, Vehicle Airconditing and Refrigerator Manufacturers, Showcase, Ice Cream and Market Case Manufacturers, Project Design, Installation and Engineering Firms, Cold Storage House Manufacturers. The cluster map is given in Figure 19.

The members of the cluster organisation is selected as the sample. The main reasons are; in addition to having an important position in Izmir's economy and the total HVAC-R sector in Turkey, the cluster is an actively operating cluster and the clustering initative is high.

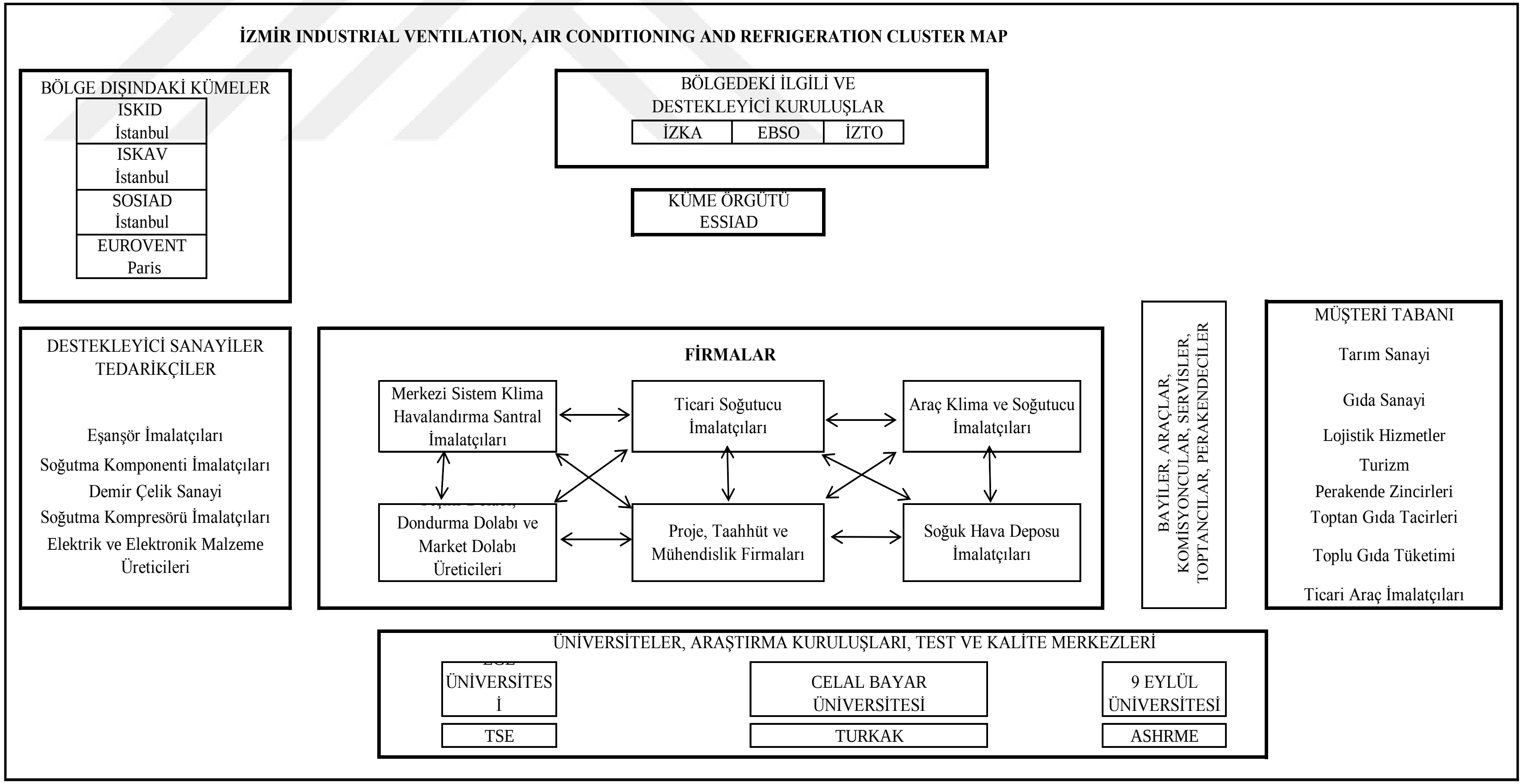
Institutional Context

Izmir has a very rich potential of institutional context. There are 6 universities and 3 technoparks. Izmir Development Agency is working actively by conducting needs analysis, preparing development plans for Izmir and drawing roadmaps in several topics including clustering,innovation,energy,etc. KOSGEB Provincial Directorate provides funds for SMEs.

Other institutions related to IVAC-R sector are Aegean Region Chamber of Industry, Izmir Chamber of Commerce, Air Conditioning Sectoral Exporter's Union (in Ankara). Cluster companies have their product test in Turkish Accreditation Agency (TURKAK), Turkish Standards Instıtution (TSE) and Eurovent. Due to the high costs and long waiting times of the testing and accreditation period, the cluster firms is currently establishing the testing laboratory in Izmir which was mentioned above.

As per the specific barriers classification (Tödtling, Trippl, 2005) IVAC-R cluster can be categorised as in an "old industrial region" due to the following reasons. The region is specialised in a mature industry, the R&D activities have an incremental nature. The region has well developed subsystems and clustering is strong (which may bring the RIS failures since it causes lock-ins).

Figure 19:IVAC-R Cluster Map



Source: Zobu et al.,2010

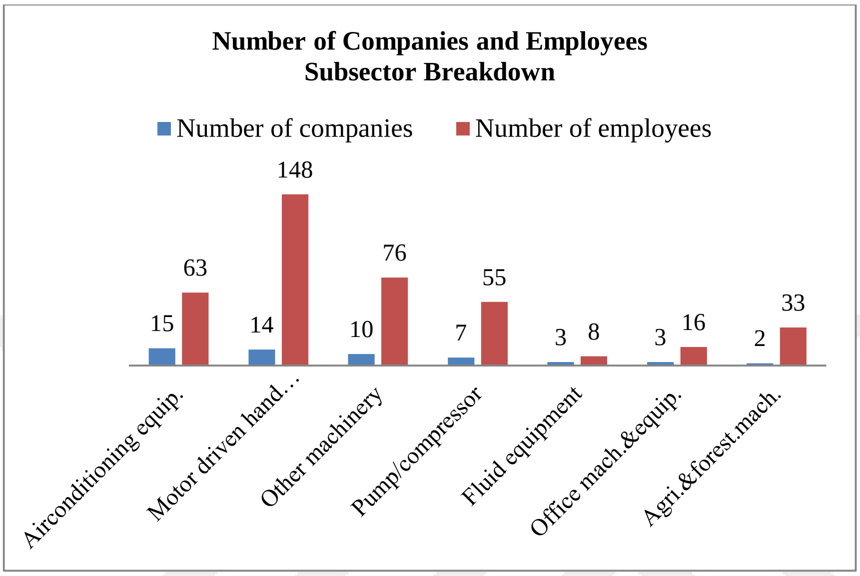
4.5.1.2. Denizli Machinery Cluster

In terms of number of industrial companies Denizli is 7th with 3% in Turkey and a share of 18% in the Aegean Region (T.R. Ministry of Science, Industry and Technology, 2012).There are 27.501 registered private companies in Denizli (TEPAV, 2014). Out of these, 1319 companies are industrial firms registered in Denizli Chamber of Industry (Denizli Chamber of Industry, 2014). The share of main sectors in the overall is 45% textile manfuacturing, 12% food manufacturing, 8% mine and stone quarries, 8% machinery, equipment and main metal industry (5% machinery and equipment production, 3% main metal industry) (Denizli Chamber of Industry, 2014).

The first machinery manufacturers of Denizli were established in 1950-1960's. During 1973-1977 metal goods manufacturing has developed; the companies which were established in metal goods sector constitutes 36,3% of the total companies established in Denizli. During the Fifth Five-Year Development Plan Period 1978-1984, 60 new companies were established in which 13,2% is in metal goods and 6,7% is metal industry sectors. After Denizli the crisis in 1999 in the textile sector, the investments in Denizli have diversified and machinery sector has become an attractive sector in Denizli.

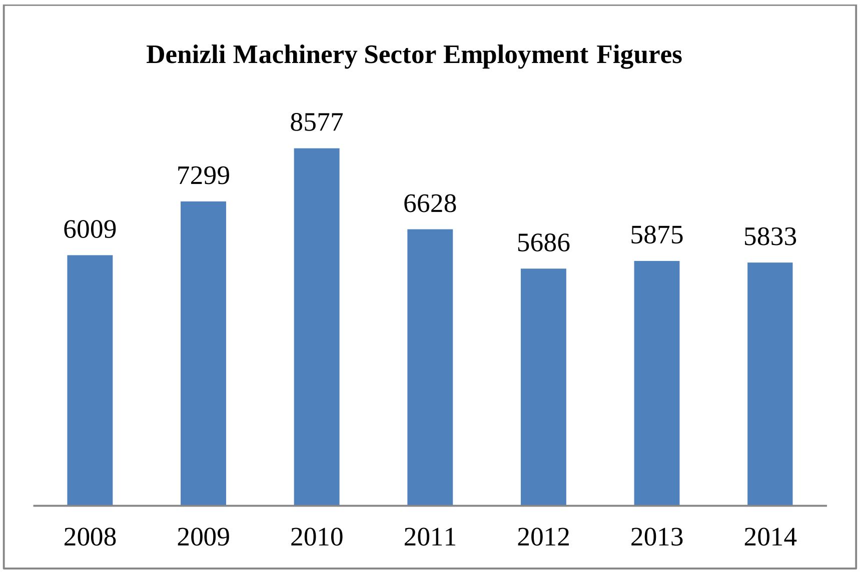
There are 54 manufacturing companies operating in the machinery sector. Airconditioning equipment and motor-driven hand tools manufacturers have a prominent share; they constitute the ½ of the overall sector (Figure 20). The sector is supplier of mainly the machinery sector; however in recent years, it also meets the demands of main industry sectors of Denizli such as textile, food, cable, and other (marble, wood, fire engine) (Table 22). In the cluster, in addition to 54 main manufacturing companies, 46 supplier/machinery and sub-industry manufacturing companies exist (Denizli Chamber of Industry, 2014). Although from 2008 to 2010 there had been an increase in the employment figures, after 2010 this number had falled reaching to 5833 in 2014 3,3% of overall Denizli employment figures (Figure 22). The number of companies and the empoyment figures as per subsector breakdown is illustrated in Figure 21.In 2013, the sector has a total of 30.843.000 USD export to 67 countries (Table 23). The exports are mainly to Iran, Azerbaijan, Iraq, Saudi Arabia and other Arab countries. The export to EU countries has 13% share in the overall exports.

Figure 20: Number of Companies and Employees As Per Subsector



Source: Denizli Chamber of Industry, 2014

Figure 21: Denizli Machinery Sector Employment Figures



Source: Denizli Chamber of Industry, 2014

Institutional Context

The main institutions related Denizli Machinery Cluster include Denizli Chamber of Industry, Denizli Chamber of Commerce, Denizli Organised Industrial Zone, Denizli Free Trade Zone, Pamukkale University, Pamukkale Technopolis,

Table 22: Machinery Cluster Customer Base (as per share in overall sales)

Sector	Share
Machinery&Equipment Manufaturers	13,88%
Metal Goods Manufacturers	11,96%
Main Metal Industry (Rolling mills, etc.)	11,48%
Food&Drink Producers	9,09%
Textile Manufacturers	8,13%
Construction	8,13%
Electric Machinery and Device Manufacturers (Cable, Home Appliances, etc.)	7,18%
Minery&Stone Quarries	5,74%
Marble	4,78%
Agriculture&Forestry	3,83%
Clothing&Fur	3,35%
Chemistry	2,39%
Furniture	2,39%
Plastics&Rubber	1,91%
Leather&Shoes	0,48%
Other	5,26%

Source: Denizli Chamber of Industry, 2014

Table 23: Denizli Machinery Sector Export Figures (USD)

	2009	2010	2011	2012	2013
Machinery	30.243.461	24.495.652	36.367.761	36.883.000	30.843.000
Vehicles and side industry	6.361.190	6.519.323	7.769.980	8.416.000	7.208.000
Ship and Yacht		186.168	1.241	17.000	20.000

Source: Denizli Chamber of Industry, 2014

KOSGEB and South Aegean Region Development Agency. Denizli Abigem is also providing training and consultancy services.

Pamukkale University is the only university in Denizli. It was founded in 1992 and has 45,000 students and 1400 academicians. It has seven faculties, namely Engineering, Architecture and Design, Technical Education, Economics and Administrative Sciences, Arts and Sciences, Education and Medicine. The university also has schools, vocational schools and institutes.

Pamukkale Technolopolis which is a business and research center within Pamukkale University was founded in 2008. It is located in 50.820m^2 of open and 14.500 m^2 of closed area near the university. Within the area, as well as the incubators and the administrative units, Technology Transfer Office, Patent Institute Information and Document Center and University-Industry Cooperation Research and Application Centers operate. The incubator has 99 companies, in which Informatics Technologies and Software has 55%. Within the technopolis, there is Informatics Cluster which is currently funded by UR-GE Project. Machinery and Equipment companies located in the Technopolis has the 7% in total.

Main funding organisations located in Denizli are the Small and Medium Size Enterprises Development and Support Organization (KOSGEB) and South Aegean Development Agency (GEKA). GEKA also supports the development of the region and the industry by needs analysis and by designing funding schemes.

The owners and employees of the cluster companies have social relationships for decades. The social ties flourished by the establishment of Association of Machinery Businessman (MAKSİAD) in 2005 with the aim of development of the sector; however more concrete clustering ideas started to develop in 2015 during the "Increasing the Competitiveness of Machinery Sector Project" initiated by TOBB. Following the needs analysis and the roadmap twelve companies participated to the Machinery Sector UR-GE Project; however, due to the heterogeneity of the subsectors of the cluster companies, they cannot reachto the minimum number to organise or participate to a joint event.For this reason, the project is currently suspended.

This cluster provides a good case for two reasons. First, it has the same knowledge base as the Industrial Ventilating, Climatization and Refrigeration Cluster and the sectors –although not the same- are similar. Second, the cluster is in the emergence phase, this attribute is supposed to shed light on how the clusters in the synthetic knowledge base formwhich enables to interpret the cluster evolution of a synthetic knowledge base from the beginning to the maturity.

Denizli Machinery cluster has all the attributes of peripheral regions. The main problem observed in the peripheral regions is the "organisational thinness" which means the lack of dynamic clusters and supporting institutions. The clusters are often in traditional industries, the innovation and R&D activities are at the low level. Although supporting institutions physically exist, they are ineffective, and networks with these institutions are weakly developed. The knowledge suppliers and educational institutions are far from being specialised, and also networks with the specialised knowledge suppliers such as universities and research organisations is often weak (Tödtling and Trippl, 2005).

The cluster life phase/stage identification criteria is described in the following section.

4.5.2. Identification of The Clusters' Life Phases/Stages

The sample clusters are classified by taking Menzehl and Fornahl's (2010) criteria (Table 20) for the identification of the cluster life cycles which include

a) Size of the cluster

b) Utilization of the size of the cluster

c) Diversity of knowledge, competencies and organizational forms

d) Utilization of the diversity

The specifications of each cluster are explained in the following sections. The identification was confirmed with Social Network Analysis which are given in Section 4.8.1.

4.5.2.1. Denizli Machinery Cluster

a) Size of the cluster

In Denizli machinery cluster, although according to the reports there are 54 companies in the main sector, according to the interviews with Denizli Chamber of

Industry revealed that most of them are newly established and small firms operating in small industrial estates, and 14 companies were identified as actively operating. 12 of these companies were included in the UR-GE project.

b) Utilization of the size of the cluster

The cluster members have various collective efforts; there is a high cluster initiative. Cluster companies established ESSIAD in 1990 long before the IZKA clustering project. They stick to the cluster roadmap; they have been carrying out Accredited Testing Laboratory Project and UR-GE projects for 2 consecutive periods to pursue their goals. In the meanwhile, they have established the Air Conditioning Sectoral Exporters' Union (ISIB) and under this union's umbrella have been organizing meetings two times a year to discuss the problems of HVAC-R sector with other members and representatives of the sector in Turkey.

c) Diversity of knowledge, competencies and organizational forms

The companies operate in different sectors, there are only 54 main companies operating in 7 subsectors. Therefore the cluster is quite heterogeneous in terms of knowledge, competencies and organizational forms.

d) Utilization of the diversity

Although the personal relations are strong, due to the heterogeneity, there are scarce possibilities for interaction both in terms of trade and knowledge sharing.

Denizli Machinery Cluster carries all the characteristics of the emerging cluster where it can hardly be perceived as a cluster; the main problem is reaching the critical mass. However; it has cluster initiative to gather and pursue common goals.

4.5.2.2. IVAC-R Cluster

a) Size of the cluster

The cluster has an important position in Izmir economy and the overall HVAC-R sector in Turkey industry with 2050 companies, total employment of 16.550; and USD 94,697,754 export which is 17%, 12.33%, 6.88% of the Turkish HVAC-R sector, respectively.

b) Utilization of the size of the cluster

There is high cluster initiative, since the establishment of ESSIAD in 1990, joint efforts have been carried out such as preparation and implementation of the cluster roadmap, Accredited Testing Laboratory Project, UR-GE projects, establishment of the Air Conditioning Sectoral Exporters' Union (ISIB) and benchmarking project.

c) Diversity of knowledge, competencies and organizational forms

The cluster competencies are mostly focused on six subsectors, the trading relations are high, they hardly need specialization from outer region.

d) Utilization of the diversity

Strong and dense network not only in terms of trade relations but also personal relations. IVAC-R cluster carries the most of the characteristics of the mature cluster.

Table 24 summarizes the characteristics of each cluster and classification as per their life stage.

Table 24: Main Characteristics of the Selected Clusters as Per Their Life Stage

Cluster Name / Main Criteria	IVAC-R Cluster	Denizli Machinery Cluster
Size of the cluster	The cluster has an important position in Izmir economy and the overall HVAC-R sector in Turkey industry	Few companies and employees
Utilization of the cluster size	Various collective efforts (high cluster initiative) • Establishing ESSIAD in 1990 • Preparation and implementation of the cluster roadmap, • Accredited Testing Laboratory Project • UR-GE projects (2 consecutive periods) • Establishment of the Air Conditioning Sectoral Exporters' Union (ISIB) and having regular meetings under this union's umbrella • Benchmarking project	Hardly perceivable as a cluster, few collective actions (however has a potential and few collective efforts to grow) • Establishment of MAKSİAD in 2005 • Collective efforts to establish an machinery specialized organized industrial zone. • UR-GE project
Diversity of knowledge, competencies and organizational forms	Focused competencies Hardly need specialization from outer region	Quite heterogeneous in terms of knowledge, competencies and organizational forms. 54 companies in more than 7 subsectors.
Utilization of the diversity	Strong and dense network not only in terms of trade relations but also personal relations.	Scarce possibilities for interaction. Although personal relations are strong, due to the heterogeneity of competencies and knowledge rare trade relations.

4.6. DATA COLLECTION

In this research, both primary and secondary data was collected. The secondary data was gathered from the previous cluster analysis reports, sectoral reports and so on.

In order to collect primary data, a survey was conducted. In the first step, in order to gather comprehensive knowledge about the progress of the clusters throughout the time, interviews were held with the organisations coordinating the clustering efforts. In the case of IVAC-R cluster, this organisation was the cluster organisation which is ESSIAD. Denizli cluster did not have a cluster organisation yet; however Denizli Chamber of Industry, coordinating the two projects of the cluster (specialized organised industrial zone and UR-GE) had the information about the cluster, the interview was held with Denizli Chamber of Industry. Interview topics included the time of the initiation of clustering efforts, the leading institution(s) or individual(s) then and now, the steps taken from the beginning until now, the current status of the cluster and finally the future plans of the clusters.

In the second step, a questionnaire was prepared and applied to the cluster companies. The total number of companies interviewed is 34. Out of 34 companies, 13 companies are in emerging cluster (Machinery Cluster, Denizli) and 21 companies are in mature cluster (IVAC-R, İzmir). Although in the emerging cluster there are 54 companies, according to the information received from Denizli Chamber of Commerce, the number of main companies which have been participating in clustering efforts (including UR-GE project) was 14. Out of this number, 13 companies were interviewed. In the mature cluster, ESSIAD members were selected as the sample. Out of 85 companies, 21 companies accepted to participate to the survey. The questionnaire was applied by face-to-face interviews and telephone interviews. The structure of the questionnaire structure is explained in the following section.

In this study, institutional thickness have been analysed in the light of Amin and Thrift's (1994) institutional thickness concept. In the first place, during the interviewswith ESSIAD and Denizli Chamber of Industry to gather information about the clusters, the present and dominant institutions were identified. The cooperation with these institutions were questioned in the questionnaires and the relationship between the cooperation and innovation were analysed in the model. The result of the overall analysis shed light on the mutual awarenes of being involved in a common enterprise.

4.6.1. Questionnaire

The questionnaire is given in Annex 1. Below, the aim of the questions and to what they refer to is explained.

Section 1- General Information (Questions 1-4) aim to collect general information about the firm. Since the firm age, employees' educational level and the activity type (such as design, production of special product or mass product is related to the innovative performance of the firm, these points were included in the questionnaire.

Section 2 - Innovation Performance (Questions 5-8) include questions regarding the innovation indicators which aim toassess the innovativeperformance of the firms. Innovative performance will not only be assessed by new product or process development technological innovation) but also innovations on marketing or organisational (non-technological) side.

Section 3- Knowledge Sources (Questions 9-11) aim to identify the knowledge sources of the firms which is one of the independent variables. The technological and market knowledge sources were asked separately. In order to ease the process, rosters indicating the list of the cluster member companies' were provided from the cluster managing organisations and these roasters were used in theinterview. The respondents were asked whether the firm was exchanging knowledge with the firms listed and what is the type of this relationship (customer, supplier, other) which will enable us to reveal the type of the knowledge source. After the list, the respondent was asked to name 5 most important knowledge sources which are outside of the cluster, aiming to figure out whether the firm has connections with external sources. Finally the respondent was asked to score each knowledge source from 1 to 5 in terms of importance for the firm's innovative performance. Question 11 was asked to identify what kind of activities are more likely to establish new knowledge sources.

Section 4 - Institutions and Their Activities (Questions 12-19) will identify the relationships with the “institutions” which is the other independent variable. In question 12, the name of the institutions that the firm cooperates with were asked, in the following question the respondent will be asked to name and indicate their importance in terms of their contribution to the firm’s innovative performance. The research aim is to figure out not only the type of institutions which are effective in each life stage but also the type of activity which is useful; for this purpose questions 14 and 15 ask the importance of the activities with respect to their contribution. In order to figure out how the cluster improved the firm in terms of innovative performance, in question 16 the respondents were asked to grade the benefits of the cluster. And finally in order to figure out the milestones of each life cycle which made the cluster to move to the next stage,in questions 17-18 and 19, the respondents were asked to the explain the most significant change in the cluster from the beginning, what made this change to happen and what else should be done to move forward to one step further. Although this will be a quantitative research, the last three questions are qualitative in nature, however it will be useful to explore the development of the cluster and see whether the firms see it the same way as the academics.

4.6.2. Data Analysis Methods

First, the clusters were examined in terms of their overall network structure. The type and spatial level of the knowledge sources which were asked in questions 9 and 10 were analysed by Social Network Analysis. The results of the SNA were used to validate the cluster life stage identification.

The multivariate model which was formed to predict innovative performance by institutitons and knowledge sources controlling for life stage was analysed by Ordinal Regression Method Proportional Odds.

The life stages were compared and the below mentioned hypothesis were tested by using Mann-Whitney U Tests.

H_3: The types and the spatial levels of the knowledge sources which influence cluster firms' innovative performance differ throughout evolution of the cluster.

H_4: The type of institutions which influence the cluster firms' innovative performance differ throughout evolution of the cluster.

4.6.2.1. Social NetworkAnalysis

Social Network Analysis is a tool to analyse the relationships of a network. These relations defined by linkages among units/nodes are a fundamental component of SNA (Scott, 2000). It is the mapping and measuring of relationships and flows between people, groups, organizations, computers or other information/knowledge processing entities. The social network analyst is interested in how an actor is embedded within a structure and how the structure emerges from the micro-relations between individual parts (Hanneman, 2002). By the use of computer softwares, the network map can be generated through SNA.

SNA was developed mainly by sociologists and researchers in social psychology in the 1960s and 1970s, it was further developed in collaboration with mathematics, statistics, and computing. It became an attractive tool for other disciplines like economics, marketing or industrial engineering (Scott, 2000).

The application of the network concept and the social network approach to the business field dates back to 80’s and 90’s (Thorelli, 1986; Jarillo, 1988; Powell, 1990). Gulati (1998) introduced a social perspective to business network studies and analysed how relationships can affect both the behaviours and performance of companies.

As networks have gained importance in regional economics and economic geography (Grabher and Ibert 2006), economic geography has also become one of the disciplines in which SNA attracts attention; there is a growing number of regional studies applying SNA (TerWal and Boschma; 2009).

Main measures of SNA are density, centrality (degree, closeness and betweenness) and clustering coefficient.

4.6.2.1.1. Density

Network density describes the general level of connectedness in a network. It is defined as the ratio of actual links to all possible links in the network. It is a number that varies between 0 and 1.0. When density is close to 1.0, the network is said to be dense, otherwise it is sparse. The problem with the measure of density is that it is sensible to the number of network nodes, therefore, it cannot be used for comparisons across networks that vary significantly in size (Scott,2000).

Density is calculated differently depending on whether the links are directed or undirected. Directed links show the direction of the link, whereas undirected link just shows the link between the nodes.

In undirected links, density is calculated as the ratio of the number of existing ties in the network to the maximum possible number of ties if all the actors/individuals were connected to all other individuals in the network (Scott, 1988).

$$\Delta = \frac{L}{g(g-1)/2} = \frac{2L}{g(g-1)} = \frac{\bar{d}}{g-1}$$

Where Δ is the density, g is the number of the nodes, g(g-1)/2 is $\binom{g}{2}$ which is all the possible links, L is the number of actual links in the network.

In networks having directed links, density is calculated as:

$$\Delta = \frac{L}{g(g-1)}$$

4.6.2.1.2. Centrality

Network centrality refers to how resourceful or influential an actor is in the network compared to other actors in the network (Brass et al., 2004). A central position may provide various advantages to the central actor such as more access to information and resources (Brass et al., 2004; Freeman, 1979; Tsai, 2001). Central position gives an advantage in spreading the message to all other actors in the shortest amount of time due to its direct and indirect connections (Uzzi,1996).

Freeman (1979) classifies the measures to assess the centrality of a network as degree, closeness and betweenness.

Degree (also called local) centrality is expressed in terms of the number of nodes to which a node is connected meaning that high degree of centrality of an actor means that a central actor has more options to access resources or information (Brass and Burkhardt, 1992; Freeman, 1979). The degree of an actor is important since it implies that central actors have the most ties to other actors in the network (Wasserman and Faust, 1994).

Closeness (also called global) centrality is expressed in terms of the distances among the various nodes. *Local centrality* only considers direct ties (the ties directly connected to that node) whereas *global centrality* also considers indirect ties (which are not directly connected to that node). Closeness centrality formula is given below.

$$C_c(n_i)=\left[\sum_{j=i}^{g} d\left(n_i, n_j\right)\right]^{-1}$$

where $C_c(n_i)$ is the closeness of the actor, d(ni, nj) is the number of lines in the linking actors i and j. is $\left[\sum_{j=i}^{g} d\left(n_i, n_j\right)\right]$ is the total distance of i from all others in the network.

Betweenness centrality suggests that even weakly connected individuals may still be essential for certain transactions as they act as intermediary to communicate the information (Freeman, 1984). Structural holes theory is based on betweenness centrality. Zaheer and Bell (2005) found that innovative firms that *also* bridge structural holes get a further performance boost. Betweenness index for n_i is the sum of estimated probabilities over all pairs of actors (Wasserman and Faust, 1994).

$$C_{B(n_i)} = \sum_{j<k} g_{jk}(n_i) / g_{jk}$$

4.6.2.1.3. Clustering Coefficient

Another measure for the networks is clustering coefficient. Clustering coefficient measures the extent to which a node’s contacts are linked with one another (Wasserman and Faust, 1994).Individual clustering for a node i is

$CI_i(g) = \frac{Number of triangles connected to node i}{number of triples centered at i}$, $CI_i(g)$ varies between 0 and 1.

Average clustering coefficient is calculated as

$$CI^{Avg}(g) = \frac{1}{n}\sum_i CI_i(g)$$

4.6.2.2. Mann Whitney U Test

To examine the differences in knowledge source types and institutions (hypothesis), Mann-Whitney U test was used. The Mann–Whitney U-test is used as an alternative to the *t*-test when the data are not normally distributed. The test is non-parametric and does not involve a distribution assumption. The hypothesis is that the two independent samples are drawn from a single population, and therefore their probability distributions are equal (Malhotra and Birks, 2007).

4.6.2.3. Ordinal Logistic Regression

Ordinal Logistic Regression (OLR) method was used to analyse the multivariate model. Ordinal Logistic Regression is used when the outcome variable is ordered or ranked but the distances between the categories are unknown. This order can be in the form of 1=strongly agree, 2=agree, 3=disagree, and 4=strongly disagree as used in many social research (without an assumption that the distance from strongly agreeing and agreeing is the same as the distance from agree to disagree); or an ordered categorization such as 1=Low 2= Medium 3= High. In this model since the outcome variable “innovation performance” is categorized as 1=Low; 2=Medium and 3=High, ordinal regression method is used for the analysis of the results.

OLRis nonlinear and the magnitude of the change in the outcome probability for a given change in one of the independent variables depends on the levels of all of the independent variables. The researcher should be cautious in ordering/ranking since different assumptions about the ordering can result in different conclusions (Miller and Volker, 1985).

The ordinal regression model is called the cumulative model because the model is built based on the cumulative response probabilities of being in category or lower given the known explanatory variable (Walters, et al.2001). When the outcomes of Y are ordinal and are assigned the values 0, 1,... , k, cumulative probabilities can be defined by

$C_{ij}= \Pr (Y \geq j \mid X_i)$ $i = 1, \ldots, n$ $j= 1, \ldots k$

j indexes the k possible cumulative probabilities obtained from using k cut-offs to dichotomize Y (Peterson and Harrell, 1990).

Several regression models can be used to describe the relationship between an ordinal response variable and one or more explanatory variables such as the logit and probit versions of the ordinal regression model, by McKelvey and Zavoina (1975), the logit version as the proportional odds model by McCullagh (1980), the adjacent-category model, the constrained continuation-ratio model and non-proportional oddsmodel (Fu, 1998). The models differ in which and how the response levels are compared.The ordinal regression model uses link functions for the calculation of the probability.The link function is a transformation of the cumulative probabilities of the dependent ordered variable that allows for estimation of the model. These link functions are; logit, negative log-log, complementary log-log, probit and cauchit link functions. Logit function is used when the probability of all the categories are equal. Complementary log-log is suitable if the probability value is higher in higher categories whereas negative log-log is used when the probability is higher in lower categories. Probit link function is used when there is normally distributed latent variable; if there are many extreme values, cauchit link is used. Therefore if the cumulative probability does not change suddenly in one category, logit and probit link functions are the most appropriate functions (Koutsoyuannis, 1977).

The ordinal regression model with the logit link which is also known as the proportional odds model (McCullagh 1980). It compares the probability of an equal or smaller response with the probability of a larger response. The model is constrained by the requirement that the log odds of each explanatory variable does not depend on the response category (McCullagh, 1980). As the proportional odds model with the logit function where covariates have the same effect on the odds as the response variable has at any category, it is appropriate for our model and will be used for the analysis.

4.6.2.3.1. Proportional Odds Model

The proportional odds model, also called the constrained cumulative logit model, compares theprobability of an equal or smaller response with the probability of a larger response. Proportional odds model means that covariates have the same effect on the odds as the response variable has at any dividing point by regarding different values of covariates as shifting the response distribution to the right (or left) without changing its spread or shape. In the proportional odds model, the cumulative logits model the effect of covariates on odds of response below or equal to the cutpoint (also referred to as threshold) *j* in the latent variable. First, the odds that an outcome is less than or equal to *j*, versus being greater than *j*, given **x** is defined as follow:

$$g_j(x) = \log\left[\frac{\Pr(Y \leq j \mid x}{\Pr(Y > j \mid x}\right]$$

The logitequals the linear form of a + βX (Hosmer and Lemeshow, 1989).

$$=\alpha_j - \beta' x,\ j=1,\ldots..,c-1$$

where $\boldsymbol{\beta} = (\beta 1, \beta 2, \ldots, \beta p)\_$ is a vector of *p* regression coefficients. The log odds does not depend onthe response level, and the regression coefficients $\beta 1, \ldots, \beta p$ are constant across the logits. The intercepts satisfy the relationship $\alpha 1 < \alpha 2 < \cdot\cdot\cdot < \alpha c-1$. The negative sign of $\boldsymbol{\beta}\mathbf{x}$ is included to allow for the usual interpretation that a positive value of βk means that as xk increases, the probability of higher values of Y also increases (Long and Freese,2001).

4.6.2.3.2. Testing the Model Fit in Ordinal Regression Analysis

4.6.2.3.2.1. Deviance (-2 Log Likelihood statistic)

Deviance is an indicator of how much unexplained information there is after the model has been fitted, with large values of -2Log Likelihood (-2LL) indicating poorly fitting models. It compares the difference in probability between the predicted outcome and the actual outcome for each case and sums these differences together to provide a measure of the total error in the model. One way to interpret the size of the deviance is to compare the value for our model against a „baseline" model. The change in the -2LL statistic can be used to test whether the suggested model is significantly more accurate than simply always guessing that the outcome will be the more common of the categories. The model with no explanatory variables is named as the baseline and the model with the explanatory variables is "new" or "final" (www.restore.ac.uk).

X2= [-2LL (baseline)] - [-2LL (final)]

with degrees of freedom(df)= kbaseline- kfinal, where k is the number of parameters in each model.

If the final model explains the data better than the baseline model there should be a significant reduction in the deviance (-2LL) which can be tested against the chi-square distribution to give a *p* value. If $p<0,5$; we reject that the baseline model is more accurate to explain the outcome; suggesting that the final model gives a significant improvement over the baseline intercept-only model; the model gives better predictions than predictions based on the marginal probabilities for the outcome categories.

4.6.2.3.2.2. Pearson Chi-Square

Goodness-of-fit is made to test whether the observed data are consistent with the model that we fitted to it. To test the goodness-of-fit we look at the Pearson chi-square and deviance. Pearson chi-square is calculated as

$$x^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i} = N \sum_{i=1}^{n} \frac{(O_i/N - p_i)^2}{p_i}$$

where

X^2 = Pearson's cumulative test statistic,

O_i = the number of observations of type *i*.

E= total number of observations

E_i=the expected (theoretical) frequency of type *i*,

n = the number of cells in the table.

The null hypothesis suggests that the model is a good fit. In the case of $p > 0,05$ for both values then we fail to reject the null hypothesis; meaning that the model has a good fit for the data.

4.6.2.3.2.3. Pseudo R-Squared

The coefficient of determination, (R^2 or r^2) is a number that indicates the proportion of the variance in the dependent variable that is predictable from the independent variable. Pseudo R-squared measures the success of the model in explaining the variations in the data. The pseudo R squared indicated that the proportion of variations in the outcome variable was accounted for by the explanatory variables. The larger the pseudo R square is, the better the model fitting is.

The generalized R^2 was originally proposed by Cox and Snell and calculated as (Cox and Snell,1989)

$$R^2 = 1 - \left(\frac{L(O)}{L(\hat{\theta})}\right)^{2/n}$$

The McFadden's R square compares the likelihood for the intercept only model to the likelihood for the model with the explanatory variables in order to assess the model goodness of fit and calculated as

$R^2 = 1 - (ln \frac{L}{lnLo})$

Other Pseudo R^2 methods for measuring the strength of the relationship between dependent and independent variables is Nagelkerke (N) statistics which is calculated as (Nagelkerke, 1991)

$$R_N^2 = \frac{R_{CS}^2}{1 - L_O^{\frac{2}{n}}}$$

4.6.2.3.2.4. Testing the Proportionality of Odds Ratio (Test of parallel lines)

In the proportional odds (PO) model of ordinal regression, the assumption is that the Odds Ratio (OR) is equal at each threshold; meaning that the effects of any explanatory variables are consistent or proportional across the different thresholds. To evaluate the appropriateness of this assumption, “test of parallel lines” is used. This test compares the ordinal model which has one set of coefficients for all thresholds, to a general model with a separate set of coefficients for each threshold. Therefore, the null hypothesis is that the model has one set of coefficients for all thresholds. In the case of $p>0,05$; we fail to reject the null hypothesis; meaning that the explanatory variables have the same effect on the odds regardless of the threshold.

4.7. LIMITATIONS OF THE RESEARCH

This research has some limitations. First of all, at the time when this study was applied, the economic and political situation of the country was ambigious, therefore firms were reluctant to participate to the study, therefore the sample size could reach to 34 companies. Another limitation was the unwillingness of the firms to tell their knowledge sources, especially when it comes to external sources they hesitated to mention the names. This, on the one hand reveals the lack of trust among companies, on the other hand, may distort the analysis results. Last but not the least, it would certainly be better to compare one cluster's two different phases, however; since the the multivariate model and the measure were used for the first time in this study, it was not possible to reach such past information of the cluster.

4.8. RESEARCH FINDINGS

4.8.1. Profile of The Sample

The questionnaire was applied to two different clusters in two provinces of Turkey; IVAC-R Cluster in Izmir and Machinery Cluster in Denizli. The clusters were selected from different life stages; machinery cluster was in emergence phase whereas IVAC-R cluster was in maturity phase at the time that the research was applied. The total number of companies interviewed is 34. Out of 34 companies, 13 companies belong to the emerging cluster (Machinery Cluster, Denizli) and 21 companies to the mature cluster (IVAC-R Cluster, Izmir) (Table 25).

Classification of clusters as per their life stages were made in accordance with the criteria of Menzehl and Fornahl (2011) and social network analysis (SNA) was conducted to validate this classification. Although the sample size is small, due to choosing the right kind of companies as the sample, identified life stages are validated. Knowledge sources were analyzed by SNA to get an overall picture of the network structures of the two clusters. The sources are separated as market and technological knowledge sources; and each type was analysed separately for each cluster.

The findings of SNA show that the mature cluster is a larger network than the emerging cluster; it has 3 times as many nodes as the emerging cluster ($nodes_{mature}$=104; $nodes_{emerging}$=32). The mature cluster companies have more contacts than the emerging cluster; the mature cluster companies have twice as many links as the emerging cluster ($degree_{emerging}$=2; $degree_{mature}$=3,907). Although emerging cluster has higher density ($density_{emerging}$=0,064 > $density_{mature}$=0,038), it would be misleading to conclude that the emerging cluster has a higher general level of connectedness since this value stems from mature cluster's being a larger network than the emerging one; the ratio of interviewed companies to total number of companies in mature cluster is smaller than the emerging cluster's ratio. In the emerging cluster two of the companies do not share knowledge with the cluster firms (Figure 22), whereas in mature cluster there is no such company; all the companies interviewed have at least one contact with the main cluster companies (Figure 23). Mature cluster has a higher average clustering coefficient; which shows that the companies forms different cliques/subclusters around them. This is also normal due to two reasons, their sectors they cooperate with different suppliers/customers and they have enough number of companies to form cliques. Therefore we conclude that although the emerging cluster has a higher density, the mature cluster is larger, companies have more contacts and they tend to form groups within the cluster. Market knowledge sources statistics is summarised in Table 25.

With regards to the technological knowledge sources, emerging cluster has higher number of nodes (74) and links (87) than the market knowledge sources. Despite this increase, the mature cluster's general level of connectedness (density) is almost twice as higher ($density_{mature}$=0,0293; $density_{emerging}$=0,0161). Mature cluster have more contacts than the emerging cluster companies; the companies have 2 contacts in average in the emerging cluster and 3,4 contacts in the mature cluster. Mature cluster have higher clustering coefficient (0,099) than the emerging cluster (0,014) showing the tendency to form groups within the cluster compared to the emerging one. The statistics of the technological sources is summarised in Table 26. The network maps are illustrated in Figure 24 and Figure 25.

The criteria of developed by Menzehl and Fornahl (2011) suggests that in emerging networks interaction possibility is scarce, whereas in maturity (sustainment) phase the network is dense and strong. The findings are in line with the criteria, as the SNA results show mature cluster has a stronger network as it has higher nodes and links, more contacts and in technological knowledge sources higher density. In addition, main cluster companies have contacts with eachother. The clusters were compared by Mann-Whitney U tests and the results also support that in technological knowledge sources the two clusters are significantly different in terms of degree, closeness centrality, betweenness centrality and clustering coefficient (Table 25) and in marketing knowledge sources, in terms of closeness centrality and clustering coefficient (Table 26). Test statistic results are given in Appendix 2.

Figure 22: Emerging Cluster Market Knowledge Sources

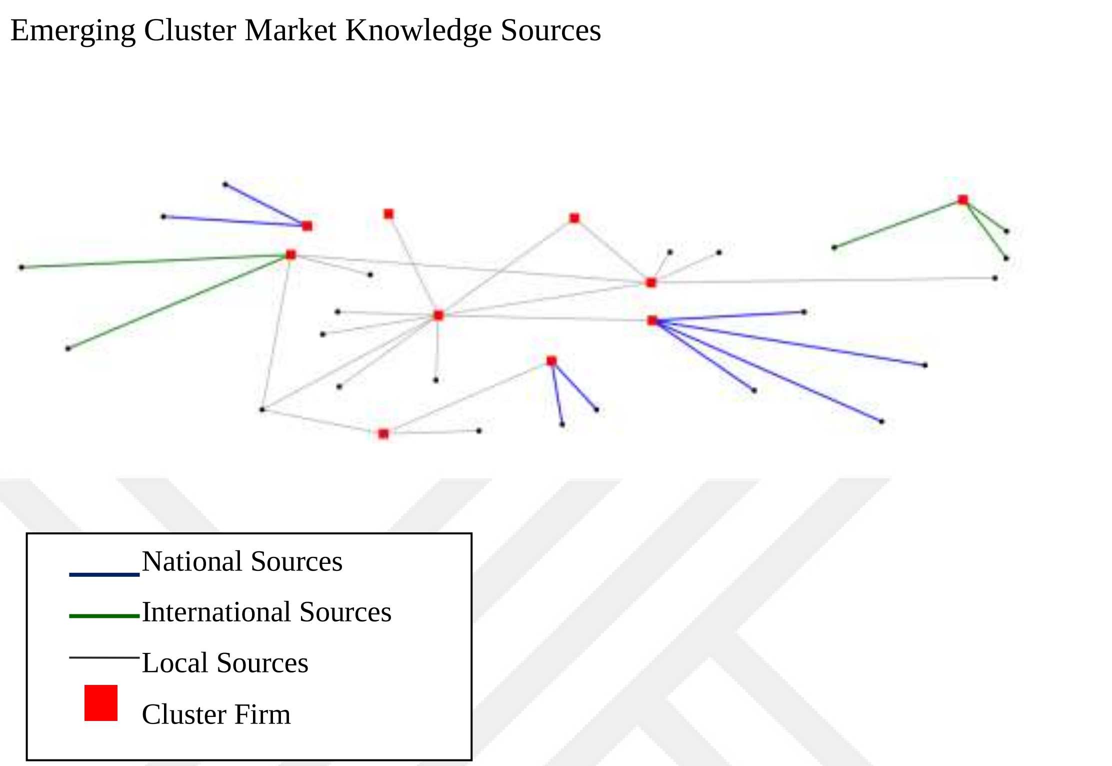


Figure 23: Mature Cluster Market Knowledge Sources

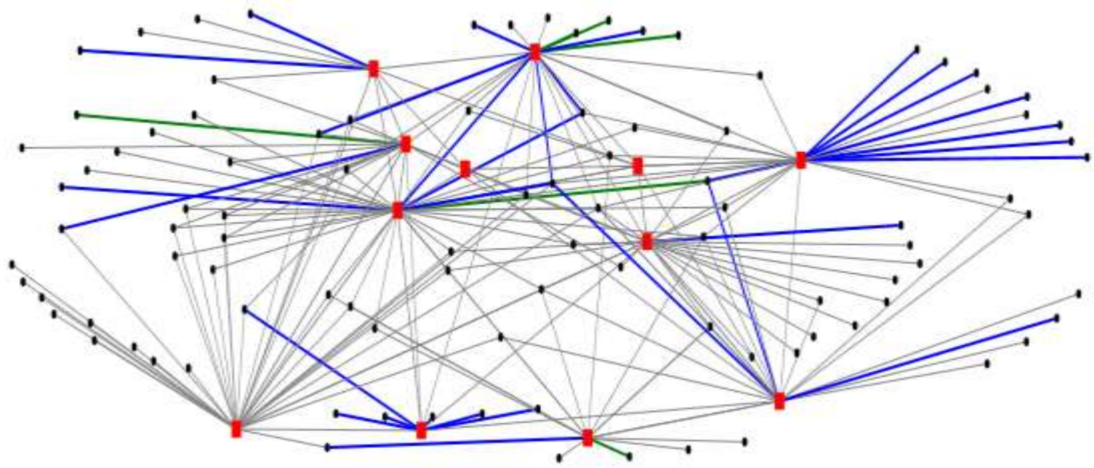


Table 25: Comparison of Network Measures of the Two Clusters-Market Knowledge Sources

Network Measures	**Emerging Cluster**	**Mature Cluster**	**Mann-Whitney U Test (2-tailed)**
Number of nodes	32	104	N/A
Number of links	32	225	N/A
Density	0,064	0,038	N/A
Degree	2,000	3,907	0,107
Betweenness Centrality	22,091	88,042	0,829
Closeness Centrality	0,060	0,004	0,000
Clustering Coefficient	0,008	0,281	0,000

Figure 24: Emerging Cluster Technological Knowledge Sources

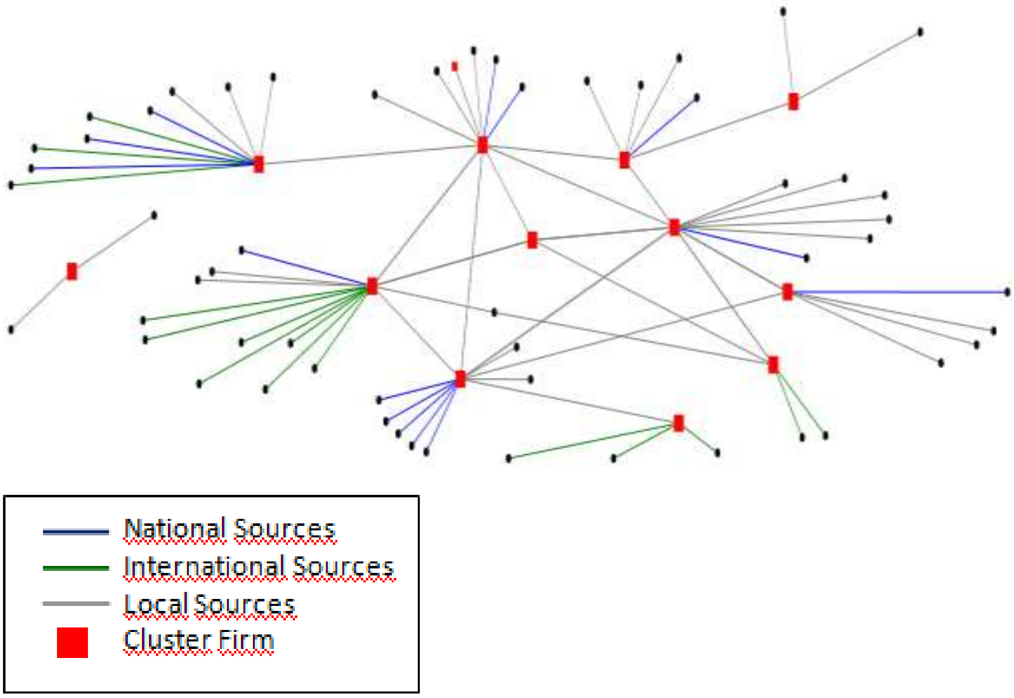


Figure 25: Mature Cluster Technological Knowledge Sources

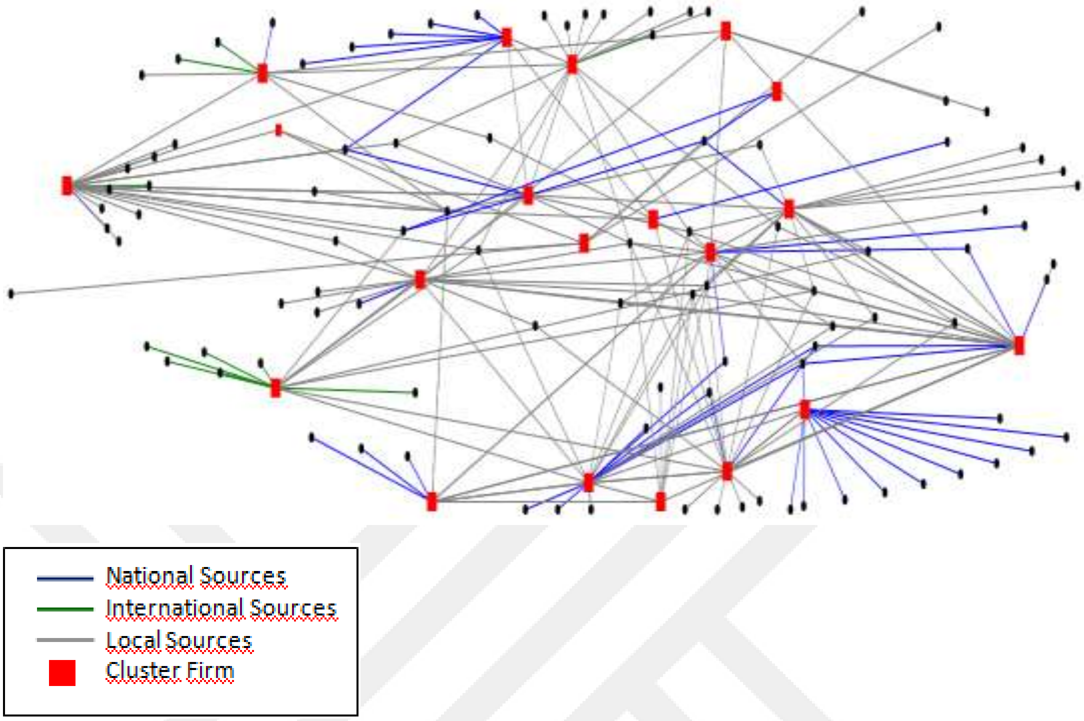


Table 26: Comparison of Network Measures of the Two Clusters-Technological Knowledge Sources

Network Measures	Emerging Cluster	Mature Cluster	Mann-Whitney U Test (2-tailed)
Number of nodes	74	119	N/A
Number of links	87	219	N/A
Graph Density	0,0161	0,0293	N/A
Degree	2,176	3,462	0,000
Betweenness Centrality	69,735	135,613	0,004
Closeness Centrality	0,022	0,003	0,000
Clustering Coefficient	0,014	0,099	0,000

4.8.2. Descriptive Statistics

The total number of companies interviewed is 34; 13 companies from emerging and 21 from mature cluster (Table 27). 29 companies (85%) operate in manufacturing sector, whereas 3 companies (9%) are in project design and installation and 2 companies (6%) are in trade sector (Table 28).

Firm ages span over a wide range from 7 to 84 in the emerging cluster and 3 to 67 in the mature cluster; however in both clusters more than 75% of the companies are between 11-40 years old (Table 29).

The number of employees in the emerging cluster (machinery) ranges from 15-98, whereas in the mature cluster (IVAC-R) it has a wider range of 6 to 240 (Table 30). In both clusters, more than 50% of the companies do not employ graduates in their companies (7 companies in the emerging cluster and 12 companies in the mature cluster). In the emerging cluster, the ratio of graduates to the total number of employees ranges from 0-15% whereas in the mature cluster this ratio is 0-33% . This ratio was included since it could be an indicator of the innovative performance; however out of 10 high innovation performers, 6 companies had not employed graduates and only 3 of them have a ratio within 6-20% range (Table 31).

Table 27: Number of Interviewed Companies

Cluster Life Cycle Phase	**Number of companies**	**%**
Emerging (Machinery Cluster, Denizli)	13	38
Mature (IVAC-R Cluster, İzmir)	21	62

Table 28: Main Sector Frequency

Main Sector	**Emerging**	**Mature**	**Total**	**%**
Manufacturing	13	16	29	85
Project Design/ Installation	0	3	3	9
Trade	0	2	2	6
Total	13	21	34	100

Table 29: Firm Age

Firm Age	Emerging	Mature	Total
0-10	1	2	3
11-24	6	10	16
25-40	3	7	10
40-50	2	0	2
50 +	1	2	3
Total	**13**	**21**	**34**

Table 30: Number of Employees as per Cluster Life Stage

Number of Employees	Emerging	Mature	Total
6-14	0	7	7
15-49	8	5	13
50-99	5	4	9
100-240	0	3	3

Table 31: Ratio of Graduates to Total Employees Cluster Breakdown

Ratio of graduates to total employees	Emerging	Mature	Total
0	7	12	19
1-5%	4	4	8
6-15%	2	1	3
20-33%	0	4	4

Table 32: Descriptive Statistics of Firm Age, Number of Employees and Ratio of Graduates

	N	Minimum	Maximum	Mean	Std. Deviation
Firm Age	34	3	84	26,68	16,342
Number of employees	34	6	240	50,79	54,41
Ratio of graduates to total employees	34	0	33,33	4,57	8,41

With respect to innovation indicators, 10 companies have introduced a product innovation new to the market and has patent or applied for it in the last three years. 24 companies have developed a product or process which is new to the firm. Table 33 gives the innovation indicators in cluster breakdown. Since some companies applied more than one type of innovation, the sum of the numbers exceeds total number of companies in the survey.

Table 33: Innovation Indicators Cluster Breakdown

	Emerging Cluster	**Mature Cluster**	**Total**
Number of firms introducing the following innovations in each category in the last three years			
New to the Market (Product/Process)	3	7	10
New to the Firm (Product/Process)	11	13	24
Application of an existing method (for the first time to the firm)	1	4	5
Change in Marketing Strategy	3	9	12
Change in Organisational Strategy	1	4	5
Patent holder/Have applied for patent	3	7	11
Having an R&D department/R&D assigned personnel	8	7	15

By the evaluation of the innovation indicators, 10 companies are identified as high 16 moderate and 8 as low innovation performers. The number of each category in cluster breakdown is given in Table 34.

Table 34: Innovation Performance

Innovative Performance Level	Emerging Cluster	Mature Cluster	Total	%
Low	3	5	8	23,5
Moderate	7	9	16	47,0
High	3	7	10	29,5
Total	**13**	**21**	**34**	**100,00**

4.8.3. Findings With Regards To Knowledge Sources

Knowledge sources were first classified as "Marketing Knowledge Sources" and "Technological Market Sources". These sources were examined in terms of i) Types and ii) Spatial levels. Knowledge source types were categorized as customer, supplier and other. For each category, "average importance", "number of knowledge sources" and "shares" were taken as indicators. Knowledge spatial levels were categorized as "international", "national" and "local". Similar to the knowledge sources, for each category, "average importance", "number of knowledge sources" and "shares" were taken as indicators.

In the multivariate model, neither of the indicators (importance, number of knowledge sources and shares) of knowledge sources type (customer, supplier, other) and the spatial level (local, national, international) were significantly correlated to innovation (Table 35-38). Furthermore, when put into the model, the model validity was uncertain, therefore they are not maintained in the model. The means of each indicator of knowledge sources in terms of importance, numbers and shares are given in Appendix 2.

Table 35: Innovation-Technological Knowledge Source Types Significance Tests

	p-value Sig. (2-tailed)
Number_customer	0,969
Number_supplier	0,539
Number_other	0,738
share_customer	0,522
share_supplier	0,959
share_other	0,907
imp_customer_tech	0,265
imp_supplier_tech	0,769
imp_other_tech	0,733

Table 36: Innovation-Market Knowledge Sources Types Significance Tests

	p-value
Number_customer_mrk	0,173
Number_supplier_mrk	0,176
Number_other_mrk	0,079
share_customer_mrk	0,305
share_supplier_mrk	0,318
share_other_mrk	0,112
imp_customer_mrk	0,395
imp_supplier_mrk	0,242
imp_other_mrk	0,106

Table 37: Innovation and Technological Knowledge Source Spatial Level Correlation Significance Tests

	p value Sig. (2-tailed)
number_of__int_source_tech	0,793
number_of__national_source_tech	0,912
number_of__local_source_tech	0,952
Share_of_ int_source_tech	0,866
Share_of_national_ source_tech	0,479
Share_of_local_ source_tech	0,846
İmportance_int_tech	0,858
İmportance_nat_tech	0,646
İmportance_local_tech	0,457

Table 38: Innovation-Market Knowledge Sources Spatial Level Correlation Significance Tests

	p value Sig. (2-tailed)
number_of__int_source_mrk	0,746
number_of__national_source_mrk	0,054
number_of__local_source_mrk	0,053
Share_of_ int_source_mrk	0,872
Share_of_national_ source_mrk	0,108
Share_of_local_ source_mrk	0,116
İmportance_int_mrk	0,756
İmportance_nat_mrk	0,186
İmportance_local_mrk	0,132

Literature suggests that knowledge sources are important factors of innovation, however; in the multivariate model, none of the three indicators of knowledge sources (importance levels, share of categories in total and number of sources) were significantly correlated with innovation. Lack of correlation between knowledge sources and innovation is supported by the respondents' statements. When the questions related to the knowledge sharing, regardless of the innovation category and cluster phase, their first reaction was "we have friendship ties but we don't really share knowledge".

With regards to the differences in two different cluster life stages, the importance, numbers and shares of each category in knowledge source types (customer, supplier and other) and spatial levels (international, national and local) of the two clusters were compared. In addition, there is no significant difference between the two cluster life stages (emergence and maturity) in terms of neither types (customer, supplier or other) nor spatial levels (international, national or local). The results of the Mann Whitney U Test are given below.

H_0= Market knowledge source types are the same in different cluster life stages.

H_1= Market knowledge source types are different for different cluster life stages.

As seen in Table 39, all the significance values for all the indicators are greater than 0,05, therefore we fail to reject the null hypothesis. We observe no significant difference between the two cluster life stages (emergence and maturity) in terms of market knowledge sources types (customer, supplier or other).

Table 39: Test Statistics of Two Clusters (Market Knowledge Source Type)

	Mean		Mann-Whitney U	Asymp. Sig. (2-tailed)
	Emerging (N=13)	Mature (N=21)		
Source Type				
imp_cust_MRK	4,23	4,10	132,500	0,86
imp_supp_MRK	4,69	3,81	93,000	0,06
imp_other_MRK	3,92	4,52	100,500	0,11
Number_source_customer_MRK	2,31	6,00	130,5	0,80
Number_source_supplier_MRK	1,08	2,67	99,5	0,11
Number_source_other_MRK	1,31	1,52	115,0	0,33
share_cust_MRK	0,24	0,28	134,5	0,93
share_supp_MRK	0,08	0,19	100,0	0,12
share_other_MRK	0,30	0,10	105,0	0,15

H_0= Market knowledge source spatial levels that influence cluster firms' innovative performance are the same in different cluster life stages.

H_1= Market knowledge source spatial levels that influence cluster firms' innovative performance differ in different cluster life stages.

As seen in Table 40, all the significance values for all the indicators are greater than 0,05; therefore we fail to reject the null hypothesis. We observe no significant difference between the two cluster life stages (emerging and maturity) in neither national, local nor international spatial levels of marketing knowledge sources.

Table 40: Test Statistics of Two Clusters (Market Knowledge Sources Spatial Level)

	Mean		Mann-Whitney U	Asymp. Sig. (2-tailed)
	Emerging (N=13)	Mature (N=21)		
Source Spatial Level				
importance_international_ MRK	4,54	4,29	124,0	0,53
importance_national_ MRK	4,23	4,00	120,0	0,50
importance_local_MRK	4,38	3,76	108,5	0,27
number_international_source_MRK	0,23	0,48	123,5	0,51
number__national_source_MRK	1,15	1,52	122,5	0,57
number_local_MRK	3,31	7,33	113,5	0,37
share_international_MRK	0,06	0,06	128,0	0,67
share_national_MRK	0,22	0,10	134,0	0,92
share_local_MRK	0,34	0,37	131,5	0,85

H_0= Technological knowledge source types are the same in different cluster life stages.

H_1= Technological knowledge source types differ in different cluster life stages.

The signficance values for all the indicators are greater than 0,05 (Table 41); therefore we fail to reject the null hypothesis. There is no significant difference between two cluster life stages (emergence and maturity) in terms of technological knowledge source types.

Table 41: Test Statistics of Two Clusters (Technological Knowledge Sources Types)

	Mean		Mann-Whitney U	Asymp. Sig. (2-tailed)
	Emerging (N=13)	Mature (N=21)		
Source Type				
imp_customer_tech	3,15	3	130,5	0,83
imp_supplier_tech	3,46	3,38	132,5	0,88
imp_other_tech	4,15	4,14	116	0,42
number_of_source_customer_tech	2,31	6,43	70,0	0,02
number_of__source_supplier_tech	1,92	2,62	131,5	0,85
number_of__source_other_tech	2,46	1,57	94,5	0,10
share_customer_tech	0,29	0,64	71,0	0,02
share_supplier_tech	0,25	0,24	132,5	0,88

H_0= Technological knowledge source spatial levels are the same in different cluster life stages.

H_1= Technological knowledge source spatial levels are different for different cluster life stages.

The significance values for all the indicators are greater than 0,05 (Table 42); therefore we fail to reject the null hypothesis. There is no significant difference between two cluster life stages (maturity and emergence) in terms of technological knowledge sources spatial levels (international, national or local).

Table 42: Test Statistics of Two Clusters (Technological Knowledge Sources Spatial Level)

	Mean		Mann-Whitney U	Asymp. Sig. (2-tailed)
	Emerging (N=13)	Mature (N=21)		
Source Spatial Level				
imp_int_tech	4,08	3,67	118,5	0,45
imp_nat_tech	3,62	3,14	114,0	0,41
imp_local_tech	3,38	3,00	110,5	0,35
number_of__int_source_tech	1,00	1,05	129,5	0,77
number_of__national_source_tech	1,38	2,14	117,5	0,48
number_of__local_source_tech	3,92	7,38	93,0	0,12
share_international_tech	0,18	0,10	122,5	0,56
share_national_tech	0,15	0,24	120,0	0,56
share_local_tech	0,59	0,61	129,0	0,79

Literature suggests that in synthetic knowledge bases, the links between the firms and the research institutes are not as dense as in the analytical base, tacit knowledge is more important where interactive learning with customers and suppliers should be high (Asheim and Coenen, 2005) and geographical proximity is important in synthetic KBs. The findings are in line with the literature; in the technological knowledge sources, local knowledge sources and customer type of knowledge sources have the largest share within their category in all innovation levels and the highest importance (see Table 41 and 42). Both technological and market knowledge sources are considered as "below moderately important" with two exceptions; in the low innovation category customers and in high innovative category local sources are considered between important and moderately important. Although the literature suggests that the external sources allow firms to access knowledge which is not available in the region, and therefore boosts innovativity, the findings of this study show that local sources have the highest importance in high category compared to other categories.

In both clusters, firms in the same cluster do not cooperate with eachother; there are no joint research projects. As expressed in the interviews, knowledge sharing is mostly on very general topics. In Denizli, the respondents gave two reasons for the low network relations. First, firms are in different sectors, therefore there is not a common topic to share knowledge which is in line with literature; in emerging clusters there are scarce possibilities for cooperation mainly due to the heterogenity of the knowledge and competencies. The reason for the ones which are in the same sector to be reluctant to share knowledge is the risk of their competitor to take advantage of their knowledge. In IVAC-R cluster, the network ties are more dominant, the number of companies in the cluster is higher, and they mainly trade with eachother. However, this cooperation is mostly on customer and supplier type, the companies in the same sector do not cooperate with eachother on technological issues. Companies gave the same reason as Denizli; sharing knowledge means sharing company secrets; in a fierce business environment, they don't want to lose their competitive advantage by strengthening their rivals. For both clusters this shows that there is lack of trust among companies, social capital is not well developed for cooperation on the innovation side.

4.8.4. Findings With Regards To Institutions

In the multivariate model, for the independent variable institutions type "cooperation with institutions" was taken as the indicator. These institutions are; university, research institutions, TÜBİTAK, KOSGEB, development agency, training institutions and other. In the questionnaire, "cluster organization" was included as one of the institutions that might have influenced the innovative performance; however in the emerging cluster all the firms responded that there is no cluster organization, therefore, this variable is not included in the analysis.

At this point, a dummy variable was created and valued as 0= "no cooperation with the institution" 1=" cooperates with the institution". As seen in Table 43 none of the companies in low innovation performance category cooperates with institutions. The relations with institutions is more common in high category than in moderate category. In high category, the percentage of having relations with university, TÜBİTAK and KOSGEB is 80%, 70% and 90% respectively; whereas in moderate category these numbers are 50%, 18,75% and 62,50%.

The results of the validity test of the model are given in Appendix 3. The model has a good fit ($p<0.05$). Our model gives better predictions than the baseline (intercept only) model. The model has a significant statistics for both the Pearson’s chi-square, ($p=0,695$) and Deviance ($p=0,764$); suggesting that the model indicates that the observed data are consistent with the estimated values in the fitted model. The pseudo R-squares for McFadden suggests that the model explains %48,1 of; whereas Cox and Snell %63,8, and Nagelkerke %72,6 of the variation of the firms in innovative performance. Especially Nagelkerke and Cox and Snell statistics suggest that the model explains a large proportion of variation in the data. Test of parallel lines $p=0.187 > 0.05$ the it is concluded that the coefficients of the variables are same in three categories of the dependent variable. Although the sample size is small, due to choosing the right kind of companies as the sample, our model is validated and explains a large proportion of variation in data.

The correlation matrix of the variables is given in Table 44. In the multivariate model cooperation with university, TÜBİTAK and KOSGEB were statistically meaningful ($p=0,001$; $p=0,001$; $p=0,000$, respectively) and included in the model. On the other hand, cooperation with research institutions, training and consultancy institutions, and other institutions were not significantly correlated therefore not included in the model.

Control variable is taken as the life stage of the clusters. A dummy variable was created and labeled as 1=Emerging cluster (represents Denizli machinery cluster); 2=Mature cluster (represents Industrial Ventilating, Heating and Refrigeration cluster)

The correlation matrix of the variables used in the final model is given in Table 45.

Table 43: Cooperation with Institutions Frequencies Innovation Category Breakdown

		INNOVATION CATEGORY			Total
		low	Moderate	high	
University	no cooperation	8	8	2	18
	Cooperates w/	0	8	8	6
TÜBİTAK	no cooperation	8	13	3	24
	Cooperates w/	0	3	7	10
KOSGEB	No cooperation	8	6	1	15
	Cooperates w/	0	10	9	19
Research Institutes	No cooperation	8	16	10	34
	Cooperates w/	0	0	0	0
Development Agency	No cooperation	8	10	8	26
	Cooperates w/	0	6	2	8
Training Institutions	No cooperation	8	12	8	28
	Cooperates w/	0	4	2	6
Other	No cooperation	6	7	6	19
	Cooperates w/	2	9	4	15
	Total	**8**	**16**	**10**	**34**

Table 44: Correlation Matrix of Institutions

Correlations (Kendall's tau_b)								
		Innovative Performance	University	training_ institution	Development agency	TÜBİTAK	KOSGEB	other_inst
Innovative Performance	Correlation Coefficient	1,000	,541**	,161	,130	,545**	,605**	,080
	Sig. (2-tailed)	.	,001	,329	,430	,001	,000	,626
University	Correlation Coefficient		1,000	,027	,588**	,555**	,363*	,112
	Sig. (2-tailed)		.	,875	,001	,001	,037	,521
training_inst	Correlation Coefficient			1,000	-,257	,378*	,101	,521**
	Sig. (2-tailed)			.	,140	,030	,564	,003
development_agency	Correlation Coefficient				1,000	,098	,214	,066
	Sig. (2-tailed)				.	,572	,220	,706
TÜBİTAK	Correlation Coefficient					1,000	,184	,206
	Sig. (2-tailed)					.	,292	,236
KOSGEB	Correlation Coefficient						1,000	,074
	Sig. (2-tailed)						.	,672
other_inst	Correlation Coefficient							1,000
	Sig. (2-tailed)							.
	N							34

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 45: Correlation Matrix of the Final Model

Correlations (Kendall's Tau_b)						
		Innovative Performance	University	TÜBİTAK_	KOSGEB	Cluster Life Stage
Innovative Performance	Correlation Coefficient	1,000	,541**	,545**	,605**	,063
	Sig. (2-tailed)	.	,001	,001	,000	,702
	N	34	34	34	34	34
University	Correlation Coefficient		1,000	,555**	,363*	,014
	Sig. (2-tailed)		.	,001	,037	,935
	N		34	34	34	34
TÜBİTAK	Correlation Coefficient			1,000	,184	-,156
	Sig. (2-tailed)			.	,292	,369
	N			34	34	34
KOSGEB	Correlation Coefficient				1,000	,032
	Sig. (2-tailed)				.	,853
	N				34	34
Life Cycle Stage	Correlation Coefficient					1,000
	Sig. (2-tailed)					.
	N					34

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

In the multivariate model, TÜBİTAK and KOSGEB have significant correlations with innovation performance ($p_{TÜBİTAK}$=0.02; p_{KOSGEB}=0.003) whereas "life stage of the cluster" and "university" does not have a significant correlation given TÜBİTAK and KOSGEB and controlling for life stage (Table 46).

In Table 46 in the estimates column, the value next to the independent variable show the cumulative logit of that group. The estimate for KOSGEB=0 is $Estimate_{KOSGEB=0}$= -3,888. By taking the $e^{estimate}$, we find the odds ratio of "no cooperation" to "cooperation". Odds ratio of "no cooperation" to "cooperation"is $e^{-3,823}$=0,0205. Since $e^{-3,823}$ = 0,0205<1 and p=0,003<0,005; we conclude that KOSGEB =0 group (not funded by KOSGEB) is less likely to pass to higher levels of innovation than KOSGEB =1 (have relations) group. We make the same conclusion for TÜBİTAK also since estimate (TÜBİTAK=0)=-3,785. Odds ratio of "no cooperation" to "cooperation"ise$^{-3,785}$= 0,0227<1 and p=0,017<0,005. Therefore we conclude that TÜBİTAK and KOSGEB predict innovation; companies which have a relationship with TÜBİTAK and KOSGEB are have higher levels of innovative performance.

Table 46: Results of the Model Analysis

	Parameter	Estimate	Std. Error	Sig.
Threshold	[innovative_performance = 1]	-8,369	2,339	0
	[innovative_performance = 2]	-3,501	1,593	0,028
Location	[life_cycle=1]	-1,097	1,003	0,274
	[life_cycle=2]	0a	.	.
	[TÜBİTAK=0]	-3,785	1,583	0,017
	[TÜBİTAK=1]	0a	.	.
	[KOSGEB=0]	-3,888	1,296	0,003
	[KOSGEB=1]	0a	.	.
	[University=0]	-1,117	1,015	0,271
	[University=1]	0a	.	.

Link function: Logit. a. This parameter is set to zero because it is redundant.

With regards to the differences in two different cluster life stages, “importance” and dummy variable “cooperation with institutions” of the two clusters were compared. Descriptives are given in Appendix 2. The results of the Mann-Whitney U test were given below.

H_0= The importance of the institutions which influence the innovative performance are the same in two different cluster life stages.

H_1= The importance of the institutions which are important for the innovative performance changes in two different cluster life stages.

Since all the p-values for all institutions are larger than 0,05 (Table 47); we fail to reject the null hypothesis. There is no significant relationship between the two cluster life stages in terms of importance of the institutions.

Table 47: Importance of the Institutions Mann Whitney U Test Results

	Mean		Mann Whitney U	Asymp. Sig. (2-tailed)
	Emerging (N=13)	Mature (N=21)		
Importance of Institutions				
importance_University	3,77	3,48	128,000	0,727
importance_TÜBİTAK	4,31	4,14	131,000	0,793
importance_Local_fund_inst	4,38	3,86	92,500	0,088
importance_Other_institutions	4,31	4,90	110,500	0,100

Ho=The type of the institutions that the companies cooperate are the same in different cluster life stages.

H_1= The type of the institutions that the companies cooperate changes in different cluster life stages.

Since all the p-values for all institutions are larger than 0,05 (Table 48); we fail to reject the null hypothesis. There is no significant difference between the two clusters in terms of cooperation with a specific institution.

Table 48: Findings of the Hypothesis Tests for Institutions

	Mean		Mann Whitney U	Asymp. Sig. (2-tailed)
	Emerging (N=13)	Mature (N=21)		
Cooperation with Institutions				
University	0,46	0,48	134,500	0,935
research_inst	0,00	0,00	136,500	1,000
train_inst	0,23	0,14	124,500	0,520
dev_agency	0,15	0,29	118,500	0,385
TÜBİTAK	0,38	0,24	116,500	0,369
KOSGEB	0,54	0,57	132,000	0,853
other_inst	0,54	0,38	115,000	0,376

Results of the comparison of two life stages in terms of knowledge sources and institutions are summarised in Table 49.

Table 49: Comparison of Life Stages-Knowledge Sources and Institutions

	Hypothesis	P Values Sig. (2-tailed)
Knowledge Sources	H_0= Market knowledge source types are the same in different life cycle stages. H_1= Market knowledge source types are different for different life cycle stages.	$p_{customer}$ = 0,864 > 0,05 $p_{supplier}$ = 0,062 > 0,05 p_{other} = 0,113 > 0,05 Not supported
	H_0= Market knowledge source spatial levels are the same in different life cycle stages. H_1= Market knowledge source spatial levels are different for different life cycle stages.	$p_{international}$ = 0,530 > 0,05 $p_{national}$ = 0,502 > 0,05 p_{local} = 0,272 > 0,05 Not supported
	H_0= Technical knowledge source types are the same in different life cycle stages. H_1= Technical knowledge source types are different for different life cycle stages	$p_{customer}$=0,827 > 0,05 $p_{supplier}$=0,882 > 0,05 p_{other}=0,421 > 0,05 Not supported
	H_0= Technical knowledge source spatial levels are the same in different life cycle stages. H_1= Technical knowledge source spatial levels are different for different life cycle stages	$p_{international}$=0,453 > 0,05 $p_{national}$=0,854 > 0,05 p_{local}=0,664 > 0,05 Not supported
Institutions	H_0= The importance of the institutions which are important for the innovative performance are the same in two different life cycle stages. H_1= The importance of the institutions which are important for the innovative performance changes in two different life cycle stage	$p_{importance\_University}$=0,727 $p_{importance\_TÜBİTAK}$=0,793 $p_{importance\_Local\_fund\_inst}$=0,088 $p_{importance\_Other\_institutions}$=0,100 Not supported
	H_0=The type of the institutions that the companies cooperate are the same in two different life cycles. H_1= The type of the institutions that the companies cooperate changes in two different life cycles.	$p_{University}$ =0,935 $p_{research\_inst=1}$=1,000 p_{train_inst}=0,520 p_{dev_agency}=0,385 $p_{TÜBİTAK}$=0,369 p_{KOSGEB}=0,853 p_{other_inst}=0,376 Not supported

Although we see no significant differences between cluster life stages, a significant difference is observed between the different innovation level categories. The importance of the institutions increase as the innovative category rises (Table 50). In high innovation category university has the highest level of importance (2=important) followed by TÜBİTAK (2,7=between important and moderately important). However, in the moderate innovation performance category, these ratings are low; 4,8 for TÜBİTAK and 3,9 for the university. Moderate and high categories rate the same for local funds, a low grade close to 4 (slightly important) (Table 50). Furthermore, there is a significant difference between high and low innovation categories, in terms of both importance of and cooperation with the university, KOSGEB and TÜBİTAK (Table 51).

Table 50: Importance of The Institutions –Innovation Category Breakdown

	Mean		
Importance of the Institutions	Low (N=8)	Moderate (N=16)	High (N=10)
University	5	3,9	2
TÜBİTAK	5	4,8	2,7
Local Funds	5	3,8	3,7
Other instituitons	5	4,4	4,8

The low level of importance and not having cooperation with the institutions in the low innovation category can be explained by not having an innovative idea to apply for such funds. However in the moderate category it takes a different route. The interviewed companies in the moderate category stated that although they had innovative ideas, generally they were reluctant to apply for these funds due to long and bureocratic procedures; in some cases, the project per se could be completed in a shorter time than the application process. Especially in the emerging cluster most of the companies stated that the university academics are either incompetent to cooperate with firms or the topics that the academics study are not relevant with the industry's needsand in some cases the fee they charge is more than their contribution to the project. The reason for the high innovative category companies' to cooperate with institutions can be explained as; these companies have larger projects with high budgets and long duration where funding gets more important. In addition, since these projects are highly innovative (new to the market) the company needs an expert from external sources, this explains the high importance of the university for this category.

Table 51: Comparison of High and Low Innovation Category Levels in Terms of Institutions

Test Statistics						
	importance_ University	importance_ TUBİTAK	importance_ KOSGEB	University	TÜBİTAK	KOSGEB
Mann-Whitney U	8,000	12,000	8,000	8,000	12,000	4,000
Wilcoxon W	63,000	67,000	63,000	44,000	48,000	40,000
Z	-3,194	-2,870	-3,169	-3,298	-2,942	-3,688
Asymp. Sig. (2-tailed)	,001	,004	,002	,001	,003	,000
Grouping Variable: Innovative Performance						

4.8.5. Interpretation Of The Findings

The results of the SNA show that the mature cluster is bigger in terms of number of cluster companies and these companies have more contacts (both in market and technological knowledge sources) than the emerging cluster. This is in line with the literature which suggests that the number of companies increase during the maturing process; however the knowledge sharing is at very low levels in both of the clusters.

In the multivariate model, we aimed to predict innovation with the knowledge sources and the institutions taking the cluster life stage as the control variable. In our model, knowledge sources and the innovation were not significantly correlated. With regards to the institutions, although three of them, university, TÜBİTAK and

KOSGEB are correlated to innovation, only the funding institutions -TÜBİTAK and KOSGEB- predict innovation in the model.

Comparison of the two life stages shows that there is not a significant difference between two clusters with respect to knowledge sources and the institutions in terms of numbers, shares or the importance. On the other hand the importance of the institutions rise as the innovation category rises. In terms of cooperation with the institutions, there is a significant difference in two innovation categories- high and low. In low category, none of the companies cooperates with these institutions, whereas in high category this 70-90% of the companies do. In addition, larger firms (in terms of number of employees) also tend to cooperate with university, TÜBİTAK and training institutions. Therefore larger firms and innovative firms have more cooperation with institutions, which can be interpreted as -relatively to the other firms-; they have larger projects which are high in budget and have long duration, where external specialist’s contribution and funding is required.

However, the qualitative side of the research (Q16-19) and conversations during the interviews provide valuable information on the indirect contribution of the institutions. Companies stated that application and implementation of the project with funding institutions made their companies to set their goals, objectives and strategies and helped get a better reporting system, they adapted the these reports for their daily operations. They can reach more accurate information in a very short time period which improved the efficiency of the overall operations.

Interviews made by organisations and firms also showed that institutions contribute to development of the clusters. The mature cluster has a cluster organisation (ESSİAD) which carries out clustering efforts in an organized manner. The cluster organisation runs an UR-GE project (a common project for the development of the cluster companies), by which it organizes training courses, seminars, and trade missions and leads the participation to fairs. Firms in the mature cluster see this as a concrete benefit of being in a cluster. The test laboratory project run by the cluster initiative is also regarded very important by the cluster companies as it will reduce their testing costs dramatically. This testing laboratory will be an accredited world class laboratory and it will be the first one in Turkey. The project is funded by the development agency, Aegean Region Chamber of Industry (EBSO), and TOBB. This funding support is shows the good cooperation of the cluster organisation members with those institutions. Also, by the mature cluster's demand, IZKA is running an international project for this cluster. The project will examine the development of the world leader Italian cluster in the same sector, to reveal the steps that the Italian cluster has taken, the companies in the two clusters will gather in workshops for cooperation purposes. These are good practices of insitutions' contributions to the cluster development, which supports the literature on clusters, RIS and the institutions. Although there is not a direct contribution, indirectly there is an enormous benefit of being in RIS with a developed institutional context, it provides opportunities for the firms such as meeting with world class firms and having a world class laboratory which a company could not achieve by itself. The social capital in the mature cluster also has a very important role to reach this level. In cluster member meetings, they took the decision to establish a Sectoral Foreign Trade Association, which is on the national level. Twice a year, the members come together with all parties of the HVAC-R sector in Turkey ,- main companies, universities, customers, suppliers, and related instituitons- and the companies in the same sector but not in this cluster to discuss the sector's problems and solutions with various aspects. Furthermore, this association strengthened the cluster more as they have their own say on the governmental level. This is an initative which make the cluster to enlarge and move on to the national level.

Table 52 summarizes illustrates the comparison of the two clusters.

Table 52: Comparison of the Two Clusters

	Denizli Machinery Cluster	**IVAC-R Cluster**
Life Stage/Phase	Emergence	Maturity/Sustainment
Number of Interviewed Companies	13	21
Knowledge Base	Synthetic	Synthetic
RIS barrier	Peripheral Region	Old Industrial Region
Cluster Organisation	Does not exist yet	ESSIAD
Average Innovative Performance of the Firms		
Low	3 (23%)	5 (24%)
Moderate	7 (54%)	9 (43%)
High	3 (23%)	7 (33%)
SNA Results (Marketing)		
Number of nodes	32	181
Number of links	32	104
Density	0,064	0,038
Degree	2,000	3,907
Betweenness Centrality	22,091	88,042
Closeness Centrality	0,060	0,004
Clustering Coefficient	0,008	0,281
SNA Results (Technological)		
Graph Density	0,0161	0,0293
Degree	2,176	3,462
Betweenness Centrality	69,735	135,613
Closeness Centrality	0,022	0,003
Clustering Coefficient	0,014	0,099
Types of knowledge sources important for the innovative performance	No significant difference	
Types of institutions important for the innovative performance	No significant difference	

CONCLUSION

This study analyses the development of clusters throughout time with respect to their knowledge sources and institutional context aiming to find what the type and spatial level of knowledge sources and type of institutions are the predictors of innovation in different cluster life stages in a synthetic knowledge base. In order to figure out the differences of cluster life stages, two clusters from two different phases -emergence and maturity- were chosen as sample.

Knowledge sharing within a cluster is a natural process and a must, but knowledge sources should not be limited to the local level, for the innovativity the cluster has to get knowledge from external sources as well. Considering that the clusters are in synthetic knowledge base, tacit knowledge should be having more importance, it is expected that interactive learning with customers and suppliers be high. However, the results of this study reveal a negative profile for both clusters in terms knowledge sharing; the knowledge sharing is at very low levels both locally and externaly. Among the three spatial levels of knowledge sources, local sources have the highest importance in both clusters. Although this is in line with literature, it is risky for the clusters as it carries the risk of cognitive lock-in where the cluster members begin to think and act the same way. The literature shows that the lock-in is the cause of the decline of the succesful clusters. The statements of the interviewees in the mature cluster showed that there is high competition among the cluster members and this is mainly on pricing. In order to get out of this facit cycle, the firms should act more innovatively by getting in contact with more external sources. Although the lack of cooperation on the innovation side is weak in both clusters, the mature cluster has a more organized social capital than the emerging cluster; they are active members of the cluster organisation, and work for the benefit of the cluster such as getting funds for the cluster, and expanding the scope of the cluster and so on.

Current network structures do not provide a good picture concerning the future trajectory of the clusters; on the other hand; the information received during the interviews in IVAC-R cluster is promising in the sense that the cluster firms and the cluster organisation are aware that they have to open up to new markets, and the external knowledge flows are required. The UR-GE projects to open up to foreign markets, and also an international project to benchmark the world leader Italian HVAC-R sector can be a milestone in the cluster's trajectory leading to the re-orientation of the cluster. Denizli Machinery Cluster (emerging cluster) is also trying to gather in the specialized industrial zone, with the aim of increasing communication possibilities. The milestone for this cluster will be increasing the number of companies to reach a critical mass.

Another finding on the knowledge sources is that -contradictory to the literature-, they are not correlated with innovation. However, it would be misleading to interpret it as external sources do not affect companies' innovativeness positively. The companies in this study have mostly introduced innovativeness new to the Turkish market, comparing these clusters with highly innovative clusters can lead to a different conclusion.

In terms of the firms' cooperation with institutions, no significant difference is observed, however; when we analyse the trajectory of each cluster throughout time, we observe a big gap between the two clusters with regards to the institutional context. The emerging cluster does not have a cluster organisation to manage the cluster yet, whereas the mature cluster has cluster organization which carries out clustering efforts in an organized manner. Also the development agency IZKA has concrete support for the mature cluster's development in various aspects, with respect to the emerging cluster, there is no cooperation with the development agency GEKA. The statements of the interviewees show that the mature cluster's success is mainly due to its social capital and the institutions' support and more importantly the cooperation between these two parties which is in consistent with the RIS literature. This is completely opposite in the emerging cluster. During the interviews, firms have complained about the local institutions, universities and funding organizations. The only institution that cooperates with the cluster is Denizli Chamber of Industry. The Chamber supports the cluster in terms of organization and carries out the establishment of the specialized organized industrial zone. The cluster firms believe that clustering raised awareness on cooperation; they have a common goal of building Specialised Industrial Zone. They believe that gathering in the same place will provide opportunity to meet more often and accelerate clustering efforts. For the emerging cluster to step up to the next level, specialised industrial zone can be a good opportunity, however; the number of companies (critical mass) should be increased, and also the supplier side of the cluster should be improved. Therefore it can be concluded that Denizli Machinery sector suffers from being in a peripheral region which has a low institutional capacity.

The multivariate model suggests that two funding institutions; KOSGEB and TÜBİTAK are the predictors of innovative performance given university and controlling for the life stage. Firms in the high innovation category benefit from the institutions in terms of funding, utilization of an expert/consultancy service. Also, larger firms tend to cooperate with these institutions and training institutions. The statements of the interviewees show that there are mainly two reasons for medium and low category firms' not cooperating with the institutions. First, these firms don't have innovative ideas to get funding, and second, they find the application and project management process too bureaucratic. These companies should be improved in terms of innovativeness and by easing their access to the funds. This can be achieved by raising awareness on innovativeness and funds. However, these activities are mostly on giving a seminar on innovation or training courses on writing projects. Although this may work on the higher firms, for the lower segment companies, it might be better to start with best practices, e.g. showing them how the reporting in the application and management system will improve their efficiency and how an innovative idea changed a company's profile.

This study also shows that the contribution of the institutions is not only on the technological side; but also on the non-technological development for the firms and the clusters.

This study is original in the sense that it compares two life phases of the clusters in terms of knowledge sources and institutional context and their relation to innovative performance in the synthetic knowledge base. It contributes to the literature by showing that

1. The cluster life stage does not affect the pattern of knowledge sources and cooperation of firms with institutions,

2. Cooperation with institutions patterns change in different innovation category, and it is highest in the high innovation category,

3. A developed institutional context affect the cluster development positively.

This study was applied on the synthetic knowledge base, further studies can examine the other knowledge bases to make a comparison among the three knowledge bases. In addition, as mentioned previously as a limitation, this study was applied in two different cluster with two different cluster life stages since there was no previous research related to our study. To analyse the trajectory of one cluster throughout the time in terms of network structure, innovation performance and the institutional context will make sense. To observe how these clusters have changed, same clusters can be analysed again in future when they pass along the milestones, for the emerging cluster moving to the organised industrial zone and for the mature cluster, opening of the test laboratory and finalisation of the international project.

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APPENDICES

Appendix 1: Kümelenmenin Firmaların İnovasyon Performansına Etkisi Doktora Tezi Anket Çalışması

Firma Adı	:	
Adres	:	
Telefon	:	
Görüşülen kişinin ismi ve ünvanı	:	

BÖLÜM 1: FİRMA BİLGİLERİ

1. Firma kuruluş yılı:

2. Çalışan sayısı:

3. Çalışan eğitim düzeyi:

Yüksek Lisans	kişi
Üniversite	kişi
Diğer	kişi

4. Lütfen firmanızın faaliyet alanını belirtiniz:

Standart ürün üretimi ☐

Özel ürün üretimi ☐

Dizayn ☐

Diğer (lütfen belirtiniz) ☐

BÖLÜM 2: İNOVASYON PERFORMANSI

5. Firmanızda son 3 yılda aşağıdaki faaliyetlerden hangisi/hangileri gerçekleştirilmiştir?

	Pazar için yeni bir ürün ve/veya üretim süreci geliştirilmiştir.
	Firma için yeni olan bir ürün ve/veya üretim süreci geliştirilmiştir.
	Halihazırda mevcut olan ancak firma için yeni sayılan bir üretim süreci firmada uygulamaya başlanmıştır.
	Firmanın pazarlama stratejisinde değişiklik yapılmış/yeni pazarlara satış yapmaya başlanmıştır.
	Firma yeni organizasyonel stratejiler uygulamaya başlamıştır.

(Firmanın yukarıdaki seçeneklerin hiçbirini işaretlememesi durumunda Bölüm 3'e geçilecek.)

6. Son 3 yıl içinde firma tarafından yeni patent alınmış ve/veya patent başvurusu yapılmıştır.

Evet ☐ Hayır ☐

7. Firmanın Ar-Ge/Ürün geliştirme departmanı

Bulunmaktadır ☐ Bulunmamaktadır ☐

8. Firmanızda yeni bir ürün/üretim süreci geliştirme faaliyetleri ağırlıklı olarak aşağıdakilerden hangi yöntemle gerçekleştirilmektedir?

	Ürün spesifikasyonları tedarikçisi olduğumuz firma tarafından bize gönderilmektedir.
	Firmamız müşterilerden talep geldikçe yeni ürün/üretim yöntemi geliştirme çalışmaları yapmaktadır.
	Satış-pazarlama/ar-ge birimi tarafından düzenli olaraktoplanan bilgiler doğrultusunda sistematik olarak ürün geliştirme çalışmalarıyapılmaktadır.

BÖLÜM 3: BİLGİ KAYNAKLARI

9. Lütfen yeni ürün/üretim teknolojisi anlamında bilgi paylaşımı yaptığınız firmaları ve yeni ürün/üretim süreci geliştirmede firmanız için öneminibelirtiniz.(1=en önemli, 5=önemli değil)

Firma /Kurum Adı	Firma /kurum ile ilişki		İlişki türü (Müşteri/Tedarikçi/ Diğer)	Önem derecesi
	Evet	Hayır		

10. Lütfen pazarlama ve/veya organizasyonel yenilik anlamında bilgi paylaşımı yaptığınız firmaları ve teknolojik dışı yenilik anlamında firmanız için öneminibelirtiniz.

(1=en önemli, 5=önemli değil)

Firma /Kurum Adı	Firma /kurum ile ilişki		Firma türü (Müşteri/Tedarikçi/Diğer)	Önem derecesi	Bölge (Yerel/bölge içi/ulusal/ uluslararası)
	Evet	Hayır			

11. Lütfen aşağıdaki faaliyetleri işbirliği yaptığınız firmalar ile ilişkilerin kurulmasındaki faydasına göre sıralayınız. (1=en faydalı 5=en az faydalı)

	Firma çalışanı/ortaklarının önceki kişisel ilişkileri
	Küme üyelerini biraraya getiren toplantılar
	Ticaret heyetleri ve fuarlara katılım
	Katıldığımız eğitimler
	Diğer (Lütfen açıklayınız)

BÖLÜM 4: KURUMLAR VE FAALİYETLERİ

12. Lütfen işbirliği yaptığınız kurumları belirtiniz.

	Üniversite
	Araştırma kurumları (Lütfen belirtiniz)
	Eğitim kurumları (Lütfen belirtiniz)
	İZKA
	TÜBİTAK
	KOSGEB
	Küme yönetim organizasyonu

	Diğer (Lütfen belirtiniz)

13. Lütfen yukarıda belirttiğiniz kurumlarınınovasyon anlamında firmanız için öneminibelirtiniz. (1=en önemli, 5=önemli değil)

Önem Derecesi	Kurum Adı
	Universite/Araştırma Kurumları
	TÜBİTAK
	Küme Yönetim Organizasyonu
	KOSGEB
	İZKA vb. fon sağlayan kurumlar
	Diğer (Lütfen belirtiniz)

14. Lütfen aşağıdaki faaliyetleri yeni ürün/üretim süreci geliştirmeanlamındaki faydasına göre sıralayınız. (1=en önemli, 5=önemli değil)

Önem Derecesi	Faaliyet
	Personele yönelik düzenlenen teknik eğitimler
	Küme üyelerini biraraya getiren toplantılar
	Kurumlar tarafından verilen teknolojik uzmanlık desteği
	Fuarlar, fon kaynakları vb. hakkında bilgilendirme yapılması
	Araştırma projeleri vb. için fon desteği sağlanması

15. Lütfen aşağıdaki faaliyetleri teknoloji dışı yenilik anlamındaki faydasına göre sıralayınız. (1=en önemli, 5=önemli değil)

Önem Derecesi	Faaliyet
	Personele yönelik düzenlenen eğitimler
	Küme üyelerini biraraya getiren toplantılar
	Kurumlar tarafından verilen uzmanlık desteği
	Fuarlar, fon kaynakları vb. hakkında bilgilendirme yapılması
	Pazar araştırma, fuarlara katılım vb. için fon desteği sağlanması

16. EHİS kümesinde bulunmak firmanızın inovasyon performansına ne şekilde katkıda bulunmuştur? Lütfen aşağıdaki seçenekleri faydasına göre sıralayınız.

(1=en önemli, 5=önemli değil)

	Kümede yeralan inovatif firma/kurumlarla işbirliği yapmamı sağladı.
	Küme dışındaki firma/kurumlarla işbirliği yapmamı sağladı.
	Ortak küme faaliyetleri ile ar-ge maliyetlerimiz düştü.
	İşgücü kalitem arttı /Kaliteli işgücüne ulaşabilmemi sağladı.
	Kümeye sağlanan özel desteklerden faydalanmamı sağladı.

17. Sizce kümenin başlangıç yıllarından bugüne kadar kümedeki en belirgin değişiklik nedir?

18. Kümedeki bu değişikliğe en çok hangi faaliyetin faydalı olduğunu düşünüyorsunuz?

19. Kümenin bir aşama ileri gitmesi/gelişmesi için ne tür aktiviteler yapılması gerektiğini düşünüyorsunuz?

Katıldığınız için teşekkür ederim.

Appendix 2: Frequency Tables of Knowledge Sources

A2-1: number_of_source_customer_tech * Life Cycle Stage Crosstabulation

		Life Cycle Stage		Total
		Emerging	Mature	
number_of_source_customer_tech	0	4	4	8
	1	2	1	3
	2	3	0	3
	3	1	2	3
	5	2	3	5
	6	0	2	2
	7	0	2	2
	8	0	1	1
	9	1	0	1
	10	0	1	1
	11	0	2	2
	12	0	1	1
	17	0	1	1
	18	0	1	1
Total		13	21	34

A2-2:number_of__source_supplier_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
number_of__source_supplier_tech	0	5	9	14
	1	2	2	4
	2	3	3	6
	3	1	2	3
	5	1	2	3
	6	0	1	1
	9	1	1	2

	16	0	1	1
Total		13	21	34

A2-3: number_of__source_other_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		
		Emerging	Mature	Total
number_of__source_other_tech	0	5	14	19
	1	2	2	4
	2	1	2	3
	3	1	1	2
	4	2	0	2
	6	0	1	1
	8	1	0	1
	9	1	0	1
	18	0	1	1
Total		13	21	34

A2-4: share_customer * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_customer	0	4	4	8
	0.07	1	0	1
	0.09	1	0	1
	0.14	0	1	1
	0.18	1	0	1
	0.25	1	0	1
	0.4	1	0	1
	0.44	0	1	1
	0.5	0	1	1
	0.55	0	1	1
	0.58	0	1	1
	0.63	0	1	1
	0.67	1	0	1
	0.69	1	0	1
	0.71	2	0	2
	0.8	0	1	1
	0.83	0	1	1
	1	0	9	9
Total		13	21	34

A2-5: share_supplier * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_supplier	0	5	9	14
	0.05	0	1	1
	0.13	0	1	1
	0.14	1	0	1
	0.17	0	1	1
	0.18	1	0	1
	0.19	0	1	1
	0.23	1	0	1
	0.25	0	1	1
	0.29	1	0	1
	0.33	1	0	1
	0.42	0	1	1
	0.45	1	1	2
	0.5	0	2	2
	0.64	1	0	1
	0.71	0	1	1
	0.76	0	1	1
	1	1	1	2
Total		13	21	34

A2-6: share_other * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_other	0	5	14	19
	0.07	0	1	1
	0.08	1	0	1
	0.1	0	1	1
	0.13	0	1	1
	0.14	1	0	1
	0.29	1	1	2
	0.36	1	0	1
	0.38	0	1	1
	0.5	0	1	1
	0.6	1	0	1
	0.73	1	0	1
	0.75	1	0	1
	0.95	0	1	1
	1	1	0	1
Total		13	21	34

A2-7: imp_customer_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_customer_tech	very important	1	3	4
	important	5	5	10
	fair	2	6	8
	not so important	1	3	4
	not important	4	4	8
Total		13	21	34

A2-8: imp_supplier_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_supplier_tech	very important	1	4	5
	important	2	3	5
	fair	5	4	9
	not so important	0	1	1
	not important	5	9	14
Total		13	21	34

A2-9: imp_other_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_other_tech	very important	0	2	2
	important	1	1	2
	fair	1	3	4
	not so important	6	1	7
	not important	5	14	19
Total		13	21	34

A2-10: number_of__int_source_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
number_of__int_source_tech	0	9	13	22
	1	1	3	4
	2	1	2	3
	3	1	1	2
	6	0	2	2
	7	1	0	1
Total		13	21	34

A2-11: number_of__national_source_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
number_of__national_source_tech	0	6	7	13
	1	2	5	7
	2	1	2	3
	3	3	3	6
	4	0	1	1
	5	1	0	1
	6	0	2	2
	11	0	1	1
Total		13	21	34

A2-12: number_of__local_source_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		
		Emerging	Mature	Total
number_of__local_source_tech	0	2	3	5
	1	0	2	2
	2	2	1	3
	3	4	0	4
	4	1	1	2
	5	0	2	2
	6	2	4	6
	9	1	0	1
	10	1	1	2
	12	0	1	1
	13	0	2	2
	14	0	1	1
	16	0	2	2
	19	0	1	1
Total		13	21	34

A2-13: share_international * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		
		Emerging	Mature	Total
share_international	0	8	14	22
	0.05	0	1	1
	0.06	0	2	2
	0.1	0	1	1
	0.14	1	0	1

	0.33	1	0	1
	0.4	1	1	2
	0.5	1	1	2
	1	1	1	2
Total		13	21	34

A2-14: share_national * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_national	0	6	7	13
	0.05	0	1	1
	0.06	0	1	1
	0.07	1	0	1
	0.09	1	1	2
	0.11	0	1	1
	0.18	1	0	1
	0.2	0	3	3
	0.24	0	1	1
	0.29	0	1	1
	0.33	1	0	1
	0.38	0	2	2
	0.43	2	0	2
	0.45	1	0	1
	0.86	0	1	1
	0.92	0	1	1
	1	0	1	1
Total		13	21	34

A2-15: share_local_regional * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_local_regional	0	2	3	5
	0.08	0	1	1
	0.14	0	1	1
	0.33	1	0	1
	0.4	0	1	1
	0.43	2	0	2
	0.5	0	1	1
	0.55	1	0	1
	0.57	1	0	1
	0.6	1	0	1
	0.62	0	1	1
	0.63	0	2	2
	0.76	0	1	1
	0.8	0	2	2
	0.82	1	0	1
	0.88	0	1	1
	0.89	0	1	1
	0.9	0	1	1
	0.91	1	1	2
	0.94	0	1	1
	1	3	3	6
Total		13	21	34

A2-16: imp_int_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_int_tech	very important	0	5	5
	important	4	2	6
	moderate	0	1	1
	not important	9	13	22
Total		13	21	34

A2-17: imp_nat_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_nat_tech	0	1	0	1
	very important	1	3	4
	important	3	5	8
	moderate	2	6	8
	slightly	1	0	1
	not important	5	7	12
Total		13	21	34

A2-18: imp_int_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_int_tech	very important	0	5	5
	important	4	2	6
	moderate	0	1	1
	not important	9	13	22
Total		13	21	34

A2-19: imp_nat_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_nat_tech	very important	1	3	4
	important	3	5	8
	moderate	2	6	8
	slightly	1	0	1
	not important	6	7	13
Total		13	21	34

A2-20: imp_local_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_local_tech	very important	2	2	4
	important	1	6	7
	moderate	3	7	10
	slightly	4	2	6
	not important	3	4	7

A2-20: imp_local_tech * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_local_tech	very important	2	2	4
	important	1	6	7
	moderate	3	7	10
	slightly	4	2	6
	not important	3	4	7
Total		13	21	34

A2-21: Number_source_customer_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
Number_source_customer_MRK	0	8	14	22
	1	1	0	1
	2	2	0	2
	3	1	1	2
	8	0	1	1
	15	0	1	1
	17	0	1	1
	22	1	0	1
	23	0	1	1
	26	0	1	1
	34	0	1	1
Total		13	21	34

A2-22: Number_source_supplier_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		
		Emerging	Mature	Total
Number_source_supplier_MRK	0	11	12	23
	1	0	1	1
	2	1	1	2
	5	0	5	5
	10	0	1	1
	12	1	0	1
	18	0	1	1
Total		13	21	34

A2-23: Number_source_other_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		
		Emerging	Mature	Total
Number_source_other_MRK	0	8	17	25
	1	2	0	2
	2	0	1	1
	3	2	0	2
	5	0	2	2
	9	1	0	1
	20	0	1	1
Total		13	21	34

A2-24: share_cust_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_cust_MRK	0	8	14	22
	0.33	1	0	1
	0.4	1	0	1
	0.6	0	1	1
	0.65	1	0	1
	0.73	0	1	1
	0.75	1	0	1
	0.77	0	1	1
	0.87	0	1	1
	1	1	3	4
Total		13	21	34

A2-25:share_supp_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_supp_MRK	0	11	12	23
	0.05	0	1	1
	0.13	0	1	1
	0.18	0	1	1
	0.23	0	1	1
	0.35	1	0	1
	0.4	0	1	1
	0.5	0	1	1
	0.67	1	0	1
	0.71	0	1	1
	0.78	0	1	1
	1	0	1	1

A2-25:share_supp_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_supp_MRK	0	11	12	23
	0.05	0	1	1
	0.13	0	1	1
	0.18	0	1	1
	0.23	0	1	1
	0.35	1	0	1
	0.4	0	1	1
	0.5	0	1	1
	0.67	1	0	1
	0.71	0	1	1
	0.78	0	1	1
	1	0	1	1
Total		13	21	34

A2-26: share_other_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_other_MRK	0	8	17	25
	0.25	1	0	1
	0.29	0	1	1
	0.45	0	1	1
	0.5	0	1	1
	0.6	1	0	1
	0.95	0	1	1
	1	3	0	3
Total		13	21	34

A2-27: imp_supp_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_supp_MRK	very important	0	1	1
	important	0	5	5
	moderate	2	3	5
	not important	11	12	23
Total		13	21	34

A2-28: imp_other_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
imp_other_MRK	very important	1	1	2
	important	2	0	2
	moderate	1	3	4
	slightly	2	0	2
	not important	7	17	24
Total		13	21	34

A2-29: number_international_source_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
number_international_source_MRK	0	11	16	27
	1	1	2	3
	2	1	1	2
	3	0	2	2

A2-29: number_international_source_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
number_international_source_MRK	0	11	16	27
	1	1	2	3
	2	1	1	2
	3	0	2	2
Total		13	21	34

A2-30: number__national_source_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
number__national_source_MRK	0	9	12	21
	1	0	3	3
	2	2	1	3
	3	0	1	1
	4	1	1	2
	6	0	2	2
	7	1	0	1
	8	0	1	1
Total		13	21	34

A2-31: number_local_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
number_local_MRK	0	8	11	19
	1	1	1	2
	3	2	0	2
	5	0	1	1
	8	0	1	1
	9	1	0	1
	13	0	1	1
	14	0	1	1
	17	0	1	1
	19	0	2	2
	25	0	1	1
	27	1	0	1
	33	0	1	1
Total		13	21	34

A2-32: share_international_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_international_MRK	0	11	16	27
	0.05	0	2	2
	0.07	0	1	1
	0.13	0	1	1
	0.33	1	0	1
	0.4	1	0	1
	1	0	1	1
Total		13	21	34

A2-33: share_national_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_national_MRK	0	9	12	21
	0.04	0	1	1
	0.05	0	1	1
	0.07	0	1	1
	0.1	0	1	1
	0.14	0	1	1
	0.2	0	1	1
	0.21	1	0	1
	0.26	0	1	1
	0.32	0	1	1
	0.67	1	0	1
	0.86	0	1	1
	1	2	0	2
Total		13	21	34

A2-34: share_local_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
share_local_MRK	0	8	11	19
	0.14	0	1	1
	0.6	1	0	1
	0.61	0	1	1
	0.68	0	1	1
	0.79	1	0	1
	0.8	0	1	1
	0.85	0	1	1
	0.86	0	1	1
	0.87	0	1	1
	0.9	0	1	1
	0.96	0	1	1
	1	3	1	4
Total		13	21	34

A2-35: importance_international_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		Total
		Emerging	Mature	
importance_international_MRK	very important	0	2	2
	important	2	2	4
	slightly	0	1	1
	not important	11	16	27
Total		13	21	34

A2-36: importance_national_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		
		Emerging	Mature	Total
importance_national_MRK	very important	1	0	1
	important	0	5	5
	moderate	3	2	5
	slightly	0	2	2
	not important	9	12	21
Total		13	21	34

A2-37: importance_local_MRK * Life Cycle Stage Crosstabulation

Count

		Life Cycle Stage		
		Emerging	Mature	Total
importance_local_MRK	very important	0	1	1
	important	1	4	5
	moderate	1	5	6
	slightly	3	0	3
	not important	8	11	19
Total		13	21	34

A2-38: Types of Technological Sources-Innovation Category Breakdown: Importance, Number and Share Means

	Low	Moderate	High
	Mean	Mean	Mean
imp_customer_tech	2,5	3,2	3,3
imp_supplier_tech	3,4	3,6	3,2
imp_other_tech	4,5	4,0	4,1
number_of_source_customer_tech	5,8	4,4	4,9
number_of__source_supplier_tech	2,8	2,1	2,4
number_of__source_other_tech	0,6	2,6	1,8
share_customer	0,6	0,5	0,5
share_supplier	0,3	0,2	0,3
share_other	0,1	0,2	0,2

A2-39: Spatial Level of Technological Sources-Innovation Category Breakdown: Importance, Number and Share Means

	Low	Moderate	High
	Mean	Mean	Mean
imp_int_tech	3,8	3,8	3,9
imp_nat_tech	3,3	3,6	3,0
imp_local_tech	3,3	3,3	2,8
number_of__int_source_tech	1,1	1,0	1,0
number_of__national_source_tech	2,3	1,1	2,7
number_of__local_source_tech	5,8	6,9	4,9
share_international	0,1	0,1	0,1
share_national	0,1	0,0	0,2
share_local_regional	0,6	0,8	0,6

A2-40: Types of Market Sources-Innovation Category Breakdown: Importance, Number and Share Means

	High (N=10)	Moderate (N=16)	Low (N=8)
	Mean	Mean	Mean
imp_cust_MRK	4,4	4,1	4,0
imp_supp_MRK	4,5	4,2	3,8
imp_other_MRK	5,0	4,1	4,1
Number_source_customer_MRK	8,2	3,5	2,3
Number_source_supplie_MRK	3,4	1,8	0,9
Number_source_other_MRK	1,7	2,0	0,0
share_cust_MRK	0,4	0,3	0,1
share_supp_MRK	0,2	0,1	0,1
share_other_MRK	0,2	0,3	0,0

A2-41: Spatial Levels of Market Sources-Innovation Category Breakdown: Importance, Number and Share Means

	High (N=10)	Moderate (N=16)	Low (N=8)
importance_international_MRK	4,6	4,2	4,5
importance_national_MRK	4,4	4,2	3,7
importance_local_MRK	4,8	3,7	3,9
number_international_source_MRK	0,3	0,6	0,1
number__national_source_MRK	3,0	0,8	0,6
number_local_MRK	10,0	4,9	2,4
share_international_MRK	0,0	0,1	0,0
share_national_MRK	0,3	0,1	0,1
share_local_MRK	0,4	0,4	0,1

A2-42: Innovation-Technological Knowledge Source Types Significance Tests

	p-value Sig. (2-tailed)
Number_customer	0,969
Number_supplier	0,539
Number_other	0,738
share_customer	0,522
share_supplier	0,959
share_other	0,907
imp_customer_tech	0,265
imp_supplier_tech	0,769
imp_other_tech	0,733

A2-43: Innovation-Market Knowledge Sources Types Significance Tests

	p-value
Number_customer_mrk	0,173
Number_supplier_mrk	0,176
Number_other_mrk	0,079
share_customer_mrk	0,305
share_supplier_mrk	0,318
share_other_mrk	0,112
imp_customer_mrk	0,395
imp_supplier_mrk	0,242
imp_other_mrk	0,106

A2-44: Innovation and Technological Knowledge Source Spatial Level Correlation Significance Tests

	p value Sig. (2-tailed)
number_of__int_source_tech	0,793
number_of__national_source_tech	0,912
number_of__local_source_tech	0,952
Share_of_ int_source_tech	0,866
Share_of_national_ source_tech	0,479
Share_of_local_ source_tech	0,846
İmportance_int_tech	0,858
İmportance_nat_tech	0,646
İmportance_local_tech	0,457

A2-45: Innovation-Market Knowledge Sources Spatial Level Correlation Significance Tests

	p value Sig. (2-tailed)
number_of__int_source_mrk	0,746
number_of__national_source_mrk	0,054
number_of__local_source_mrk	0,053
Share_of_ int_source_mrk	0,872
Share_of_national_ source_mrk	0,108
Share_of_local_ source_mrk	0,116
İmportance_int_mrk	0,756
İmportance_nat_mrk	0,186
İmportance_local_mrk	0,132

A2-46: Correlations of Employees and Institutions

Correlations									
		Ratio of graduates to total employees	Number of employees	University	Research_ inst	Train _ inst	dev_ agency	TÜBİT AK	KOSGE B
Ratio of graduates to total employees	Pearson Correlation	1	0,067	0,027	.[a]	-0,015	-0,02	0,038	0,045
	Sig. (2-tailed)		0,706	0,879	.	0,934	0,912	0,833	0,801
Number of employees	Pearson Correlation	0,067	1	,422*	.[a]	,553**	0,073	,585**	0,135
	Sig. (2-tailed)	0,706		0,013	.	0,001	0,68	0	0,447
University	Pearson Correlation	0,027	,422*	1	.[a]	0,027	,588**	,555**	,363*
	Sig. (2-tailed)	0,879	0,013		.	0,878	0	0,001	0,035
research_ inst	Pearson Correlation	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]
	Sig. (2-tailed)	.	.	.		.	.	.	.
train_inst	Pearson Correlation	-0,015	,553**	0,027	.[a]	1	-0,257	,378*	0,101
	Sig. (2-tailed)	0,934	0,001	0,878	.		0,143	0,027	0,572
dev_agency	Pearson Correlation	-0,02	0,073	,588**	.[a]	-0,257	1	0,098	0,214
	Sig. (2-tailed)	0,912	0,68	0	.	0,143		0,58	0,225
TÜBİTAK	Pearson Correlation	0,038	,585**	,555**	.[a]	,378*	0,098	1	0,184
	Sig. (2-tailed)	0,833	0	0,001	.	0,027	0,58		0,299
KOSGEB_ Local	Pearson Correlation	0,045	0,135	,363*	.[a]	0,101	0,214	0,184	1
	Sig. (2-tailed)	0,801	0,447	0,035	.	0,572	0,225	0,299	
a. Cannot be computed because at least one of the variables is constant.									
*. Correlation is significant at the 0.05 level (2-tailed).									
**. Correlation is significant at the 0.01 level (2-tailed).									

A2-47: Descriptive Statistics for the Emerging Cluster

Descriptive Statistics				
	N	Minimum	Maximum	Mean
University	13	0	1	0,46
research_inst	13	0	0	0,00
train_inst	13	0	1	0,23
dev_agency_local	13	0	1	0,15
TÜBİTAK_national	13	0	1	0,38
KOSGEB_local	13	0	1	0,54
other_inst	13	0	1	0,54
importance_University	13	1	5	3,77
importance_TÜBİTAK	13	2	5	4,31
importance_Cluster_Initiative	13	3	5	4,85
importance_Local_fund_inst	13	1	5	4,38
importance_Other_institutions	13	1	5	4,31

A2-48: Descriptive Statistics for the Mature Cluster

Descriptive Statistics				
	N	Minimum	Maximum	Mean
University	21	0	1	0,48
research_inst	21	0	0	0,00
train_inst	21	0	1	0,14
dev_agency_local	21	0	1	0,29
TÜBİTAK_national	21	0	1	0,24
KOSGEB_local	21	0	1	0,57
other_inst	21	0	1	0,38
importance_University	21	1	5	3,48
importance_TÜBİTAK	21	1	5	4,14
importance_Cluster_Initiative	21	2	5	4,14
importance_Local_fund_inst	21	1	5	3,86
importance_Other_institutions	21	3	5	4,90

A2-49: Importance of Activity for Technological Innovation

Descriptive Statistics		
Type of Activity	N	Mean
Technical training	26	2,73
Cluster member meetings	26	4,15
Technological_support	26	3,81
Participation to Fairs	26	2,77
Project_funding (by_institutions)	26	3,27

A2-50: Importance of Activity for Non-Technological Innovation

Descriptive Statistics		
Type of Activity	N	Mean
Training	21	3,85
Cluster_meet	21	4,71
specialist_support	21	4,67
Participation_fair	21	4,05
Funding	21	3,71

A2-51: Test Statistics SNA results-Marketing Knowledge Sources

Test Statistics[a]

	degree_mrk	between_mrk	close_mrk	cluster_coef_mrk
Mann-Whitney U	1380,500	1629,500	,000	1039,500
Wilcoxon W	1908,500	2157,500	5460,000	1567,500
Z	-1,612	-,216	-8,963	-3,758
Asymp. Sig. (2-tailed)	,107	,829	,000	,000

a. Grouping Variable: life_stage

A2-52: Test Statistics SNA results-Technological Knowledge Sources

Test Statistics[a]				
	degree_tech	between_tech	close_tech	cluster_coef_tech
Mann-Whitney U	3243,000	3916,000	1595,000	3762,500
Wilcoxon W	6564,000	7237,000	8735,000	7083,500
Z	-4,551	-2,858	-8,266	-3,629
Asymp. Sig. (2-tailed)	,000	,004	,000	,000
a. Grouping Variable: life_stage				

Appendix 3: Validity Test of the Model

The model was analysed by using logit link function. SPSS performs a chi-square to test the difference between the -2LL for the two models.

H_0: The final model does not make any better predictions than the baseline (intercept only model.

H_a: The final model makes better predictions than the baseline (intercept only) model.

Since the $p<0.05$ we have a significant chi-square statistic, we reject the null hypothesis. Our model gives better predictions than the baseline (intercept only) model.

A3-1: Model Fit

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	55,272			
Final	20,740	34,532	4	,000

Link function: Logit.

The model has a significant statistics for both the Pearson's chi-square, (p=0,695) and Deviance (p=0,764); suggesting that the model indicates that the observed data are consistent with the estimated values in the fitted model.

A3-2: Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	12,689	16	,695
Deviance	11,698	16	,764

Link function: Logit.

The pseudo R-squares for McFadden suggests that the model explains %48,1 of; whereas Cox and Snell %63,8, and Nagelkerke %72,6 of the variation of the firms in innovative performance. Especially Nagelkerke and Cox and Snell statistics suggest that the model explains a large proportion of variation in the data.

A3-3: Pseudo R-square

Pseudo R-Square

Cox and Snell	,638
Nagelkerke	,726
McFadden	,481

Link function: Logit.

In the test of parallel lines $p=0.187 > 0.05$; it is concluded that the coefficients of the variables are same in three categories of the dependent variable.

A3-4: Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	20,740			
General	14,579	6,161	4	,187

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.