ANALYSIS OF KNOWLEDGE AND TECHNOLOGY TRANSFER BETWEEN RESEARCH INFRASTRUCTURES AND INDUSTRY IN TURKEY

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

ANALYSIS OF KNOWLEDGE AND TECHNOLOGY TRANSFER BETWEEN RESEARCH INFRASTRUCTURES AND INDUSTRY IN TURKEY

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The main purpose of this study is to analyze the knowledge and technology transfer (KTT) behaviors and attitudes of researchers in research infrastructures (RI) and explore the motivating and deterring factors for their commercialization actions. The study is focused on the researchers in the 4 RIs, which have been supported within the Law on Supporting Research Infrastructures in Turkey. In the study, quantitative data collected through survey among researchers is integrated with the qualitative data gathered through interviews with the RI directors. The research results indicate that researchers' overall engagement in various KTT channels other than academic publishing is low. Commercialization activities are the least common form of KTT activities. In terms of motivating factors for commercialization, research related achievements and societal benefits are more important for researchers than personal gains or other factors. The three most significant deterrent factors for researchers' commercialization behavior are; (i) Insufficient time because of the intensity of academic and scientific activities, (ii) Firms' lack of interest or knowledge about R&D and (iii) Mismatch between the culture and expectations of firms and RIs. Since the legal framework of RIs is relatively new, the survey results reflects both the

preliminary effects of the new system and the impact of the higher education system in general and previous settings in the RIs. In the light of the survey and interview findings, policy recommendations and measures are presented in the last section of the study.

Keywords: Research Infrastructure, Knowledge Transfer, Technology Transfer, Commercialization

ÖZ

TÜRKİYEDE ARAŞTIRMA ALTYAPILARI İLE SANAYİ ARASINDAKİ BİLGİ VE TEKNOLOJİ TRANSFERİNİN ANALİZİ

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Bu çalışmanın temel amacı araştırmacıların, bilgi ve teknoloji transferine ilişkin davranış ve yaklaşımlarının analiz edilmesi ile ticarileştirme faaliyetlerinde bulunma konusunda onları motive eden ve engelleyen faktörleri tespit etmektir. Bu çalışma, Türkiye'de Araştırma Altyapılarının Desteklenmesine Dair Kanun çerçevesinde desteklenmekte olan 4 araştırma altyapısındaki araştırmacılara odaklanmaktadır. Çalışmada, araştırmacılara yönelik anket çalışmasından elde edilen nicel veriler ile araştırma altyapı müdürleriyle yapılan mülakatlardan elde edilen nitel veriler kullanılmıştır. Araştırma sonuçlarına göre, araştırmacıların akademik yayın dışındaki bilgi ve teknoloji transferi faaliyetlerinde bulunma düzeyleri düşüktür. Ticarileştirme faaliyetleri, araştırmacıların bilgi ve teknoloji transferi faaliyetleri arasında en düşük düzeye sahiptir. Ticarileştirmeye yönelik motivasyon faktörleri olarak, araştırmayla ilgili başarı ve kazanımlar ile sosyal faydalar, bireysel kazanç ve diğer faktörlere göre araştırmacılar için daha fazla önem taşımaktadır. Araştırmacıların ticarileştirme faaliyetlerini olumsuz yönde etkileyen en önemli üç faktör; (i) akademik ve bilimsel faaliyetlerin yoğunluğu nedeniyle ticarileştirme faaliyetlerine yeterli zaman ayrılamaması, (ii) özel sektörün Ar-Ge konusunda isteksiz olması veya bilgi sahibi olmaması ve (iii) özel sektör ve araştırma altyapısının farklı kurumsal kültür ve beklentilere sahip olmasıdır. Araştırma altyapılarına ilişkin yasal düzenlemenin

göreceli olarak yeni olması nedeniyle, araştırma sonuçları hem yeni sistemin ilk sonuçlarını, hem de yükseköğretim sisteminin ve araştırma altyapılarındaki önceki sistemin etkilerini yansıtmaktadır. Çalışmanın son bölümünde, anket ve mülakat sonuçları doğrultusunda politika ve uygulama araçlarına ilişkin öneriler sunulmuştur.

Anahtar Kelimeler: Araştırma Altyapıları, Bilgi Transferi, Teknoloji Transferi, Ticarileştirme

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

AUTM	Association of University Technology Managers
EC	European Commission
EU	European Union
ESFRI	European Strategy Forum on Research Infrastructures
IPR	Intellectual Property Rights
KTT	Knowledge and Technology Transfer
NIS	National Innovation System
OECD	The Organization for Economic Co-operation and Development
RI	Research Infrastructure
TTO	Technology Transfer Office
TUBITAK	The Scientific and Technological Research Council of Turkey

CHAPTER 1

INTRODUCTION

In knowledge-based economies, research and innovation has become the primary driving force for sustainable development and global competitiveness. In this regard in today's competitive environment, production and application of knowledge effectively and increasing innovation capability are critical policy issues for countries. Thus, in recent decades, governments heavily concentrate on improving knowledge production and knowledge transfer systems and developing national innovation capability.

Innovation systems of countries are mostly analyzed and discussed under the concept of 'National Innovation System' that draws attention to the linkages and interaction between the actors in an economy. The interactions and joint activities of these public and private institutions lead to the development and diffusion of new technologies and knowledge and contribute to the innovation process (OECD,1997). Therefore, understanding the main characteristics of national innovation systems is critical for policy makers in order to develop proper policies for increasing innovative performance and competitiveness.

Public research that is mainly funded by public resources and executed by public research institutions and universities has very critical functions in national innovation systems. They are the main source of important scientific and technological discoveries that have become major innovations worldwide such as the internet and the scanning electron microscope (OECD, 2013). Therefore, strength of university/public research institution-industry relations is regarded as a major factor for high innovation performance at firm level, sector level or country level (Arvanitis et al., 2008).

In this regard, increasing socio-economic impact of public research has become an important policy concern for policy makers while knowledge and technology transfer between universities/public research institutions and industry has gained considerable attention in the literature.

Policymakers have adopted regulatory actions or developed various policies and support mechanisms in order to increase socio-economic impact of public research. Although many policy measures have been developed to promote university-industry interaction, its potential benefits are not sufficiently achieved especially in the developing countries. This issue is still widely discussed in the international policy platforms in order to identify best practices and exchange knowledge and experience between countries.

Research institutions/infrastructures, with a high level of scientific excellence, are the potential source of breakthrough scientific and technological discoveries and play a significant role in attracting qualified researchers, linking the research communities and leading the technological development. They are quite distinct within and across countries in terms of managerial and governance structures, mission, nature of research (basic, applied or mixed) and funding/income structure. Some of these institutions operate under the ownership of universities while others are directly affiliated to the related Ministries.

In Turkey, in recent years there has been a growing interest towards increasing socio-economic impact of the Research Infrastructures (RI). In the last decade, a significant amount of public budget has been allocated for the establishment and development of RIs in Turkey. However, recent studies and analyses point out that there is a need to improve economic and social impact of these structures, maintain their long term sustainability and develop their interactions with industry. For this aim, a new legislation, namely the Law No. 6550 on Supporting Research Infrastructures, has been adopted in 2014 that aims to convert the RIs into sustainable structures that have their own management bodies, own budget and personnel system and works in close

collaboration with private sector and other stakeholders. The Law mainly introduced a new performance-based support system for RIs in order to maintain effective utilization and sustainability of them.

Developing the knowledge and technology transfer (KTT) activities between RIs and industry is among the top policy priorities in Turkey but studies aiming to analyze the KTT process between RIs and industry is rather a neglected area. This study would make an important contribution to the literature since the main purpose of this study is to investigate the researchers' behaviors and views about various KTT channels and explore the motivating and discouraging factors for their commercialization actions.

This study is focused on the 'Researchers in the four RIs that have been supported within the Law No. 6550 on Supporting Research Infrastructures in Turkey'. Recent studies emphasize that exploring the behavior, views and perception of the 'individual researcher' is very important for developing effective policies and research commercialization activities are commonly executed by eminent researchers in the top-ranked departments or universities (Lam, 2011). Therefore, the researchers in the high performing RIs that have been supported by the RI Law No. 6550 in Turkey have been selected as the unit of analysis of this study. Moreover, RI Law No. 6550 introduces various new mechanisms in order to foster KTT performance of RIs and this study would contribute to assess the preliminary effects of these new measures.

In the study, 'commercialization' behavior of researchers in RIs are analyzed in more detail since in Turkey there has been a growing interest among policy makers towards increasing commercialization of public research in recent years. On the other hand, a wide variety of other forms of KTT instruments are investigated by asking the researchers' involvement level and attitudes regarding these activities. In the study mixed method research approach is used by integrating and interpreting the quantitative data collected through online survey among researchers with the qualitative data gathered through interviews with the directors of the RIs.

This study includes six chapters. In the second chapter, historical development of university-industry and government relations are explained within the context of triple helix and entrepreneurial university concepts. This chapter includes 3 sub-sections. In the section 2.1, definition of KTT between universities/RIs and industry, its importance and benefits for both parties, different types of KTT channels and various policies and support mechanisms adopted by different countries are explored. In the section 2.2 role of RIs in national innovation systems are investigated by emphasizing varieties in the applications and experiences of the countries, additionally recent OECD and EU policies are introduced.

Third chapter focuses on the literature that explores the determinants of KTT, including commercialization. In this chapter as an introduction, extent and content of academic research about KTT and the several factors that affect the KTT tendency and intensity of academicians and researchers are explained. In the section 3.1, recent studies that is concerned with the motivating and deterring factors influencing the propensity of 'researchers' in universities or research institutions to involve in any form of KTT actions are investigated. Finally, main findings of the both theoretical and empirical literature are reviewed.

Fourth chapter focuses on the policies and supports schemes for the development of technology transfer and commercialization in Turkey. In the sub-section 4.1, historical development of policies and support mechanisms towards establishment and development of RIs and the latest developments in this area are reviewed with the related data.

Fifth Chapter includes two sections. Section 5.1 reviews the main purpose of this study and the qualitative and quantitative methodologies used to collect data. In this section aim and content of the survey and interview is explained in detail by making comparisons with the literature. Section 5.2 involves the detailed discussion of the findings of the both survey and the interviews.

In chapter 6, initially a summary of the study is presented. Then overall research findings and policy implications are discussed and policy recommendations rand measures/tools are proposed for increasing knowledge and technology transfer between RIs and industry in Turkey.

CHAPTER 2

DEVELOPMENT OF UNIVERSITY-INDUSTRY-GOVERMENT RELATIONS

In the past, traditionally universities and research institutions mostly focused on knowledge production and education activities. However, in recent decades, there has been a growing interest towards increasing contribution of these organizations to economic and social development.

The economic and societal contribution of public research has been discussed in the 'triple helix' approach and 'entrepreneurial university' concepts. In the 19th century, universities went through a transition in terms of their roles in the society. Their 'research' function gained considerable importance in addition to their teaching role and thus the 'modern university' concept has emerged. In the 20th century, increased international competition, the end of the Cold-War and the emergence of new knowledge based development models have caused these roles of the universities to be questioned (Leydesdorff, 2001). Up to this time, university and the industry had been considered as separate bodies with different missions and roles. However, in the 20th century, mainly between 1940s and 1970s, many products in sectors such as defense, space sciences and energy were developed as a result of the research knowledge generated in universities and research institutions. Moreover, research knowledge was identified as a critical factor for productivity and competitiveness (Landry, Amara & Ouimet, 2007). There are many empirical studies showing that research and innovation are the key instruments of economic growth and productivity.

Therefore, in the 20th century, governments began to force and also promote universities to make more direct contributions to economic growth and add new missions to their teaching and research functions and thus, the 'entrepreneurial university' concept emerged. Governments implemented laws that give up the

"professor's privilege", by which university researchers have the full rights of the invention, and grant the ownership of intellectual property to universities in order to trigger technology transfer and commercialization activities (D'Este & Perkmann, 2009; Perkmann et al., 2012). 1980 Bayh-Dole Act in US can be argued as the most significant example of this kind of policy tools. Moreover, governments adopted some other policies such as establishing science parks, innovation/technology centers, incubation centers and technology transfer offices. Thus, academic entrepreneurship, entrepreneurship education, university-industry cooperation, intellectual property protection and knowledge and technology transfer have become important aspects of the universities' missions. Hence, universities increased and diversified their roles and activities in these areas in order to contribute regional and national development. In the US, the transformation process of universities towards entrepreneurial universities has been a more bottom-up initiative while in Europe there has been a more top-down approach and this process has been led mainly by the governments (Etzkowitz, 2003).

While there was a change in the attitude and policies of governments, there were also shifts in the needs of the industry. Increased international competition, rapid technological developments, shorter product life cycles, rapidly evolving customer demands, high costs of in-house R&D and downsizing of firms to core competencies have increased firms' demand for external sources of R&D and innovation (Leydesdorff, 2001; Santoro & Gopalakrishnan, 2001). Therefore, public research generated in universities and public research institutions became a valuable and essential source for firms in order to develop new products and processes or improve the existing ones. Many studies indicate that academic research has a positive impact on industrial innovation and some authors argue that 10% of new products and processes would not have been developed without the contribution of public research (Bekkers & Freitas, 2008).

These developments both in the attitudes and the needs of actors in the national innovation systems increased the importance of university-industry and government relations. The concept of triple helix of university-industry and government

relationships was introduced by Etzkowitz and Leydesdorff in the 1990s and further developed in the early 2000s. This approach presents the fact that while there was mainly government-industry relations in the Industrial Society period, there has been a shift towards triadic relations between university-industry and government in the Knowledge Societies. In this trilateral relationship, university, industry and government are interacting with each other through various channels and directions. Interaction among these actors generates new supporting and intermediary bodies or mechanisms such as interdisciplinary research centers, venture capital systems and incubator facilities (Etzkowitz, 2007). These facilitator bodies have the potential to have critical roles in national innovations systems. For example in Taiwan, non-profit R&D institution namely the Industrial Technology Research Institute (ITRI) and Hsinchu Science-based Industrial Park has played a strategic role in the triple helix model of technological development by integrating the government, universities and industry effectively (Chen, Lin & Chu, 2013).

Three different triple helix models can be observed in countries or regions changing according to their economic structure and the role and power distribution between universities, industry and the government: (Ranga & Etzkowitz, 2013)

- **A statist triple helix model;** the government takes the controlling role and leads the university and industry and their interactions. This model is seen in Russia, China, some Latin American and Eastern Europe countries.
- **Laissez-faire triple helix model**; government, university and industry function separately from each other. The government has limited intervention in the economy and mostly tries to prevent market failures; university provides basic research and skilled human resource while firms are the driving force of the innovation.
- **Balanced triple helix model**; this is an interactive model in which university, industry and government have overlapping functions and can take the role of one another in the innovation systems. There are trilateral interactions which create new synergies in innovation processes and form new hybrid organizations.

Triple helix concept refers to the evolution of the interactions between government, university, and industry. In general, triple helix models in countries and/or regions begin from a statist model or laissez-faire model. In recent years there has been a global trend towards achieving a balanced triple helix model by stimulating this process through several policies, mechanisms and incentives. This triple helix model has three key elements: Firstly, universities have more noticeable role in innovation at the same level with industry and government and thus a new role of universities emerge in addition to their traditional roles. Secondly, innovation policy results from the collaborative relationship among the three institutional actors rather than government-led policies or internal development within the industry. Thirdly, in addition to their traditional roles, each institutional body takes the role of one another as a result of the integrated environment and changing needs (Etzkowitz et al, 2007). The increased interactions between the university, industry and government create new mechanisms and hybrid organizations that foster these relations. In this model, university spin-offs, trilateral initiatives such as joint master/PhD programs or internship/on the job training programs between university and industry that are funded by governments increase.

In recent years, with the increasing role of new actors in the national innovation systems a new approach has emerged to investigate the role of interactions between different actors in innovation processes. Quadruple helix model suggests that while analyzing the interactions in national innovations systems, 'civil society' should also be considered as an actor. This model enables to include users' needs and ideas better in innovation process and promotes open innovation since innovative products and services are developed with the involvement of the users.

2.1. KNOWLEDGE AND TECHNOLOGY TRANSFER

2.1.1. Definition and Importance of Knowledge and Technology Transfer

Before 1980s, research agenda heavily focused on cross-national technology transfer, especially from the developed nations to the less developed ones. Starting from the

early 1980s, domestic technology transfer gained greater importance in the literature, especially in the US studies (Bozeman, 2000).

In a broader sense, knowledge and technology transfer from public research can be described as the process of sharing and exchanging knowledge and technology with the external stakeholders in the national innovation system, i.e industry, governmental institutions and thus economic and social value is created. In the literature, knowledge and technology transfer is defined in multiple ways changing according to the discipline (economy, sociology etc.) and purpose of the research (Bozeman, 2000).

Roessner (1993) defines "technology transfer" as "the formal and informal movement of know-how, skills, technical knowledge or technology from one organizational setting to another". According to EU definition, knowledge transfer includes the processes for capturing, collecting and sharing explicit and tacit knowledge (Costas et al., 2012).

In a similar way, Dosi (1982) defines knowledge and technology transfer as "knowledge and technology transfer between academic institutions and the business sector is understood as any activities aimed at transferring knowledge or technology that may help either the company or the academic institute, depending on the direction of the transfer, to pursue its activities (Arvanitis et al.,2008)."

Commercialization is a kind of knowledge and technology transfer that refers to the process of turning research results into marketable products, thus creates economic value and benefits the society. Commercialization activities are mainly patenting, licensing and academic entrepreneurship, which mainly refers to spin-off firm creation. Some studies also include contract research or consultancy as commercialization activity. In this study, commercialization activities involve patenting, licensing and spin-off creation.

Knowledge transfer process can not be isolated from knowledge development process since there is also a learning and knowledge generation process for the party that will adopt and apply the external knowledge. Therefore, in order to involve in knowledge transfer process, the two parties, i.e university/research infrastructure and the industry needs to get incentives and feel rewarded from this process (Bekkers & Freitas, 2008).

Knowledge and technology transfer process provides advantages for both the universities/research infrastructures and the industry. The advantages for universities and research infrastructures could be summarized as follows (Lee & Win, 2004) :

- The opportunity to get access to the needs of the industry, market and economy in general
- The opportunity to place students, graduates and researchers to firms
- Get additional resource for research from the industry funded projects
- Earn income from commercialization activities
- Improvement in technology implementation
- New product development and spin-offs
- Creation of goodwill

On the other hand the advantages for industry could be listed as follows:

- Access to the university's/research infrastructure's physical facilities and human resource
- Access to new knowledge, technology and R&D results
- Quality improvement,
- Product/process improvement/development
- New markets
- Cost savings
- The opportunity to employ highly qualified and experienced human resource

Knowledge and technology transfer (KTT) occurs through several channels such as publications, conferences, collaborative/joint research and research partnerships, contract research, academic consulting, industry hiring/student placement, patenting/licensing, spin-offs, personal exchanges/inter-sectoral mobility. KTT mechanisms could be grouped as formal and informal channels. Formal channels are the ones that include or directly result in a legal or contractual nature. Informal mechanisms are the mediums that enable the flow of knowledge and technology through informal communication processes.

Usage and preference of different knowledge and technology transfer channels are mainly related to the disciplinary origin and nature of the knowledge, the characteristics of the researchers and the institutions involved in knowledge and technology transfer (Bekkers & Freitas, 2008). For example while patents and licensing are an important way of knowledge transfer in material sciences; personal contacts and labor exchanges are more relevant for social sciences (OECD, 2013).

There are various structural and policy related factors that affect the structure and performance of an institution's knowledge and technology transfer system such as national and institutional legal environment, economic structure, institutional setting and characteristics, researchers' characteristics and motives, effectiveness of science and technology policy and support system, industry related factors and the effectiveness of intermediary bodies such as technology transfer offices (OECD, 2013).

Many earlier studies of KTT have focused on patenting, licensing and spin-offs as the main channels of university-industry relations and analysis of other forms of KTT have been relatively neglected (D'Este & Patel, 2007). In particular, in US after the Bayh-Dole Act of 1980, most of the studies in knowledge and technology transfer concentrated on these channels since there has been an exponential increase in the number of patents, licenses and spin-offs after the enactment of this act especially until 2000s and also the quantitative data was easily available (Beyhan, 2011).

However recent studies (Abreu et al., 2009; D'Este & Patel, 2007; Póvoa & Rapini, 2010; Arvanitis & Woerter, 2008) show that patents, licenses and spin-offs are not the most significant interaction mechanism between university and industry and present an incomplete picture of knowledge and technology transfer and there are many other forms of channels used in this process. Even in some cases patenting, licensing and spin-offs constitute a small portion of KTT process and less frequent than other collaborative interactions such as joint projects or considered as less valuable than other forms by firms or researchers (D'Este & Patel, 2007; Perkmann et. al (2012); D'Este & Perkmann, 2009).

OECD survey in 2011 regarding Public Research Institutions show that personal interactions such as joint positions, joint projects, meetings and trainings are the most important linkages between these institutions and universities and firms OECD (2011). Schartinger et al. (2001) and Roessner (1993) indicate that patenting and licensing constitute a small portion of public-private relations when compared to other formal interactions such as contract research or joint research agreements (D'Este & Patel, 2007). Emprical studies of Faulkner and Senker (1995); Arundel and Geuna (2004) and Sequeira and Martin (1997) also show that KTT between university and industry occur through various channels such as consultancy, personnel mobility and joint projects and patenting and spin-offs have a comparatively small role in the KTT process (D'Este, & Patel, 2007). Perkmann et. al. (2012) indicates that according to a survey of UK researchers, over a two year period almost half of them engaged in collaborative/contract research or consultancy at least once while only 12% and 22% of them involved in entrepreneurship and patenting respectively in this period. A survey of Carnegie Mellon University presents that US R&D executives consider consulting, contract and joint research more relevant than licensing (D'Este & Perkmann, 2009).

Moreover in some cases patenting and licensing activities should be integrated with other forms of KTT in order to increase the effectiveness and success of these activities. Jensen and Thursby (2001) point out that in a licensing activity, cooperation

with inventors is crucial for further development in order to get their tacit knowledge and thus commercialize successfully. This means that other forms of KTT such as consulting are also required in addition to licensing activities for a successful commercialization process (Beyhan, 2011). Thereby, while making analysis regarding the KTT process between university/research infrastructure and industry, the focus of the study should not be limited to commercialization activities.

2.1.2. Policies For Promoting Knowledge And Technology Transfer

Improving university/public research institutions-industry collaboration and increasing KTT between these actors has gained considerable attention among policy makers especially in the last decades. In this respect, many countries have taken legislative actions and/or developed several policies and support mechanisms in order to increase socio-economic impact of public research. Although many policy measures have been developed to promote university-industry interaction, its potential benefits are not sufficiently achieved especially in the developing countries (Anić, 2017).

The policy measures include both reforms in university system and financial support schemes and setting up organizational structures and intermediary bodies such as technology transfer offices or incubators for new ventures.

Commercialization of research enables novel ideas, technologies and products to enter the market and thus create value for the economy and/or society. Therefore, commercialization has become an important concept for policy makers since it is more direct, immediate and measurable impact of research results (Perkmann et al., 2012). The increasing importance and awareness regarding technology transfer and commercialization stimulated creation of technology transfer offices as a policy tool. These offices are organized as intermediary bodies between researchers and industry and aim to increase linkages and collaborations between researchers and firms. In this respect they provide services such as consultancy, training and market research regarding intellectual property and entrepreneurship activities and mostly they

facilitate and manage these processes and relations between academicians and industry.

It can be argued that US has taken a leading and influential role in developing policies regarding the promotion of university-industry relations and KTT from public research institutions and universities. One of the most well-known policy measure of US is the Bayh-Dole Act of 1980. Before this Act, the government owned all the rights regarding the inventions supported by public funds. This Act grants the ownership of intellectual property to universities, small businesses or non-profit institutions with the aim of increasing patenting and licensing activities and these actors are encouraged to cooperate with firms in order to turn research results into economic and social value. According to the AUTM U.S Licensing Activity Survey (2016); at the beginning of 1980s the number of university patents in U.S was around 500 which increased to 7021 in 2016 and also licensing revenue has increased to almost 3 billion dollars in 2016 from an amount of 160 million USD in 1991. Although Bayh-Dole Act is not the only factor for these results, it has been widely regarded as a turning point for US in terms of technology transfer and commercialization actions. Moreover, Bayh-Dole Act inspired other countries to develop similar legislations to foster patenting and licensing activities.

In addition to the Bayh-Dole Act, since 1980s various policies have been developed in U.S. to facilitate technology transfer and commercialization such as relaxation of anti-trust guidelines and encouraging and supporting KTT activities of government (federal) laboratories since their establishment (Bozeman & Crow, 1991). In this regard, The Stevenson-Wydler Technology Innovation Act of 1980 identified "technology transfer" as the main responsibility of government laboratories and made it compulsory to allocate budget for KTT and establish technology transfer offices at major laboratories (Shipp et al., 2011).

In UK, commercial activities of universities started to increase in the mid-1980s as a consequence of high budget cuts. Moreover, government began to support this process

actively in the mid-1990s. In Germany, commercialization of research has been regarded as an important policy agenda since the 1980s. In Sweden, many intermediary and supporting organizations such as science parks and national competence centers were established in the mid-1990s (OECD, 2013).

European Commission, primarily through Framework Programs, aims to develop university/RI-industry cooperation. InnovFin – EU Finance for Innovators is one of the support programs under Horizon 2020 developed by European Investment Bank Group. This program aims to provide finance for innovative businesses and other entities[1]. InnovFin Technology Transfer capacity Building is another program that aims to increase technology transfer capacity of research organizations.

In recent years there is a growing policy concern in EU towards increasing the innovation potential and socio-economic impact of RIs. However, current RI-industry relations are not at the desired level and both sides do not fully utilize the potential benefits of the interaction mainly because of the lack or low level of information flow, different objectives and language (European Commission, 2017). Therefore, "unlocking the innovation potential of RIs" is one of the top policy agenda of EU and considered as a factor of RIs' sustainability. In this regard, various policy tools have been developed to increase innovation capacity of RIs and facilitate technology transfer from them. In recent years, even in large facilities focused on basic science, developing spillover effects over industry has become an important priority. For example, a survey of high tech contracts for the Large Hadron Collider (CERN) shows that 40% of suppliers were able to launch new products or services and that is argued as the positive effects of CERN over firms (Simmonds et al., 2013).

In South Korea, policies regarding promotion of KTT from public research institutions and universities began seriously in 2000 with the enactment of Technology Transfer

[1] http://www.eib.org/en/products/blending/innovfin/index.htm

and Commercialization Promotion Act that includes measures such as incentives for KTT and establishment of organizations dedicated to KTT (Min & Kim, 2013).

In Japan, developing university-industry relations has been on the top policy agenda since 1990s. In this regard, one important policy action was the enactment of "The Act on Special Measures for Industrial Revitalization" in 1999 that replicates the Bay-Dole Act of the US.

Accurate, reliable and relevant statistics are critical for developing effective policies. Statistics regarding performance and effectiveness of various KTT channels are limited in most countries and most of the available statistics are about commercialization activities such as patenting, licensing and spin-offs since it is easier to gather quantitative data in these areas (OECD, 2013). There are several country level surveys regarding mainly commercialization activities such as AUTM U.S. Licensing Survey, UK Survey of Knowledge Transfer Activities – Public Sector Research Establishments and Research Councils, The Annual Knowledge Transfer Survey (AKTS) of Ireland (Business Interaction and Commercialisation from Publicly-Funded Research**)**, Australia National Survey of research commercialization, Denmark Public Research Commercialisation Survey; AUTM Canadian Licensing Activity Survey.

In recent years with the increasing importance of other KTT channels, there are some efforts to develop new, more comprehensive indicators and metrics to measure KTT. In this respect, in 2011 European Commission's Expert Group on Knowledge Transfer Indicators prepared a report about a new composite indicator taking into account the various knowledge transfer mechanisms that occur through informal relations, through cooperation and through commercialization (European Commission, 2011). Since quantitative data and analysis are limited especially about KTT forms other than commercialization channels, qualitative studies related to these KTT channels such as consultancy, joint projects etc. gain importance for policy makers.

Policies and support programs promoting technology transfer and commercialization has different aspects and levels. In order to increase effectiveness and success of these policies and incentives, they should be integrated with other policy areas such as higher education, business and regional policies. In addition to policies developed at national or regional level, university or RI level policies and actions also play an important role in facilitating tech transfer and commercialization.

Analyzing and sharing best practices of policies and support programs could be beneficial while designing national policies in technology transfer and commercialization of public research. But it should be noted that differences between national innovation systems and structures of universities and research institutions may prevent successful cases to be implemented in other environments. Moreover, economic, social, legal and political factors affect the application of these policies and programs. Thereby, governments and institutions should develop policies and support programs by considering their own needs, capacities and goals.

2.2. ROLE OF RESEARCH INFRASTRUCTURES IN NATIONAL INNOVATION SYSTEMS

Universities and research institutions play a vital role in the economy since they are the main provider of knowledge, technology and skilled human resource (Lee & Win, 2004). In the last decades their role have become more critical in the national innovation systems with their increasing cooperation with industry and society.

Research institutions are at the center of the knowledge triangle of research, education and innovation and have important functions for the advancement of research and technology and utilization of the research results (EU Commission, 2016). RIs that operate effectively and with a high level of scientific excellence are the potential source of breakthrough scientific and technological discoveries and play a significant role in attracting qualified researchers, linking the research communities and leading the technological development.

Research institutions can take different names worldwide such as Research Centers, Research Infrastructures and they are quite distinct within and across countries in terms of managerial and governance structures, mission, nature of research (basic, applied or mixed) and funding/income structure. Some of these institutions operate under the ownership of universities while others are directly affiliated to the related Ministries. Since each national innovation system has its unique features and development process, research institutions in each country have different roles and functions. Their missions, governance structures and funding mechanisms evolve with the changing national and global economic and political environments and emergence of new policy challenges. In this regard, recent studies show that 'excellence' and 'connectivity' have become central concerns for research institutions and efforts for the diffusion of their research findings to the public has intensified. Their management structures changed into a more business like operational system including public-private partnerships (OECD, 2011).

The term "Research Infrastructure" is used widely in European countries. In Turkey, although there is different terminology used for public and university research centers; the term 'Research Infrastructure" gained greater acceptance in recent years especially with the adoption of the Law No. 6550 on Supporting Research Infrastructures in 2014. Therefore, in this study this term is preferred.

OECD (2017) defines Research Infrastructure (RI) as an "organisational structure dedicated to deliver data or services for basic or applied research and RIs can be single sited or geographically distributed".

EU gives special importance to the enhancement of RIs and focuses on developing a coherent and strategic vision for pan-European policy making process regarding RIs. According to EU Commission, Research Infrastructures are defined as follows;

> *Research infrastructures' mean facilities, resources and services that are used by the research communities to conduct research and foster innovation in their fields. Where relevant, they may be used beyond*

> *research, for example for education or public services. They include major scientific equipment or sets of instruments; knowledge-based resources such as collections, archives or scientific data; e-infrastructures such as data and computing systems and communication networks; and any other infrastructure of a unique nature essential to achieving excellence in research and innovation. Such infrastructures may be 'single-sited', 'virtual' or 'distributed* [2]

In EU there is a tendency to develop transnational research facilities since the late 1950s mainly by building large scale laboratories in certain fundamental science areas such as CERN (Stahlecker and Kroll, 2013). Since then co-operation between European countries in all research fields has increased and developing world class research infrastructures has become a major goal of EU research policy. In this regard, in recent years approximately 10 Billion Euros is allocated to all European RIs each year (ESFRI, 2016).

In order to gather resources, prevent duplication of efforts and sources, rationalize RI development and usage and standardize processes; EU Commission developed European Strategy Forum on Research Infrastructures (ESFRI) in 2002 (EU Commission, 2017). ESFRI is a self-regulated EU body that is composed of national delegates nominated by research ministers of EU countries and countries associated with Horizon 2020. Main responsibility of ESFRI is to develop a European level roadmap for RIs for the next 10-20 years, facilitate implementation of these projects and monitor and assess these processes and update the roadmap as needed. First ESFRI roadmap was launched in 2006 and then updated in 2008 and 2010. In 2016 the new roadmap was introduced and updated in 2018. Moreover, ESFRI facilitates initiatives that aims to better development and utilization of RIs.

In recent years, with the increase of both the number and budget of RIs, "sustainability" of the RIs have become a major concern for policy makers. Ensuring long term sustainability of RIs has been identified as a policy priority for EU since the

[2] Regulation (EU) No 1291/2013 of the European Parliament and of the Council of 11 December 2013 Establishing Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020) and Repealing Decision No 1982/2006/EC

Informal Competitiveness Council Meeting of July 2014. In this scope EU Commission carried out some studies with relevant stakeholders and these challenges were identified as critical for long term sustainability of RIs (EU Commission, 2017):

- *Ensuring scientific excellence*
- *Attracting and training the managers, operators and users of tomorrow*
- *Unlocking the innovation potential of RI*
- *Measuring the socio-economic impact of RI*
- *Exploiting better the data generated by the RI*
- *Establishing adequate framework conditions for effective governance and sustainable long-term funding for RIs at every stage in their life cycle*
- *Structuring the international outreach of RI*

2.3. CONCLUDING REMARKS

Starting from 20 th century, public research has gained considerable attention as a critical source of economic growth, competitiveness and productivity. Public research has leaded many discoveries that are used widely worldwide. Therefore, universities and research institutions have evolved as strategic actors in national innovation systems, and developing university /RI- industry relations and increasing the economic contribution of universities and RIs have become important policy concerns worldwide. Thus, 'Entrepreneurial University concept has emerged and universities have gained new missions in the areas of innovation, entrepreneurship and technology transfer.

In this regard, governments have adopted legislative actions, policies and support programs aiming to develop university-industry and government relations and facilitate technology transfer and commercialization between universities/RIs and industry. Developed countries such as U.S., U.K and Germany have a leading role in these processes while in less developed countries and developing countries university-industry relations and KTT activities are not at desired levels and have to be developed.

Accordingly, university-industry and government relations and technology transfer and commercialization concepts have gained considerable attention in the academic

studies. Second chapter presents an introduction to the wide spectrum of the academic studies in knowledge and technology transfer between university, industry and government and then focuses on the studies that analyze the determinants of the technology transfer and commercialization behavior of researchers/academicians in universities and RIs.

CHAPTER 3

LITERATURE REVIEW ON DETERMINANTS OF TECHNOLOGY TRANSFER AND COMMERCIALIZATION

In the literature, KTT between university, industry and government has been mainly analyzed through patent data, citation analyses, licensing, spin-offs and cooperation between university, industry and government institutions (Landry et al., 2007). Additionally, recent studies mostly studied the institutional structures and agents that have evolved to foster commercialization such as technology transfer offices, industry-university joint research/innovation centers, science parks and incubators (Bozeman, Link & Siegel, 2007).

There is also a large amount of empirical studies analyzing variations among universities/research centers regarding their tendency to engage in any type of KTT activity (Beyhan, 2011). Most of the studies in the KTT literature have analyzed the determinants of university-industry interactions either from the perspective of firms or from the side of university/department or RI. Studies analyzing the factors affecting KTT process by taking 'individual researcher' as the unit of analysis is relatively neglected in the literature (D'Este & Patel, 2007; Tahvanainen & Tuomo, 2018; Closs et al.,2013).

In order to be able to design proper and efficient public policies and supports regarding KTT process between universities/RIs and industry, it is important to understand "who" in these institutional bodies interacts with the industry and 'how' and 'why' they interact (D'Este & Patel, 2007). Thus, studies analyzing the determinants, motivations and obstacles for the researchers' likelihood of engagement in KTT process have been regarded as critical for policymakers in recent years.

Within various KTT mechanisms, commercialization activities have attracted particular attention both in the literature and policy community since the impact of these actions are more immediate and measurable (Perkmann et al., 2012). Commercialization from university has two stages; invention and exploitation. Although many scientists have commercially-oriented ideas, few of them become entrepreneurs or idea-exploiters (Keerati & Pichyangkura & Chandrachai, 2012). Patenting is an important step and effort for the transfer and commercialization of invention and recent studies show that patenting process heavily depends on scientists' or researchers' willingness to disclose their inventions. (Moutinho, Fontes& Godinho, 2007). Therefore, it is critical to explore individual researcher's ideas and motivations regarding patenting and other commercial activities.

There are several factors that affect the KTT tendency and intensity of academicians and researchers such as seniority, age, policies and reward system of the university/ RI, presence of technology transfer office, willingness of firms, national and local policies and incentives etc. Factors affecting the KTT activities of researchers can be classified as personal factors; institutional/organizational factors and external/environmental factors:

- **Personal Factors:** Personal characteristics such as age, gender, seniority have vital effect on the tendency of academics and researchers to engage in KTT activities. In the literature, many studies indicate that male academics have more tendency to collaborate with industry. Age has an uncertain effect since some studies find positive correlation while others find negative or no relation between academics' age and their engagement level with industry. On the other hand, although related with age, seniority is often positively correlated with academics' collaboration with industry (Perkmann et al., 2012). However, for commercialization activities, the role of seniority is ambiguous since some studies present that being younger is more associated with the risky nature of commercialization. Another personal factor that affects collaboration with industry is the scientific productivity and

success of the academics. These factors affect positively the academics' engagement with industry.

- **Institutional/ Organizational Factors:** The characteristics and culture of the institution or organization that the researchers affiliated with has an important impact on the researchers' tendency for KTT activities. Studies indicate that academics' affiliation with special institutions such as research centers has positive impact on academic' collaboration with industry (Perkmann et al., 2012). In general, basic factors such as the institutions/departments' size, scientific field or mission/focus has a vital affect on the KTT tendency of researchers (Arvanitis et al.,2008). Rahm et al. (1998) showed that type of R&D activities conducted in universities and government labs affect their technology transfer involvement. According to this survey data, universities and government laboratories that identify basic research as their mission, have less tendency to engage in KTT activities and having research diversity is the strongest indicator for technology transfer engagement (Bozeman, 2000).

  Many studies show that higher research quality of the department/university and also existence of formal technology transfer structures increase the tendency of academics' engagement in commercialization (Perkmann et al., 2012). Moreover, universities or RIs' policies about patenting, sharing of licensing revenue and incentive systems regarding KTT involvement and commercialization activities have a significant impact on researchers' tendency for KTT activities (Beyhan, 2011).

  The effect of academic incentive and reward system on researcher's patenting activity, especially the potential trade-off between publications and patenting is widely discussed in the literature (Moutinho et al., 2007). Publication is commonly accepted as the most important instrument of academic advancement and reputation. While most studies show that publishing and patenting are related and positively correlated both at the individual and institutional level, there are also some arguments suggesting that they are competing in terms of time management and type of the research done. These arguments claim that the time consumed for

one of these activities may lead to delays in the other one and also patenting is more related to applied research that may direct researchers' away from basic research. Thus, it is argued that older and senior researchers/academicians are more likely to patent compared to younger academicians that are in the early stages of their careers since they are mostly concentrate on publishing in order to advance in their academic career. For sure, the higher experience and knowledge of senior academicians are also a complementary factor for their higher patenting ratio (Moutinho et al., 2007).

- **Environmental /External Factors:** Factors that are not directly related to or under the control of the individual researcher or the institution that they are affiliated with can be called as environmental or external factors. National and local R&D and innovation system and policies, legal framework, economic and political system are the major examples of external factors. These factors become important especially in country-level comparisons. Characteristics of the national innovation system, success of the R&D and innovation support programs, effectiveness of legal framework regarding intellectual property rights and economic indicators affect the KTT and commercialization activities of researchers. Moreover, characteristics, willingness and culture of the industry is a significant factor that affects the tendency of researchers to engage in KTT activities or affect the success of their efforts.

3.1. EMPRICAL LITERATURE ON DETERMINANTS OF TECHNOLOGY TRANSFER AND COMMERCIALIZATION

In this section, the recent studies in the literature that is concerned with the motivating and deterring factors influencing the propensity of "researchers" in universities or RIs to involve in any form of KTT actions are investigated. The studies that are very close to this study in terms of aim, content and/or methodology have been explained in detail. Additionally, these studies and other similar studies have been summarized in Table 3.

Lam (2011) analyzed the personal motivational factors for the commercialization activities of scientists in 5 major UK research universities through both questionnaire with 735 scientists and 36 interviews. The analyses are based on theories of motivation in social psychology. In this regard the motivational factors are grouped as 'gold' (financial rewards), 'ribbon' (reputational/career rewards) and 'puzzle' (intrinsic satisfaction) in order to analyze both extrinsic and intrinsic factors for commercialization. This study shows that many scientists are motivated by traditional rewards of the 'ribbon' while personal gain is regarded as important by smaller number of researches. This study also draws attention to the fact that intrinsic factors are also important for many researchers. These intrinsic factors include the desire to benefit others and the society in general. Therefore, it is suggested that there should be a policy mix addressing both intrinsic and extrinsic motivations of researchers and focusing solely on financial rewards will be inadequate.

Tahvanainen et al.(2011) focused on analyzing the subjective motivation of researchers' for commercialization activities and also factors and university services affecting their commercialization efforts based on a survey of 2800 researchers at 11 Finnish research universities. In this study researchers' engagement level and motives in various industry interaction forms were also analyzed. The findings show that researchers' commercialization behavior are heavily affected by altruistic, socio-cultural or intrinsic motives rather than economic factors. The three most important motivational factors for researchers' commercialization activities are; beneficial effects for society, self-fulfillment by realizing the research results' potential and securing funding for research. In this study, researchers are classified as inventors and non-inventors. The findings show that inventors involve more in patent application processes and produce more publications. This result suggest that commercialization efforts are not contradictory to academic goals, in fact they are positively related. On the other hand, the most significant constraint for commercialization is the lack of time, followed by securing financing and economic risks of commercialization. The lack of personal interest was identified as the fourth most important deterring factor.

Closs et al. (2013) studied the motivating and deterring factors for Brazilian researchers to engage in technology transfer based on interviews with academic scientists and managers from four universities. They categorized the identified motivating factors for researchers in their study as seen below by examining similar studies in the literature. Self-direction (generate resources for research) and stimulation (solve problems, professional challenge) type factors were prominent. Factors that discouraged researchers were: time required for technology transfer (difficulty in balancing time between teaching, research and technology transfer), lack of incentive, inefficiencies in innovation system (lengthy processes, lack of firms' interest etc.), and fear of contradicting university rules.

Table 1. Classification of Motivational Factors by Closs et al. (2013)

Motivation	**Motivational Goals**
Self-direction	Generate Resources for research
Stimulation	Solve Problems, Professional Challenge
Hedonism	Personal Gains
Achievement	Personal Gratification (personal achievement, pride at creating something new/useful etc.)
Power	Academic prestige, Competition between researches in terms of patenting, licensing etc.
Universalism	Solving the problems of society, providing job opportunities for students

Arvanitis et al. (2008) investigated the factors affecting the propensity of Swiss science institutions to engage in knowledge and technology transfer activities through a survey. This study takes the "institutes or departments of science institutions (universities, research organizations etc.)" as the unit of analysis and the directors of these institutions fill in the surveys. Although this study is at the institutional-level, it is presented in this section since it provided useful insights for this study in terms of selection of KTT activities, motives and obstacles and also analysis method. This study explores wide variety of knowledge and technology transfer channels including formal, informal and commercialization activities and analyze the motives and deterrents of KTT activities. In this study, motivating factors are grouped into four main categories and deterring factors are classified under six categories:

Table 2. Classification of Motives and Obstacles by Arvanitis et al. (2008)

Motives	Obstacles
• Access to industrial knowledge; practical experience and possibilities of application • Institutional or organizational motives • Pursuing Higher Research Efficiency (cost and time savings) • Financial Motives (access to additional resources)	• Deficiencies of firms • Administrative problems • Different interests, different attitudes to research • Endangering scientific independence, neglect of basic research and publishing • Lack of confidence, risk of damaging reputation • Lack of human resources

Landry et al.(2007) explores the intensity of different knowledge transfer mechanisms and determinants of them through a survey among 1554 Canadian university researchers. This study is built on resource-based theory of firms and researches are resembled to firms in such that they have resources and capabilities such as experience, publications number, research projects etc. that are utilized in knowledge transfer activities. This study analyses the knowledge transfer from a broader view including relational and knowledge exchange channels in addition to commercialization activities. The findings show that researchers are more active in non-commercial activities. Also, their knowledge transfer activities correlate positively with the number of publications which is argued as an implication that knowledge transfer activities do not restrict their more traditional roles of researchers.

Baldini et al. (2007) analyzed the motivations and obstacles for Italian inventors for patenting through a survey of 208 faculty members. The survey results show that academicians engage in patenting primarily to increase their prestige and reputation and find new impetus for research rather than financial gains. Main obstacles for them are difficulties in identifying the commercial potential of their inventions and low level of interest from private sector.

Beyhan (2011) investigated the university-industry relations in nanotechnology sector in Turkey from both researchers' side and the firms' side by exploring the individual

and organizational factors affecting this process. In this respect determinants and motivations of scientists' involvement in KTT activities with industry is analyzed through questionnaire. This study highlights that scientists engage in various KTT channels and informal and interpersonal interactions are the most common form of these activities. The second most common type of interaction is the research related activities such as contract-based/collaborative research projects and laboratory tests and analyses. Consultancy and commercialization activities are not very common among scientists since around 9% of scientists mention that they frequently engage in consultancy. Nearly 7% of scientist state that they engage in commercialization activities. Results revealed that most important motivating factor for researchers' engagement in KTT is 'increasing funds for research'. In this study motivating factors are classified into three groups as 'motivations related to academic duties', 'motivations related to commercialization' and 'motivations to get firms' contribution for improving research results'.

Konac (2018) investigated the motivating factors for Turkish academic entrepreneurs in starting their own business, the challenges they face and their perceived success criteria based on a 23 online questionnaire and 18 interviews. In this study the most significant motivating factors for entrepreneurial activities are identified as; 'easily commercialize research results', 'utilizing scientific knowledge in commercial activities', 'pure intellectual curiosity' and 'self-improvement'. Personal income is less important compared to these factors.

Kaymaz & Eryigit (2011) analyzed the barriers for university-industry collaboration based on face-to-face survey with 170 faculty members of a university in Turkey. The research findings reveal that lack of interest from both academicians and industry; remoteness from field studies and bureaucracy are perceived as the significant deterrents for university-industry cooperation.

Table 3. Sample of Empirical Studies Focusing on Factors Affecting Researchers' Involvement in Different KTT Activities

Authors	Country	Data Source	KTT Activity Analyzed	Unit of Analysis and Number of Observations	Main Findings
J. Lee et al. (2003)	Singapore	Survey	Assessment and comparison of technology transfer activities of university research centers	3 university research centers that represent different sectors.	• Joint R&D projects increase the willingness and success of the TT. • The higher the commitment to motivate industry, the success of TT increases • The role of government is critical for TT
Landry et al.(2007)	Canada	Survey	Determinants and extent of knowledge transfer; and differences among various disciplines	1554 researchers funded by Natural Sciences and Engineering Research Council of Canada	• Researchers more active in non-commercial knowledge transfer activities • Researchers in certain fields are more active in KT • Common KT determinants for all fields are; linkages between researchers and industry and focus of the projects on users' needs. • Other KT determinants differ across research fields
Moutinho et al. (2007)	Portugese	Survey+ Interview	Individual determinants of researchers' patenting behavior	106 researchers from 9 Public sector research organizations in lifesciences and biotechnology	• Low propensity for patenting and licensing activities among the researchers • Mostly personal benefits from these activities perceived to be low • Majority find patenting process difficult and believe that they get limited support from their organizations

Table 3 (continued)

P. D. Este et al (2007)	UK	Survey	Determining different channels of interaction between academic researchers and industry and the factors for Researchers' engagement in this process		• University researchers use various KTT channels • Engage more frequently in consultancy, contract research, joint research and training compared to patenting and spin-offs • Personal factors have more impact on KTT activities than department or university related factors.
Abreu et al. (2009)	UK	Survey	Activities of academics, channels they interact with other organizations, motivations and constraints, their views about the role of academia	22.170 academics in all disciplines in UK higher education institutions	• Wide variety of interaction mechanisms • Main motivations; related to developing research activities (gaining research insights, testing the practical application of the research etc.) • Financial gain have the lowest rank • Main constraints; lack of time; bureaucracy, insufficient rewards.
Lam A. (2011)	UK	Survey+ Interview	Motivational factors for scientists' commercialization activities	36 interviews and survey of 735 scientists from 5 UK research universities.	• Scientists engage in commercialization for reputational and intrinsic reasons rather than financial rewards.
Closs et al.(2013)	Brazilia	Interview	Motivating and deterring factors for technology transfer activities of academic researchers in universities	Academic scientists and managers from 4 universities	• Major motivational factors: generate resources, solve problems, professional challenge, personal gains, personal gratification, academic prestige, competition, and solving problems of society • Major discouraging factors: time required for TT, lack of incentive, innovation environment, and fear of contradicting university rules

3.2. CONCLUDING REMARKS

A large and growing body of literature has investigated the knowledge and technology transfer between university/RIs and the industry from different aspects. In this chapter both theoretical and empirical literature regarding determinants of knowledge and technology transfer and commercialization process between universities/RIs and industry were analyzed.

There is relatively small body of literature that is concerned with the factors influencing KTT process by taking the 'individual researcher' as the unit of analysis. However in the recent years there is a growing interest towards analyzing the views, attitudes and behavior of 'researchers' since it has been realized that the individual researchers' willingness, capabilities, motivations and perceived obstacles are critical factors in technology transfer and commercialization process.

KTT tendency and intensity of researchers are influenced by several factors that can be classified as; *personal factors* such as age, gender, seniority; *institutional/organizational factors* such as culture of their institution, mission/vision and scientific field of the institution; existence of clear policies, incentive systems etc. and environmental/external factors such as national/local R&D and innovation policies, intellectual property rights system etc.

The main findings of the literature review regarding determinants of knowledge and technology transfer activities of researchers can be summarized as follows:

- Researchers' involvement in commercialization activities is less frequent compared to other forms of knowledge and technology transfer. (Landry et al. 2007; P.D. Este et al., 2007; Moutinho et al., 2007)
- Type of the research activity (basic research, applied research etc.) and mission/vision of the university/RI have an important effect on researchers' tendency on KTT activities (Arvanitis et al., 2008; Bozeman, 2000).

- Universities/RIs' policies about patenting and licensing processes and reward systems regarding technology transfer and commercialization affect researchers' engagement in KTT activities (Beyhan, 2011)
- Most studies show that patenting and publication is positively correlated, but there are also some arguments stating that they are competing in terms of time management and the research conducted. (Moutinho et al., 2007)
- Career rewards, reputational factors, benefits for society and others, realizing the application of the research and income for new research are more significant motivating factors for researchers' commercialization behavior compared to personal financial gain. (Lam, 2011; Tahvanainen et al.,2011; Closs et al, 2013; Baldini et al., 2007; Abreu et al., 2009)
- The most significant deterring factors for researchers' commercialization activities are; lack of time/difficulty in balancing time between teaching, research and commercialization; insufficient finance/incentives; lack of firms' interest. (Tahvanainen et al.,2011; Closs et al.,2013; Arvanitis et al., 2008; Baldini et al., 2007; Abreu et al., 2009)

CHAPTER 4

TECHNOLOGY TRANSFER AND COMMERCIALIZATION POLICIES IN TURKEY

In the last decade, there is an increasing trend in Turkey towards developing R&D and innovation capacity and intensity especially in private sector, promoting university-industry relations and increasing economic and social contribution of universities and research infrastructures.

In this regard, in the 9th National Development Plan (2007-2013), the concept of 'innovation' is emphasized and it is mentioned that due to insufficient cooperation among R&D performing institutions, supporting institutions and industry, public research is generally far from the needs of industry and research results can not be turned into practice. It is stated that technology transfer centers will be established in order to facilitate the transfer of R&D results to the industry. Moreover, it is indicated that in the middle and high technology sectors, R&D and innovation activities and establishment of R&D infrastructures will be supported.

In the 10th National Development Plan (2014-2018), it is stated that the aim of R&D and innovation policies is contributing to; increase technology and innovation activities with a private sector focus, commercialization of research results via constituting an innovation based ecosystem and achievement of high global competitive power with branded technology products. In this regard it is expressed that research centers in universities and public institutions will be diverted into sustainable structures that serve to all researchers, have qualified human resources, managed effectively and work in close collaboration with firms. Additionally, improving and promoting university-industry cooperation, supporting R&D and entrepreneurial activities of academicians, improving structure and operation of technology development regions in order to foster university-industry cooperation and innovative

entrepreneurship and establishing interfaces such as technology transfer centers, incubators, innovation centers and increasing cooperation among them are introduced as prioritized polices.

In this respect, various policy tools and support mechanisms have been developed in order to improve university-industry relations and promote knowledge and technology transfer in the 9th and 10th Development Plan period:

- Public support for the establishment of Technology Development Zones (TDZ) have been increased, thus number of active TDZs increased to 61 by the end of 2018. In these regions, nearly 5.300 firms have been established and 20% of these firms have academician shareholder. In these firms, 41.663 R&D personnel have been employed and 30.166 projects have been completed. Additionally, a total of nearly 64 Billion Turkish Liras sales amount and a sum of 3.7 Billion US Dollar export amount have been realized in TDZs[3].
- Technology Transfer Offices (TTO) Support Program was started by TUBITAK in 2012 in order to increase the number of TTOs in Turkey and develop the capacity of the existing ones. Within this program 41 TTOs were supported. In total there are 62 TTOs in Turkey with varying scales in terms of personnel number, budget etc. and performance in terms of R&D projects and budget, patenting and licensing activities, income etc.

  TTGV Report (2017) analyses activities and performance of TTOs through a survey among 25 TTOs that have been supported by TUBITAK between 2013 and 2017. In terms of invention disclosure numbers, top 10 TTOs had an average of 60 invention disclosures while the last 10 had 14 disclosures on average. In terms of patent application numbers top 10 performing TTOs made 25 national and 9 international patent applications on average, while for the last 10 TTOs, these numbers are 7 and 3, respectively. Moreover, survey results present that 25% of

[3] Ministry of Industry and Technology, December 2018
https://btgm.sanayi.gov.tr/Handlers/DokumanGetHandler.ashx?dokumanId=33c6d378-d601-4168-b3ce-5244b9f4fe18

TTOs did not register any patent while 18% of them registered only 1 patent. These results suggest that in Turkey TTOs are still at the developing stage. Their performance in terms of patenting and licensing are quite varying and also insufficient. Performance of TTOs are closely related to the R&D and innovation capacity of their universities in addition to their own capacities and capabilities. Therefore, it is hard to develop one to fit all model for TTOs. There is still need to develop their structure and personnel capacity in order to increase the role of these bodies in technology transfer and commercialization.

- Techno-entrepreneurship support program that provides seed capital to entrepreneurs have been implemented since 2009. Within this program, nearly 2500 entrepreneurs were supported.
- In 2012, TUBITAK developed "Entrepreneurial and Innovative Universities Index' in order to assess the relative performance of the universities in Turkey in terms of entrepreneurial and innovative activities. This policy tool can be argued as a significant step to show governments' expectation from universities to contribute more to economic development in addition to their teaching and research roles. The index has 23 indicators that are classified under 5 groups: Scientific and Technological Research Competence; Economic Contribution and Commercialization; Intellectual Property Pool; Entrepreneurship and Innovation Culture and Cooperation and Interaction.
- The Law No. 6550 on Supporting Research Infrastructures was published in Official Gazette dated 10th July 2014.
- In December 2016, new Intellectual Property Law was adopted. This is a comprehensive Law that covers trademarks, patents, utility models, designs and geographical indications that were previously protected separately by the Decree-laws. The most significant provision that the new Law introduces is that ownership of IP rights regarding patent applications of academicians are granted to the universities, similar to the regulations in U.S. and most of the EU countries.
- In 2017, 10 universities were identified as 'Research University'.
- In 2017, a regulation that makes working as a 'post-doc researcher' in universities possible was adopted.

- In 2018, TUBITAK introduced new support programs that aim to develop university/RI-industry cooperation and facilitate technology transfer and commercialization. These programs are innovative in nature and filled a significant gap in Turkish R&D and innovation support system since they are goal-oriented, focus on the 'cooperative action of the different stakeholders and target both technology development and technology transfer and application.

  One of these programs are '1004-High Technology Platforms Support Program' that aims to support technology platforms between RIs[4]/research universities and firms in which new products and technologies will be developed in a cooperative way and research results will be transferred to the firms. The support program has 2 phases. First phase includes a maximum one year preparatory period in which a road map and the management structure will be prepared. In the second phase, R&D and innovation activities will be executed according to the identified road map.

  Another program is the '2244-Industry Doctorate Program' which aims to increase the number of high qualified researchers' employment in industry. Within this scope, joint education projects of universities/RIs and industry that includes jointly supervision of PhD students that will be employed by firms are supported. In this program, fellowship for PhD students and employment supports for firms are provided.

4.1. RESEARCH INFRASTRUCTURE POLICIES IN TURKEY

In Turkey, there are research infrastructures that operate under the ownership of universities and also there are research centers that are directly affiliated with TUBITAK and other ministries such as Ministry of Agriculture, Ministry of Health. University research infrastructures have different names such as Research Center, Application and Research Center etc.

[4] Research Infrastructures that are supported by the RI Law No. 6550

In Turkey, research infrastructures have been established in universities by public funds since 2000s. Although there has been a tendency to use different terminology for public and university research centers in Turkey; the term 'Research Infrastructure' has gained greater acceptance in recent years especially with the adoption of the 6550 Law. Therefore, in this study the term 'Research Infrastructure' is preferred.

By 2019, a total amount of 7.9 billion Turkish Liras have been allocated through Annual Public Investment Programs for the establishment and development of RIs in universities and public institutions. Within this support, two types of RIs have been established: Thematic Research Centers and Central/Basic Research Centers. *Thematic Research Centers* are the units that are specialized in certain research field/fields with qualified human capital and have the capacity to perform both at regional and national level and even at international level in some cases. 131 thematic research center projects have been completed and there are ongoing 109 projects by the year 2019.

On the other hand, *Central Research Centers* are the units that are established in public universities in order to meet the common research needs of different departments. These centers aim to maintain the research capacity and culture in each university at some level and prevent inefficient procurement and usage of research tools and equipment in the university by forming a common place for all researchers. In this regard, by the end of 2018, 58 central research centers have become operational while in 38 universities establishment process is ongoing.

In recent years, policy analyses and studies regarding RIs pointed out that there are some managerial, financial and operational problems of established RIs that restricts effective utilization of these RIs and reduces their positive effects on economy and society. Thus, ensuring long term sustainability of RIs has been identified as an important policy challenge and goal in Turkey. The identified problems and challenges of the RIs in universities can be summarized as follows (Kalkinma Bakanligi, 2016):

- Lack of institutional and sustainable management

- Lack of own budget (budget is allocated and managed by the Rector)
- Lack of own personnel system, wage policy is not attractive for high qualified researchers
- Low level of cooperation with firms and other stakeholders
- Lack of budget for additional investments, maintenance costs and other operational costs

In order to overcome the above mentioned problems/obstacles and to increase the effectiveness and long term sustainability of the RIs, a new performance based support system has been developed and accordingly the Law No. 6550 on Supporting Research Infrastructures was published in Official Gazette dated 10th July 2014.

The main purpose of this Law is to increase the effectiveness and sustainability of RIs by transforming them into sustainable structures that have their own management body, own budget and personnel system and works in close collaboration with private sector and other stakeholders.

In this Law, RIs are defined as units in universities that include qualified human resources, advanced machinery, equipment, hardware and software and where R&D activities are carried out. RIs are classified into three groups as Advanced Research Laboratories, Thematic Research Laboratories and Central/Basic Research Laboratories according to their scale, mission, scope and R&D and innovation performance.

According to the new performance based support system introduced by the Law, 'Competency Assessment' regarding RIs is required to be executed by TUBITAK in order to analyze their performance as a first step. In this initial process, performance of RIs are evaluated mainly based on their research excellence and managerial competency to assess the eligibility of them to be supported within the new system. The evaluation process includes two interlinked stages. In the first stage qualitative data regarding pre-defined key performance indicators are gathered from RIs. In the

second stage, a panel of 3-4 academicians/experts in the relevant field is established and a site visit and a panel review is organized in order to evaluate the performance of the RI by both qualitative and quantitative data. Quantitative data is gathered during site visit through interviews with both the management of the RI and the researchers in the RI. As a last step, a performance evaluation panel review report is prepared.

By considering the panel review report, the Monitoring and Evaluation Committee, composed of high level representatives of the related public institutions, decides whether the RI is eligible to apply for the system or not. If the RI is found to be eligible, they are asked to prepare an application document including details about their vision, mission, goals regarding key performance indicators for 5 years, management structure, access policy and IPR policy. Application documents are submitted to the 'Research Infrastructures Board', that is at Ministerial level and if it is approved, the RI is awarded to be 'competent' to be supported within the new Law.

The support system introduced by the new Law requires performance assessment of RIs both in the selection and support process, which covers yearly, mid-term and 5-year-period performance assessments. It can be argued that the performance assessment and evaluation mechanism of this support system is one of the most properly designed one in Turkey and could be a good example for other support programs.

Developing proper key performance indicators and evaluating performance of RIs regularly are among the top policy priorities of both EU and OECD. In this respect, in the policy documents, it is emphasized that EU Commission, with national authorities, should develop a common approach towards developing key performance indicators in order to assess the socio-economic impact of RIs and make comparisons by taking into account the diversity in scientific domains and characteristics (ESFRI, 2017).

Performance assessment system of the 6550 Law includes key performance indicators in the areas of 'RI Scale and Human Capital', 'Scientific Output and Attractiveness',

'Cooperation with the Stakeholders', 'Technological Outputs and Economic Contribution' and 'Accessibility, External Users and Trainings/Services'. There are both output indicators and also impact and quality indicators. The main indicators regarding KTT performance of RIs are presented in detail in Table 4.

Table 4. Key performance Indicators Regarding KTT Performance of RIs within the Law No. 6550

Categories	Output Indicators	Impact Indicators
Cooperation With the Stakeholders	-number and budget of international collaborative projects -number and budget of projects with industry -number and budget of project with universities and public RIs.	- role of the RI in the projects -strategic importance of collaborations and impact on national economy
Technological Outputs and Economic Contribution	-national patent number -international patent number -international patent application number -number and budget of licenses -number of spin-offs -revenue and employment number of the spin-offs	-socio-economic contribution of the IP rights -role of spin-offs in the national economy
Accessibility, External Users and Trainings/Services	-Number of the Scientific Activities -Number of External users -Revenue from Test and Analysis Services -Output of the External Users (Publications, thesis etc.)	-impact on scientific competence of external users -impact of external users on research activities

Source: TUBITAK

RI Law No. 6550 introduces various regulations and mechanisms in order to foster KTT performance of RIs:

- The management structure of the RIs that are supported within the 6550 Law consist of Board of Directors, Advisory Board and the Director. Board of Directors has to include representatives from private sector and non-governmental

organizations. Additionally, there should be representatives from private sector and non-governmental organizations in the Advisory Board.

- In performance evaluation process, indicators related to industry cooperation, knowledge and technology transfer and commercialization are investigated.
- The ownership of all IP rights are granted to the Research Infrastructure and main issues are regulated by The Law. Additionally, it is mentioned that RI managements should prepare their policies regarding IP sharing and other processes. The IP policy of the RI is required to be documented in the application process of the Law.
- The Law makes it possible to establish RIs in technoparks and industrial regions. Additionally, it enables to establish a RI with the joint ownership of the university and industry.

As the above mentioned issues suggest, it can be argued that the new RI Law introduces various mechanisms and tools to improve RI-industry interaction and facilitate knowledge and technology transfer activities. Therefore, it is expected that the Law will positively affect the KTT performance of the RIs in Turkey.

In August 2017, 4 RIs which are *Izmir Biomedicine and Genome Center, Middle East Technical University Micro-Electro-Mechanical Systems Center, Sabanci University Nanotechnology Research and Application Center and Bilkent University National Nanotechnology Research Center* were approved as competent to be supported under the Law 6550 and obtained a public legal entity with its own budget and management structure.

In this regard, these RIs established professional management structures composed of Board of Directors, Advisory Board and the RI Manager. The board of directors is the decision making body of the RI and responsible for all strategic administrative and financial decisions. The board of directors have at least five and at most nine members and are composed of representatives from the host university, representatives of other universities, representatives from relevant public bodies,

private sector and/or non-governmental organizations. The number and composition of the Board of Directors depends on the category of the RI that is Advanced Research Laboratories, Thematic Research Laboratories or Central/Basic Research Laboratories.

4.1.1. Izmir Biomedicine and Genome Center (IBG)

Izmir Biomedicine and Genome Center (IBG) was established in Dokuz Eylul University in 2014 with an investment budget of nearly 180 million Turkish Liras. IBG has an enclosed space of approximately 22.250 m2.

The mission of the center is defined as 'to contribute development of innovative technologies and products towards prevention, diagnosis and treatment of diseases by engaging in advanced basic and translational research in life sciences'. Main research areas are; cancer, genetics, genomics, biopharmaceutical production, immunology and bioinformatics. R&D activities of IBG can be classified as follows: 60% basic research, 30% applied research and 10% experimental development.

By the end of 2018, IBG has 64 researchers, 56 R&D support personnel (technicians and administrative staff) and 127 MSc and PhD students. The number of projects with different stakeholders can be seen from Table 5. There is not any patents that belong to IBG between the years 2014-2018. Most probable reasons for this situation is that IBG is a relatively young RI and also in life sciences patenting processes are longer.

Table 5. Number of New Projects in Collaboration with Different Stakeholders in IBG

	2015	2016	2017	2018
International Cooperation	1	2	1	4
Private Sector	-	1	-	-
Public/University	2	1	-	-
No Cooperation	8	9	12	10

Source: TUBITAK

4.1.2. Middle East Technical University MEMs Center (METU MEMs)

Middle East Technical University MEMs Center (METU MEMs) was established in 2008 with an investment budget of nearly 150 million Turkish Liras. Main research areas are Image Sensors, RF MEMS, Bio MEMS, Power MEMS and Inertial Sensors. R&D activities of SUNUM can be classified as follows: 20% basic research, 40% applied research and 40% experimental development. By the end of 2018, METU MEMs has 32 researchers, 28 R&D support personnel (technicians and administrative staff) and 44 MSc and PhD students.

Table 6. Number of New Projects in Collaboration with Different Stakeholders in METU MEMs

	2015	2016	2017	2018
International Cooperation	1	-	-	-
Private Sector	1	-	-	-
Public/University	-	-	-	-
No Cooperation	2	3	-	-

Source: TUBITAK

Table 7. Patent Numbers in METU MEMs

	2015	2016	2017	2018
National Patent	1	3	-	-
International Patent	2	5	2	3
International Patent Application	1	4	5	1

Source: TUBITAK

4.1.3. Sabanci University Nanotechnology Research and Application Center (SUNUM)

Sabanci University Nanotechnology Research and Application Center (SUNUM) was established in 2011 with an investment budget of nearly 120 million Turkish Liras. SUNUM has an enclosed space of approximately 7368 m2. Main research fields are nanomaterials; energy; food, agriculture and environment; lifesciences and defence and space. R&D activities of SUNUM can be classified as follows: 10% basic

research, 85% applied research and 5 % experimental development. By the end of 2018, SUNUM has 40 researchers, 20 R&D support personnel (technicians and administrative staff) and 22 MSc and PhD students.

Table 8. Number of New Projects in Collaboration with Different Stakeholders in SUNUM

	2015	2016	2017	2018
International Cooperation	9	10	13	8
Private Sector	9	10	15	12
Public/University	5	6	15	10
No Cooperation	74	71	58	41

Source: TUBITAK

Table 9. Patent Numbers in SUNUM

	2015	2016	2017	2018
National Patent	2	1	-	-
International Patent	8	-	-	-
International Patent Application	13	3	3	3

Source: TUBITAK

4.1.4. Bilkent University National Nanotechnology Research Center (UNAM)

Bilkent University National Nanotechnology Research Center (UNAM) was established in 2007 with an investment budget of nearly 150 million Turkish Liras. UNAM has an enclosed space of approximately 9200 m2. Main research fields are nanoscience and nanotechnology, material sciences, physics, biology and chemistry. R&D activities of UNAM can be classified as follows: 35 % basic research, 45 % applied research and 20 % experimental development. By the end of 2018, UNAM has 117 researchers, 43 R&D support personnel (technicians and administrative staff) and 119 MSc and PhD students.

Table 10. Number of New Projects in Collaboration with Different Stakeholders in UNAM

	2015	2016	2017	2018
International Cooperation	-	-	1	1
Private Sector	4	-	6	1
Public/University	-	1	-	-
No Cooperation	46	19	15	4

Source: TUBITAK

Table 11. Patent Numbers in UNAM

	2015	2016	2017	2018
National Patent	4	5	4	7
International Patent	5	11	6	9
International Patent Application	32	18	8	2

Source: TUBITAK

As the above presented data regarding projects and patents of RIs suggest, currently cooperation of RIs with other stakeholders and their KTT performance are low and quite varying. It can be argued that these differences are mainly derived from the discrepancies in their research type, research field, age of the RI and their mission/vision.

CHAPTER 5

FACTORS AFFECTING TECHNOLOGY TRANSFER AND COMMERCIALIZATION ACTIVITIES OF RESEARCHERS IN RESEARCH INFRASTRUCTURES

5.1. METHODOLOGY

Previous studies highlighted that in order to develop proper and effective policies and support programs, it is vital to explore the behaviors, views and attitudes of the 'individual researcher" and there is a relatively small body of literature that analyze the KTT process by taking the individual researcher as the unit of analysis (D'Este & Patel, 2007; Tahvanainen & Tuomo, 2018; Closs et al.,2013). Therefore, the main focus of this study is the 'Researchers in the RIs in Turkey' and main purpose of the study is to analyze the researchers' behaviors and views about knowledge and technology transfer and explore the motivating and deterring factors for their commercialization actions.

In this study commercialization behavior of researchers in RIs are analyzed in more detail since in Turkey there has been a growing interest among policy makers towards commercialization of public research in the recent years. On the other hand, as many recent studies in the literature suggested, other KTT activities should not be neglected since in some cases they could be more significant or more effective than patenting, licensing and spin-offs and some KTT activities such as consultancy are complementary to the commercialization activities (Abreu et al., 2009; D'Este & Patel, 2007; Póvoa & Rapini, 2010; Arvanitis & Woerter, 2008). Therefore, the content of this research is not limited to commercialization. Engagement level and attitudes of researchers regarding various KTT mechanisms are also investigated. In this regard, the sub-questions regarding the main research question are as follows;

- What is the level of researchers' involvement in various KTT mechanisms?
- What are their views about the importance of different KTT channels?
- Why do researchers cooperate with private sector and which factors stimulate them to engage in commercialization activities?
- Which factors discourage them from engaging in commercialization activities?
- Do policies, services and management of the research infrastructure/university support the KTT and commercialization activities of the researchers or discourage them?
- Do certain national policies and support system support the KTT and commercialization activities of the researchers or discourage them?

In Turkey, statistics and national level surveys regarding KTT between universities/RIs and industry are very limited. In this study mixed method approach is used by integrating and interpreting the quantitative data collected through an online survey among researchers with the qualitative data gathered through interviews with the directors of the Research Infrastructures. This approach enables cross-validation of the views of researchers and the RIs' directors, thus strengthens the findings of the analysis and provides insights for policy proposals.

The online questionnaire survey (Appendix A) was conducted among researchers/academicians in the 4 research infrastructures that have been supported by the Law No. 6550 in Turkey. Thus, target group of the survey is the *researchers that are working or affiliated with the 4 research ınfrastructures*, namely Izmir Biomedicine and Genome Center (IBG), Middle East Technical University MEMs Center (METU MEMs), Sabanci University Nanotechnology Research and Application Center (SUNUM) and Bilkent University National Nanotechnology Research Center (UNAM). Previous studies indicate that research commercialization activities are commonly executed by eminent researchers in top-ranked departments or universities (Lam, 2011). Thus, the researchers in the high performing RIs that have been supported by the new RI Law in Turkey have been selected as the unit of analysis of this study.

The questionnaire design was based on theoretical and empirical findings of the literature on knowledge and technology transfer between university/research institutions and the firms. The questionnaire was tested for validity and reliability by taking the reviews of one RI manager and two researchers. Then managers of the RIs were contacted and informed about the aim and content of the survey and requested to send out the online survey to all researchers in the RIs. The survey was carried out in July-August 2018.

Total population for questionnaire consists of 170 researchers and a total of 44 responses were received, which is a response rate of nearly 26 %. Table 12 shows the distribution of respondents by the RIs, total number of researchers and response rates in the RIs.

Table 12. Distribution of Respondents by Research Infrastructures

RI Name	Frequency of Respondents	Total Population*	Response Rate
IBG	13	55	23,6
ODTU MEMS	8	25	32,0
SUNUM	12	36	33,3
UNAM	11	54	20,4
TOTAL	**44**	**170**	**25,9**

*By the end of June 2018

The survey questionnaire includes 4 sections: In the first section there are questions regarding general characteristics of the researchers such as academic title, age, gender, work experience and academic output.

The second section begins with an introductory note describing the terms ‘Knowledge and Technology Transfer’ and ‘Commercialization’ in order to make these terms clear for respondents and thus increase the reliability and validity of the questionnaire. This section includes questions regarding technological and entrepreneurial outputs (patents, licenses, spin-offs) of researchers and questions about the intensity and perceived importance of various KTT channels. Number and classification of KTT

forms between universities/RIs and firms analyzed in the empirical literature varies. For example, Bekker and Freitas (2008) analyzed the importance of 26 different KTT activities; Arvanitis et al. (2008) investigated the usage of 19 channels of KTT activities and 3 forms of commercialization (i.e. patenting, licensing and spin-offs) and Beyhan (2011) explored 18 different KTT channels, including 3 commercialization activities.

This study aims to explore intensity and importance of a wide spectrum of KTT activities including academic publishing, research related activities, informal and personal contacts, consulting, educational activities and commercialization actions. In this regard, by considering the similar studies in the literature 12 KTT forms were identified as valid for Turkish research ecosystem since some channels that are cited in the literature are not common or familiar concepts for researchers in Turkey. "Academic publishing" is included among the KTT mechanisms since it is a significant medium for knowledge transfer and also in Turkey most of the researchers in RIs are also academicians and publication is the major factor for their academic promotion. Moreover, in the literature there are studies exploring the relation between academic publishing and other KTT instruments such as patenting and some studies argue that there is tradeoff between publishing and patenting in terms of time management and research type (Moutinho et al., 2007). Therefore, the intensity of academic publishing in KTT process and researches' view about academic publishing are investigated in this study.

The third section is dedicated to the commercialization activities of the researchers and starts with the definition of the 'Commercialization'. In this section there are questions that aims to investigate researchers' attitude towards commercialization, motivating and deterring factors for their commercialization actions and their views and perceptions about the role and impact of the RI and the university in this process. Researchers are asked to assess the degree of the importance/relevance of the motivating or deterring factors for their commercialization behavior on a 5 point likert scale. Additionally, in order to better analyze the most important or relevant motivating

and deterring factors for researchers' commercialization activities, they were asked to select and rank the 3 most significant/relevant factor for them.

As previous studies in the literature suggested, characteristics and policies of researchers' institutions/departments such as mission, type of the R&D activities conducted, existence of clear policies and reward systems about patenting, licensing and revenue sharing affect the researchers' engagement in technology transfer and commercialization activities (Bozeman, 2000; Beyhan, 2011). Therefore, in this questionnaire, researchers were asked to assess their university and RI in terms of giving importance and supporting commercialization activities. Moreover, researchers were asked whether their university and RI has a clear policy/strategy regarding commercialization. While capturing the perception of researchers with these questions, directors of the RIs were also asked about their views, policies and strategies about commercialization through interviews.

In the last section, there are questions aiming to get the assessments of the researchers regarding the performance of their university and RI in terms of technology transfer and commercialization and also their views about technology transfer offices.

The interview (Appendix B) with RI directors includes questions aiming to learn details about the attitudes, policies and strategies of the RI managements regarding technology transfer and commercialization issues. Interviews give the chance to compare the remarks of RI directors with the replies of researchers and thus analyze how well these policies and strategies are communicated to the researchers and affect their technology transfer and commercialization behavior.

5.2. FINDINGS AND DISCUSSION

In the Table 13, descriptive characterization of the researchers are presented that enable to understand the profile of the respondents.

Table 13. Characteristics of Researchers

	Frequency	Percent
Academic Title		
Professor	8	18,2
Associate Professor	12	27,3
Assistant Professor	17	38,6
Post-Doc Researcher	4	9,1
No Academic Title	2	4,5
Other (Doctor of Medicine)	1	2,3
Gender		
Female	18	40,9
Male	26	59,1
Age		
25-29	1	2,3
30-34	3	6,8
35-39	21	47,7
40-44	11	25,0
45-49	5	11,4
50-54	3	6,8
Publication Number		
1-9	10	22,7
10-19	15	34,1
20-39	9	20,5
40-59	4	9,1
60-79	3	6,8
100 and more than 100	3	6,8
Working Duration in the RI		
Less than 1 year	8	18,2
1-3 Years	7	15,9
3-5 Years	9	20,5
5-8 Years	9	20,5
8-10 Years	4	9,1
More Than 10 Years	7	15,9
Ownership of Patent		
Yes	19	43,2
No	25	56,8

Table 13 (continued)

Number of Patents		
1	8	18,2
2-5	10	22,7
6-10	0	0
More than 10	1	2,3
Licensing		
Yes	5	11,3
No	14	31,8
Spin-Off Firm Creation		
Yes	7	15,9
No	37	84,1

Nearly 39 % of respondents are assistant professor, 27% is associate professor, 18% is professor and 9% is post-doc researchers. Almost half of the respondents are between the age of 35-39 while 25% is between 40-44 and 11% is between 45-49 years old. Most of the respondents' working time period is less than 8 years while 25% of them are working in or affiliated with the RI for more than 8 years. Nearly 43% of the researchers have patents but only 11 % of researchers licensed and 16% created a spin-off firm. These results suggest that while a considerable number of researchers are active in terms of patenting, their overall engagement in commercialization activities such as licensing and spin-off firm creation are at low level.

5.2.1. Researchers' Engagement In Various KTT Channels

Researchers were asked to state how frequently they engage in the given 12 forms and channels of knowledge and technology transfer activities (including commercialization activities) in the last 5 years period by using a five point likert scale. According to the results, the most common form of KTT activity among researchers is the academic publications since all of the researchers involve in academic publishing at some degree. On the other hand, 84% of the researchers indicate that they 'never' engaged in commercialization activities, namely licensing and spin-off firm creation. The ratio that mention they "rarely" involved in licensing and spin-off creation

activities are 11.4% and 6.8% respectively. These results imply that commercialization efforts among researchers are at very low levels.

Nearly 80% and 71% respondents mention that they never involved in joint thesis/doctoral studies and joint publications with firms respectively. This results suggest that RI-firm cooperation in educational activities is very low.

52.3% of respondents say that they "never" involved in a joint project funded by the firms and 18.2% say that they "rarely" involved in such a project. This is an expected result since in Turkey private sector' funding in contract-based R&D projects with universities or RIs is at low level. Additionally, 22.7% of researchers mention they "never" involved in a public-funded joint project with firms and %45.5 mention they "rarely" involved in such a project. According to these results it can be argued that RI/university-firm joint projects are not at desirable volume. Moreover, ratio of researchers that mention they 'never' engaged in consultancy is almost 57%.

Table 14. Researchers by the Involvement Intensity in Different KTT Activities

KTT Activities	Never	Rarely	Sometimes	Frequently	Very Frequently
	%	%	%	%	%
Academic publishing	0	6,8	27,3	36,4	29,5
Providing R&D, test and analysis services to firms	36,4	25	31,8	6,8	0
Joint projects with firms, funded by firms	52,3	18,2	25	4,5	0
Joint projects with firms, funded by public funds	22,7	45,5	22,7	6,8	2,3
Consultancy to firms	56,8	27,3	11,4	4,5	0
Joint thesis/doctoral studies with firms	79,5	6,8	11,4	2,3	0
Joint publications with researchers in firms	70,5	25	0	4,5	0
Personal relations with graduates/employees in firms	15,9	36,4	34,1	13,6	0
Training/seminar/conference for/with firms	54,5	31,8	13,6	0	0

Table 14 (continued)

Licensing activities	84,1	11,4	2,3	2,3	0
Spin-off firm creation	84,1	6,8	9,1	0	0

In order to summarize the results shown in the above table, the responses on the 5 point likert scale are transformed to a simple binary response (yes or no). In the first column all the respondents that 'somewhat' involved in KTT activities are calculated as "involved in KTT" by excluding the respondents that say 'never'. In the second column the responses "frequently" and "very frequently" are taken as the indicator of 'actively involvement' in KTT activities.

As it can be seen from the Table 15, researchers in RIs have engaged in academic publications in the first place, KTT through personal relations in the second place and thirdly, joint projects funded by public. Providing R&D and test services to private sector, using firms' R&D centers and facilities, joint seminars and training and consultancy services follow the first 3 activities. However, when we examine the "actively involved" ratios; the percentage of researchers that engage 'actively' in any KTT activity other than academic publications is very low, mostly under 10 percent.

Moreover, researchers' involvement level in commercialization activities is low compared to other forms of KTT activities. These results are similar to the findings of the studies in the literature that show that commercialization activities of researchers are less frequent than other KTT instruments. Therefore, the role and importance of other KTT channels should be explored in detail in order to better understand the university/RI-industry interactions and they should be addressed in policy making process.

Table 15. Ratio of Researchers That Involved/Actively Involved In Different KTT Activities

KTT ACTIVITIES	Involved in KTT activity (%)	Actively Involved in KTT activity
Academic publishing	100	65,9
Providing R&D, test and analysis services to firms	63,6	6,8
Joint projects with firms, funded by firms	47,7	4,5
Joint projects with firms, funded by public funds	77,3	9,1
Consultancy to firms	43,2	4,5
Joint thesis/doctoral studies with firms	20,5	2,3
Joint publications with researchers in firms	29,5	4,5
Personal relations with graduates/employees in firms	84,1	13,6
Training/seminar/conference for/with firms	45,5	0
Licensing activities	15,9	2,3
Spin-off firm creation	15,9	0

(1) Respondents that say 'never" are excluded.
(2) Respondents that say that 'frequently' and 'very frequently' are included.

Respondents were asked to rank the 3 most important KTT instruments among the above mentioned list (1= the most important). 38.6% of the respondents ranked the "Joint projects of RIs and firms that is funded by firms" as the most important channel followed by the academic publications (31.6% of the respondents). For the second most important channel, joint projects funded by public get the highest vote (36.4% of respondents). When all rankings are summed up by giving the value '3' to the first priority, '2' to the second priority and '1' to the third one. According to the 'weighted total numbers'; joint projects funded by firms rank first, joint projects funded by public rank second and academic publications rank as the third important channel.

Table 16. Respondents' Ranking of Importance of Different KTT Activities

	First		Second		Third		Total		
KTT ACTIVITIES	Count	%	Count	%	Count	%	Count	%	**Weighted Total**
Academic publishing	14	31,8	3	6,8	5	11,4	**22**	50	**53**
Providing R&D, test and analysis services to firms	0	0	0	0	3	6,8	**3**	6,8	**3**

Table 16 (continued)

Joint projects with firms, funded by firms	17	38,6	7	15,9	4	9,1	**28**	63,6	**69**
Joint projects with firms, funded by public funds	8	18,2	16	36,4	5	11,4	**29**	65,9	**61**
Consultancy to firms	0	0	1	2,3	6	13,6	**7**	15,9	**8**
Joint thesis/doctoral studies/projects with firms	1	2,3	6	13,6	4	9,1	**11**	25	**19**
Joint publications with researchers in firms	0	0	3	6,8	2	4,5	**5**	11,4	**8**
Personal relations with graduates/employees in firms	0	0	0	0	0	0	**0**	0	**0**
Training/seminar/conference for/with firms	0	0	1	2,3	2	4,5	**3**	6,8	**5**
Licensing activities	1	2,3	2	4,5	2	4,5	**5**	11,4	**9**
Spin-off firm creation	2	4,5	2	4,5	7	15,9	**11**	25	**17**

5.2.2. Views and Perceptions of Researchers About Technology Transfer and Commercialization

Researchers were asked to rate how strongly they agreed with the following statements;

"My research results are sufficiently utilized through academic publishing"
"Commercialization activities are an important part of my job"
"My university places importance on/ supports commercialization activities"
"My RI places importance on/ supports commercialization activities"
"Working in/being affiliated to a RI affects my commercialization activities positively"

Responses are given on five-point likert scale. 54.6% of respondents state that they agree with the argument that their research findings are sufficiently utilized through academic publishing while 20.5% mention that they neither agree nor disagree and

nearly 25% say that they ‘disagree’ or ‘strongly disagree’. This means that for more than half of the respondents academic publishing is sufficient for utilizing their research efforts and creating value.

Nearly 60% of researchers “neither agree nor disagree” or “disagree” with the statement that commercialization is an important part of their job. This result may have several reasons. Researchers’ attitude regarding commercialization may not be so positive or because of their academic workload or lack of innovative capabilities they do not regard commercialization as an important part of their responsibilities or because of their research field they are more engaged in basic research. On the other hand, when researchers were asked whether they considered to attempt commercializing their research findings in the future, nearly 66% mention that they would (Table 18). These results suggest that for most of them the most probable reason for not viewing commercialization as an important part of their job is that because of their workload or lack of innovative capabilities they can not spare time for commercialization activities.

Nearly 80% of respondents suppose that their university and RI supports and appreciates commercialization activities. However, 66% of researchers say that working in or being affiliated to a RI affect their commercialization activities positively.

Table 17. Researchers’ Views About Technology Transfer and Commercialization

Statements Regarding Technology Transfer and Commercialization	Strongly Disagree (%)	Disagree (%)	Neither Agree Nor Disagree(%)	Agree (%)	Strongly Agree (%)
My research results are sufficiently utilized through academic publishing	6,8	18,1	20,5	34,1	20,5
Commercialization activities are an important part of my job	0	29,5	29,5	29,5	11,5

Table 17 (continued)

University places importance on/ supports commercialization	2,3	9,1	9,1	63,6	15,9
RI places importance on/ supports commercialization	2,3	4,5	11,4	38,6	43,2
Working in a RI affects my commercialization activities positively	2,3	0	31,8	40,9	25,0

Perception of researchers about university or RI commercialization policies is an indicator whether these policies are clearly defined and communicated to the researchers. Researchers were asked whether their 'university' and 'RI' have a 'clear" policy/strategy about commercialization. The percentage of researchers who state that their university and RI has a clear commercialization policy are 55% and 60%, respectively. Nearly 30% of them mention that they "do not know" or "not sure" whether their university has a clear policy, this ratio is 34% for the RI case. The relatively high ratio of the respondents that 'are not sure/do not know" could be the result of insufficiency of identification and implementation of communication of clear commercialization policies by universities RIs as well as the lack of interest on the researchers' side.

Table 18. Researchers' Views About Commercialization

	No		Not Know/ Not Sure		Yes	
	Count	%	Count	%	Count	%
Do you intend to commercialize your research results	4	9,1	11	25,0	29	65,9
Does your university have a clear policy/strategy regarding commercialization	7	15,9	13	29,5	24	54,5
Does your RI have a clear policy/strategy regarding commercialization	3	6,8	15	34,1	26	59,1

In order to learn about policies and approach of RI management towards technology transfer and commercialization, RI directors were asked to mention the policies,

strategies and tools that they adopted in order to promote KTT and commercialization in the RI. All of the directors told that they give importance and adopt policies to increase KTT and commercialization performance of the RI. In this respect one of the directors remarked that;

> *We aim to work with the industry starting from the early stages of the projects since this increases the compatibility of our projects' results with the needs of the industry and thus commercialization possibility increases. Currently were are interacting with many firms in order to prepare for the application to new TUBITAK 1004 support program. Most of current studies and resulting patents are at TRL[5] 1-4 level. We are also trying to develop new projects with industry to develop these studies further to TRL 6-9 level.*

Another RI Director stressed that 'research field' of the RI is important in determining technology transfer and commercialization policies and mission of the RI. In this respect he mentioned that;

> *'lifesciences' is a research field in which 'Basic Research' constitutes a significant part of the research activities. We try to form a range of research activities from basic research to applied research in the RI. Also translational R&D in lifesciences are too uncertain, risky and length process in nature. TUBITAK 1004 support program will be an important facilitator for us to engage more in commercialization activities and develop our researchers' cooperation with firms further and they are very eager to involve in this project.*

Other director also emphasized that;

> *The characteristics of RIs' sector is an important factor in commercialization process since in sectors such as defense that are heavily dependent on public procurement, commercialization behavior and decision are affected by public procurement policies. He also stated that in defense sector contract based research projects in which IP rights belong to firms is very common. Therefore, also in this kind of projects firms have more decisive role in commercialization process.*

[5] Technology Readiness Level

These remarks of the RI directors support the findings of the literature suggesting that scientific field and mission/focus of the RI has a significant influence on the KTT tendency of researchers and RIs that define 'basic research' as their mission have less tendency to involve in KTT activities (Arvanitis et al., 2008; Bozeman, 2000). Therefore, scientific field/sector characteristics and type and intensity of the different research activities (basic, applied etc.) should be taken into account while assessing the KTT performance of these RIs' and policies should be developed by considering these differences.

5.2.3. Motivational and Discouraging Factors for Researchers' Commercialization Behavior

In the literature, there are different classifications regarding motivational factors for researchers' commercialization behavior changing according to the purpose of the study and the theories adopted. By considering similar studies and the aim of this study, researchers were asked to assess how important a given set of factors for motivating them to engage in commercialization activities. Responses are provided on a 5 point likert scale. Percentages of responses for each motivating factor could be seen from the Table 19. In the Table 20, total ratio of the respondents that assess the factor as "very important" and "important" are given.

Table 19. Motivations of Researchers to Engage in Commercialization Activities

Motivations to Commercialize	Very Unimportant	Unimportant	Neither Important Nor Unimportant	Important	Very Important
	%	%	%	%	%
Additional Income For Research	0	2,3	9,1	52,3	36,4
Additional Personal Income	2,3	4,5	15,9	54,5	22,7
Application/Exploitation of Research Results	0	0	4,5	47,7	47,7
Increase Job Opportunity For Students and Graduates	0	4,5	11,4	61,4	22,7

Table 19 (continued)

Contribute National and Regional Development	0	2,3	6,8	40,9	50
Develop New and High-Value Added Products	0	0	2,3	31,8	65,9
Contribute dissemination of knowledge and technology	0	4,5	6,8	59,1	29,5
Meet Requirements of Funding Institutions/Advantage for Public Funds	4,5	4,5	25	47,7	18,2
Increase Personal/RI Reputation	2,3	6,8	13,6	47,7	29,5
Access To Firms' Knowledge and R&D Results	2,3	9,1	31,8	40,9	15,9

Meeting the requirements of funding institutions or getting advantage for public funds and accessing to firms' knowledge and R&D results are regarded as relatively less important factors for researchers compared to other factors. Additional personal income and increasing reputation of RI are seen as important or very important by the 77% of researchers while other factors are seen as important/very important by more than 84% of the researchers.

Table 20. Percentage of Researchers That Assess the Motivating Factors as Important/Very Important

Motivations to Commercialize	**Very Important or Important**
Develop New and High-Value Added Products	97,7%
Application/Exploitation of Research Results	95,4%
Contribute National and Regional Development	90,9%
Additional Income or Research at the RI	88,7%
Contribute Dissemination of Scientific Knowledge And Technology	88,6%
Increase Job Opportunity For Students and Graduates	84,1%
Additional Personal Income	77,2%
Increase Personal/RI Reputation	77,2%
Meet the Requirements of The Funding Institutions/ Get Advantage for Public Funds	65,9%
Access to Firms' Knowledge and R&D Results	56,8%

In order to assess the most important motivating factors for researchers in depth. They were asked to select and rank the 3 most important factor for them. “Developing New and High-Value Added Products” and “additional income for research” are two factors that are mostly stated as the first priority (30 % and 25% of the researchers respectively). In order to better analyze the relative importance of the factors; the selections are summed up by giving the value ‘3’ to the first priority, ‘2’ to the second priority and ‘1’ to the third one. According to these results; the most important factor that motivates researchers’ commercialization action is; developing new and high-value added products, second important factor is ‘additional income for research’ and the third significant factor is ‘contributing national and regional development’. ‘Application/exploitation of research results’ is the fourth priority factor. ‘Additional personal income’ is mentioned as the fifth priority but less important compared to other four factors. Thus, research related achievements and gains and societal benefits are more important motives for researchers compared to personal gains or other factors.

Table 21. Researchers’ Ranking of the Motivating Factors

	First Priority	Second Priority	Third Priority	Total	Weighted Total
	Count	Count	Count		
Additional Income for Research at RI	11	7	5	23	52
Additional Personal Income	3	8	6	17	31
Application/Exploitation of Research Results	6	9	7	22	43
Increase Job Opportunity For Students and Graduates	1	3	4	8	13
Contribute National and Regional Development	9	7	7	23	48
Develop New and High-Value Added Products	13	8	5	26	60
Contribute Dissemination Of Scientific Knowledge And Technology	0	2	4	6	8
Meet the Requirements of The Funding Institutions/ Get Advantage for Public	0	0	2	2	2
Increase Personal/RI Reputation	1	0	1	2	4
Access To Firms' Knowledge and R&D Results	0	0	3	3	3

In order to analyze the obstacles and challenges for researchers' commercialization activities, they were asked to state at what degree they agree that the given factors are deterrent for their commercialization actions. When the share of researchers that 'strongly agree' and 'agree' are summed up, the most stated deterrent factor is the 'Mismatch between the culture and expectations of firms and RIs' (almost 86% of the respondents). Second mostly mentioned deterring factor is the 'Firms' lack of interest or knowledge about R&D' (almost 82% of researchers). This is followed by 'Firms' lack of R&D capacity' and 'financial risks of commercialization' that are mentioned by more than 77% of respondents as an obstacle.

Additionally some noteworthy results are that 61,4% of researchers say that they neither agree nor disagree that 'Difficulties in access to finance such as venture capital, bank credits' is a deterring factor for commercialization. Similarly, 54.5% and 50% of respondents mention that they neither agree not disagree with the following factors respectively; 'Ineffective service and supports at technoparks" and 'Insufficient in intellectual property regulations'. These results suggest that a high ratio of researchers are not certain about these factors or they find them as irrelevant for commercialization. In both cases, from these results it could be argued that researchers are not so informed about these mechanisms and systems or their importance/ role in commercialization efforts.

Table 22. Deterring Factors for Researchers to Engage In Commercialization

	Strongly Disagree		Disagree		Neither Agree Nor Disagree		Agree		Strongly Agree	
	Count	%	Count	%	Count	%	Count	%	Count	%
Inapplicability of research studies to practice	2	4,5	12	27,3	6	13,6	16	36,4	8	18,2
Insufficient time because of the intensity of academic and scientific activities	3	6,8	5	11,4	4	9,1	18	40,9	14	31,8
Insufficient support from the RI management	4	9,1	22	50	9	20,5	8	18,2	1	2,3
Insufficient support from the university	3	6,8	20	45,5	9	20,5	9	20,5	3	6,8
Low effect of commercialization activities for academic promotion and incentives	2	4,5	7	15,9	12	27,3	18	40,9	5	11,4
Firms' lack of interest or knowledge about R&D	0	0	1	2,3	7	15,9	16	36,4	20	45,5
Firms' lack of R&D capacity	1	2,3	3	6,8	6	13,6	19	43,2	15	34,1
Mismatch between the culture and expectations of firms and RIs	0	0	2	4,5	4	9,1	24	54,5	14	31,8
Usage of new innovative products are found to be risky by public and/or firms.	0	0	3	6,8	10	22,7	20	45,5	11	25
Lack of personal knowledge and experience about commercialization	1	2,3	3	6,8	8	18,2	19	43,2	13	29,5

Table 22 (continued)

Financial risks of commercialization	0	0	3	6,8	7	15,9	24	54,5	10	22,7
Insufficient intellectual property regulations	1	2,3	10	22,7	22	50	8	18,2	3	6,8
Uncertainties regarding sharing of IPR rights	2	4,5	4	9,1	18	40,9	17	38,6	3	6,8
Insufficient intermediary institutions and bodies	0	0	19	43,2	11	25	13	29,5	1	2,3
Insufficient public support in terms of number and quantity	1	2,3	5	11,4	10	22,7	25	56,8	3	6,8
Insufficient public support in terms of quality (application /assessment procedures etc.)	0	0	7	15,9	13	29,5	21	47,7	3	6,8
Difficulties in access to finance (venture capital, bank credits etc.)	0	0	1	2,3	27	61,4	16	36,4	0	0
Ineffective service and supports at technoparks	0	0	9	20,5	24	54,5	10	22,7	1	2,3

Table 23. Percentage of Researchers That Agree/Strongly Agree With the Deterring Factors

Deterring Factors	**Agree or Strongly Agree**
Inapplicability of research studies to practice	54,6
Insufficient time because of the intensity of academic and scientific activities	72,7
Insufficient support from the RI management	20,5
Insufficient support from the university	27,3
Low effect of commercialization activities for academic promotion and incentives	52,3
Firms' lack of interest or knowledge about R&D	**81,9**
Firms' lack of R&D capacity	77,3
Mismatch between the culture and expectations of firms and RIs	**86,3**
Usage of new innovative products are found risky by public and/or firms.	70,5
Lack of personal knowledge and experience about commercialization	72,7
Financial risks of commercialization	77,2
Insufficient intellectual property regulations	25,0
Uncertainties regarding sharing of IPR rights	45,4
Insufficient intermediary institutions and bodies	31,8
Insufficient public support in terms of number and quantity	63,6
Insufficient public support in terms of quality (application /assessment procedures etc.)	54,5
Difficulties in access to finance (venture capital, bank credits etc.)	36,4
Ineffective service and supports at technoparks	25,0

In order to identify the most significant obstacles and challenges for researchers in depth and more explicitly; the researches were asked to select and rank the three most

significant deterrent factors for commercialization (1= most significant). In order to better analyze the relative importance of the factors; the selections are summed up by giving the value '3' to the first priority, '2' to the second priority and '1' to the third one. According to the results 'Insufficient time because of the intensity of academic and scientific activities' are regarded as the most significant obstacle by researchers. It is closely followed by 'Firms' lack of interest or knowledge about R&D. The third significant deterrent factor is mentioned as 'Mismatch between the culture and expectations of firms and RIs'. It is closely followed by 'lack of personal knowledge and experience about commercialization' and 'usage of new innovative products are found to be risky by public and/or firms'.

Table 24. Researchers' Ranking of Deterring Factors for Commercialization

	First Priority	Second Priority	Third Priority	**Total**	**Weighted Total**
	Count	Count	Count		
Inapplicability of research studies to practice	6	1	3	10	23
Insufficient time because of the intensity of academic and scientific activities	8	5	5	18	39
Insufficient support from the RI management	1	0	1	2	4
Insufficient support from the university	2	3	0	5	12
Low effect of commercialization activities for academic promotion and incentives	3	4	1	8	18
Firms' lack of interest or knowledge about R&D	5	9	2	16	35
Firms' lack of R&D capacity	3	2	3	8	16
Mismatch between the culture and expectations of firms and RIs	5	5	3	13	28
Usage of new innovative products are found to be risky by public and/or firms	2	6	8	16	26
Lack of personal knowledge and experience about commercialization	5	1	10	16	27
Financial risks of commercialization	3	0	2	5	11

Table 24 (continued)

Insufficient intellectual property regulations	0	0	0	0	0
Uncertainty regarding sharing of IPR rights	0	1	1	2	3
Insufficient intermediary institutions and bodies	1	0	1	2	4
Insufficient public support in terms of number and quantity	2	2	2	6	12
Insufficient public support in terms of quality (application/assessment procedures etc.)	0	3	1	4	7
Difficulties in access to finance such as venture capital, bank credits etc.	0	1	0	1	2
Ineffective service and supports at technoparks	0	0	0	0	0

RI Directors were informed about the survey results regarding the perceived barriers for commercialization and their views about commercialization barriers and suggestions to overcome the mismatch between researchers and industry were asked. One of the directors said that;

> *Academicians and researchers should learn the 'language' of the industry. For instance, we are currently working on improving our website to make it more user-friendly for industry such as giving information about our capabilities not only by mentioning the name of machinery but also the analyses that we can provide. Academicians and researchers should investigate the needs of the industry with the help of intermediary bodies such as RIs or technology transfer offices. Needs of industry are mostly interdisciplinary. Therefore, the roles of intermediary bodies are critical in determining the needs of the industry and provide them the bunch of the required infrastructure and expertise. Researchers should also devote some time for this kind of activities since this is two way learning process both for researchers and the industry.*

Another director said;

> *First of all there are barriers and prejudices in the minds of both researchers and the industry. The work culture of the researchers is not so close to technology transfer and commercialization issues. Also priorities of the industry is mostly focused on the survival of the firm by focusing on sales,*

production, costs etc. Since R&D is a long term issue, they are reluctant and indecisive especially when uncertainties are high.

Since technology transfer offices are the most significant intermediary body in technology transfer and commercialization process, researchers were asked how often they used the services of the TTO in their universities in the last 5 years. 20.5 % of researchers say that they never used TTO services while 11.4% mention that they 'rarely' used and 36.4% of them stated they 'sometimes' benefited from TTO services.

Table 25. Researchers' Usage Frequency of TTO Services

	Never		Rarely		Sometimes		Frequently		Very Frequently	
	Count	%	Count	%	Count	%	Count	%	Count	%
TTO Usage Frequency	9	20,5	5	11,4	16	36,4	7	15,9	7	15,9

RI Directors were asked whether there should be structures in RIs to facilitate technology transfer and commercialization processes or structures like technology transfer offices in universities are sufficient. One of the directors mentioned that;

Recently, we established a specialized unit that deals with developing RI-industry relations and facilitating technology transfer and commercialization activities of researchers. We also aim to inform, drive the industry by some services. Our unit will receive invention disclosures but patenting and other processes will be delegated to the technology transfer office (TTO). In Turkey TTOs are at the developing stage. TTOs should adopt a holistic approach by targeting whole stages of technology transfer and commercialization process from awareness creation and maintaining university-industry cooperation to the last stage, commercialization, without neglecting any step in this process.

Another RI Director stated that;

We thought that a professional team in the RI should deal with the processes regarding technology transfer and commercialization instead of the researchers themselves. Therefore, we employed an Assistant Director who has a Phd in a business related area and has experience in private sector in

addition to his scientific background. He is responsible for business development, technology transfer and commercialization issues. We also plan to deal with patent attorneys in order to simplify the procedures for researchers

RI Directors were asked whether they have a performance assessment system for employees, and technology transfer and commercialization activities are included as a criteria in recruiting and promotion. One of the directors stated;

We set up employee performance evaluation system by identifying performance indicators similar to the RI' performance indicators measured by TUBITAK. Currently, the weight of academic output are same with knowledge and technology transfer and commercialization indicators but in the coming years we plan to increase the weight of KTT indicators and we shared this policy with the researchers. Also in new recruitments we give attention to the candidates that have patents or intention to patent and commercialize.

Researchers were asked to assess their RI and university in terms of technology transfer and commercialization. 75% and 66% of the researchers respectively think that their RI and university is good or very good in terms of technology transfer and commercialization. These results suggest that their idea and perception about RI's performance in KTT is better compared to their university.

Table 26. Researchers' Assesment of the RI and University In Terms Of KTT

	Very Poor	Poor	Fair	Good	Very Good
	%	%	%	%	%
Assesment of the RI	0	6,8	18,2	65,9	9,1
Assesment of The University	2,3	15,9	15,9	56,8	9,1

Knowledge and technology transfer includes bi-directional knowledge flow both from university/RI- industry and industry to university/RI. However, knowledge flow from industry to university/RI is a relatively neglected issue in the KTT studies and analyses (D'Este & Patel, 2007). In fact, knowledge of industry is very valuable for researches and academicians since it gives the opportunity to understand the technological

problems of the industry, customer/market needs and applicability of research results better.

In this study, in order to explore the intensity of researchers' usage from researches benefit from knowledge of industry, they were asked at what degree they use the knowledge and R&D results of the industry. Nearly 39% of researches mention that they never used industrial knowledge, while 32% and 20.5% state that they use rarely and sometimes respectively. As these results suggest knowledge flow from industry to researchers is also insufficient.

Table 27. Researchers' Usage Frequency of Firm Knowledge

	Never	Rarely	Sometimes	Frequently	Very Frequently
	%	%	%	%	%
Usage of Firm Knowledge	38,6	31,8	20,5	4,5	4,5

5.2.4. Summary of the Overall Findings

Main findings of the survey and the interviews are summarized below:

- Researchers have engaged in academic publications in the first place, KTT through personal relations in the second place and thirdly, joint projects funded by public.
- The percentage of researchers that engage 'actively' in any KTT activity other than academic publications is very low, mostly under 10 percent.
- Nearly 80% and 71% respondents mention that they never involved in joint thesis/doctoral studies and joint publications with firms respectively. This results suggest that RI-firm cooperation in educational activities is very low.
- The least common form of KTT activities for researchers are the commercialization activities, that is licensing and spin-off firm formation. These results are in line with the empirical literature stating that researchers' involvement in commercialization activities is less frequent compared to other forms of

knowledge and technology transfer (Landry et al., 2007; P.D. Este et al., 2007; Moutinho et al., 2007).

- While a considerable number of researchers are active in terms of patenting, their overall engagement in commercialization activities such as licensing and spin-off firm creation are at low level.
- According to researchers' assessment of the importance of the KTT channels, joint projects funded by firms rank first, joint projects funded by public rank second and academic publications rank as the third important channel.
- For more than half of the respondents academic publishing is sufficient for utilizing their research efforts and creating value.
- Nearly 60% of researchers "neither agree nor disagree" or "disagree" with the statement that commercialization is an important part of their job. On the other hand, nearly 66% of them state that they intend to commercialize their research findings. These results suggest that the most probable reasons for researchers' perception regarding commercialization not being a significant part of their job is that because of their workload or lack of innovative capabilities they can not spare time for commercialization activities.
- Nearly 80% of respondents suppose that their university and RI supports and appreciates commercialization activities. However, 66% of researchers say that working in or being affiliated to a RI affect their commercialization activities positively.
- 55% and 60% of researchers mention that their university and RI has a clear commercialization policy, respectively. Nearly 30% of them state that they "do not know" or "not sure" whether their university has a clear policy, this ratio is 34% for the RI case.
- All of the RI directors argue that they give importance and adopt policies to develop KTT and commercialization performance of the RI.
- RI directors stress some points about KTT policies of the RIs that could give valuable insights for policy recommendations:

- Working with the industry starting from the early stages of the projects increases the compatibility between industry and the RI in terms of needs and expectancy and thus increases the commercialization possibility.
- New support program of TUBITAK, namely 1004 High Technology Platforms Support Program, is an important facilitator to develop the cooperation between RIs and industry in terms of R&D and commercialization activities.
- Research field and/or sector of the RI is a critical factor that affects the KTT performance, types of the KTT activities conducted, KTT mission and policies of the RI.

- The most important factor that motivates researchers' commercialization action is; 'developing new and high-value added products', second important factor is 'additional income for research' and the third significant factor is 'contributing national and regional development'. 'Application/exploitation of research results' is the fourth priority factor. 'Additional personal income' is mentioned as the fifth priority but less important compared to other four factors. Thus, research related achievements and gains and societal benefits are more important motives for researchers compared to personal gains or other factors.
- The most significant deterrent factors for researchers' commercialization behavior are; 'Insufficient time because of the intensity of academic and scientific activities', 'Firms' lack of interest or knowledge about R&D and 'Mismatch between the culture and expectations of firms and RIs'. They are followed by 'lack of personal knowledge and experience about commercialization' and 'usage of new innovative products are found to be risky by public and/or firms'.
- 61,4% of researchers say that they neither agree nor disagree that 'Difficulties in access to finance such as venture capital, bank credits' is a deterring factor for commercialization. Similarly, 54.5% and 50% of respondents mention that they neither agree not disagree with the following factors respectively; 'Ineffective service and supports at technoparks" and 'Insufficient in intellectual property regulations'. These results suggest that a high ratio of researchers are indecisive about these factors or they find them as irrelevant for commercialization.

- RI directors stress some points about discouraging factors for commercialization that could give valuable insights for policy recommendations:
    - Researchers should explore the needs and concerns of the industry with the help of intermediary bodies.
    - The work culture of the researchers is not so compatible with KTT processes. On the other hand, firms focus on short-term, survival issues rather than R&D since R&D activities are long term and risky.
- 20.5 % of researchers say that they never used TTO services while 11.4% mention that they 'rarely' used and 36.4% of them stated they 'sometimes' benefited from TTO services.
- 75% and 66% of the researchers respectively think that their RI and university is good or very good in terms of technology transfer and commercialization.
- Nearly 39% of researches mention that they never used industrial knowledge, while 32% and 20.5% state that they used rarely and sometimes respectively.

CHAPTER 6

CONCLUSION AND POLICY RECOMMENDATIONS

In recent years, there has been a growing interest among policymakers towards increasing contribution of research infrastructures to national and local development and maintain their long term sustainability in Turkey. In this regard, a new legislation, namely the Law on Supporting Research Infrastructures No. 6550, was adopted in 2014. The main purpose of this law is to increase the socio-economic impact and sustainability of RIs.

The Law, mainly introduces a new performance based support system for RIs and aims to select the relatively high performing RIs in different scientific fields and increase their performance and sustainability by resolving their financial, managerial and operational problems. In this respect, RIs that are approved to be supported within this system would gain a legal personality and have sustainable budget, professional management bodies and a personnel system that enables to employ high qualified researchers.

This new system is one of the most properly designed support system in Turkey with a well-designed performance evaluation and monitoring system. It includes 'performance assessment' both in the selection and support process, which covers yearly, mid-term and 5 year period performance monitoring and evaluations. The results of the performance evaluation, affect the amount of the public budget allocated to the RIs. As of May 2019, 4 RIs have been approved as competent to be supported within the Law.

In Turkey, RIs' cooperation with industry and knowledge and technology transfer activities, including commercialization is at low levels, even in the high performing RIs. Therefore, developing knowledge and technology transfer between RIs and

industry are among the main goals of the Law. In this regard, the Law introduces new requirements and mechanisms to facilitate the knowledge and technology transfer between RIs and industry. Within this scope, board of directors of the RIs have to include representatives from private sector and non-governmental organizations. Additionally, there should be representatives from private sector and non-governmental organizations in the Advisory Board. Performance evaluation system of the Law involves key performance indicators regarding industry cooperation and knowledge and technology transfer activities. The ownership of all IP rights are granted to the research infrastructure and main issues are regulated by the Law. Additionally, it is regulated that RI managements should develop their policies regarding IP sharing and other related processes. The Law makes it possible to establish RIs in technoparks and industrial regions. Additionally, it enables to establish a RI with the joint ownership of the university and industry.

Although there are some studies in the literature that investigate the university-industry relations and KTT activities of academicians in Turkey, studies about RIs' knowledge and technology transfer and commercialization activities are rather limited. Therefore, this study would make an important contribution to the literature since the main focus of this study is the 'Researchers in the four RIs that have been supported within the RI Law No. 6550'. The literature suggests that research commercialization activities are commonly executed by eminent researchers in the top-ranked departments or universities (Lam, 2011). Therefore, the researchers in the high performing RIs that have been supported by the RI Law have been selected as the unit of analysis of this study. Moreover, RI Law No. 6550 introduces various mechanisms in order to foster KTT performance of RIs and this study would contribute to assess the preliminary effects of these new mechanisms.

Recent studies indicate that since KTT process heavily depends on the willingness and attitudes of the 'individual researcher', it is vital to explore the determinants, motivations and obstacles for their knowledge and technology transfer actions. This

study also makes a significant contribution to the literature since it takes the 'researches' as the unit of analysis.

The main purpose of this study is to investigate the researchers' behaviors and views about knowledge and technology transfer and explore the motivating and deterring factors for their commercialization actions. In the study, commercialization behavior of the researchers are analyzed in more detail since this issue is among the top policy priorities among the policy makers in Turkey. On the other hand, since the literature suggested that other KTT activities should not be neglected in policy analyses, this study is not limited with commercialization activities. Engagement level and attitudes of researchers regarding various KTT mechanisms are also investigated.

In the study mixed method research approach is used by integrating and interpreting the quantitative data collected through online survey among researchers with the qualitative data gathered through interviews with the directors of the RIs.

6.1. OVERALL FINDINGS AND POLICY SUGGESTIONS

- In Turkey, both statistics regarding KTT activities such as licensing, spin-offs etc. at national and university/RI level and national level surveys including various KTT activities is very limited. The lack of data restricts policy analysis and development processes at both university/RI level and national level.

  Policy Recommendations: Official statistics regarding KTT activities such as licensing, spin-offs should be gathered regularly. Additionally, country level surveys aiming to analyze technology transfer and commercialization activities between universities/RIs and industry should be carried out.

- The survey results indicate that 'Academic publishing' is the most common form of KTT activities of the researchers since all of them are involved in academic publishing at some level. Second most common KTT form is the personal relations

with graduates/employees at firms, followed by joint projects with firms funded by public funds.

The percentage of researchers that engage ‘actively’ in any KTT activity other than academic publications is very low, mostly under 10 percent.
Nearly 80% and 71% respondents mention that they never involved in joint thesis/doctoral studies and joint publications with firms respectively. This results suggest that RI-firm cooperation in educational activities is very low.

Nearly 52% and 23% of researchers state that they ‘never’ involved in a firm-funded joint project and public-funded joint project respectively while nearly 18% and 46 % of them mention that they rarely engaged in firm-funded joint projects and public-funded joint projects respectively. Both the survey results and the statistics regarding RIs’ total number of projects with industry show that number of RI-industry joint projects is insufficient.

The least common form of researchers’ KTT activities are the commercialization activities. Although a considerable share of the researchers have patents, their engagement in other commercialization activities, that is licensing and spin-off firm formation is very low.

In conclusion, the survey results indicate that even in the high performing RIs, researchers’ engagement level in various KTT activities other than academic publishing is low.

Policy Recommendations: Although there is a general tendency to concentrate in commercialization activities among policy makers, role and impact of other KTT channels on RI-industry cooperation should be analyzed in detail and considered while developing policies.

Number and budget of support programs that aims to develop joint educational activities of firms and RIs such as joint thesis, joint publication etc. should be increased. The new support program of TUBITAK, namely ‘2244-Industry

Doctorate Program' is potentially a good facilitator to develop RI-industry joint educational activities. Therefore, the number of joint projects of RIs and industry supported within this program should be increased. Additionally, joint thesis and joint publication of RIs and industry should be included as key performance indicators in the performance evaluation of RIs within the Law No. 6550.

Joint projects of RIs and firms should be supported. In this regard, the number of projects supported within the new support program of TUBITAK, namely 1004-High Technology Platforms Support Program, should be increased.

- When their view about the importance of various KTT channels are asked, researchers rank the joint projects funded by firms as first, joint projects funded by public secondly and thirdly academic publications. These results suggest joint project with firms is regarded as the most significant cooperation mechanism with industry.

  On the other hand, both their involvement level and judgement regarding importance suggest that academic publishing is used and viewed as the one of the most significant and common way of disseminating knowledge and research outputs of researchers. Additionally, more than half the respondents mention that they agree with the statement that their research results are sufficiently utilized through academic publishing. Moreover, most significant deterrent factor for researchers' commercialization actions is stated as 'insufficient time because of the intensity of academic and scientific activities'. Since the most of the researchers in RIs are also academicians in universities and legal framework of RIs is relatively new, it can be argued that these findings are mainly derived from the higher education and academic promotion system in Turkey.

  In recent years some policy tools and initiatives have been developed in order to increase research and entrepreneurial missions of universities and academicians. However, both functioning and missions of universities and academic promotion system still heavily depends on teaching activities. The new 'Research University'

concept that was introduced in 2017 is a significant step for differentiating university missions. However, legal framework and incentives and measures to promote research and related KTT activities is insufficient in research universities. The RI Law No. 6550 makes it possible for academicians to be full-time or part-time employed by RIs as a 'Researcher'. The full-time employment option would enable academicians to concentrate mainly on research activities and related technology transfer and commercialization efforts. However, currently most of the senior researchers in RIs are the academicians that are employed as part-time in the RIs. Therefore, their research and KTT behaviors are heavily affected by the rules and characteristics of the higher education system.

Policy Recommendations: In order to promote academicians to engage more in various KTT activities, their perceptions and views about university/RI-industry interaction and different knowledge and technology transfer activities should be improved.

The research findings suggest that to increase knowledge and technology transfer between RIs/universities and industry in Turkey, a structural change is needed in higher education system. In order to increase the 'research' and 'entrepreneurial' functions of the universities, higher education system should be designed more flexible that enables academicians concentrate more on research and entrepreneurial activities by reducing their teaching workload. In this regard, 'Academic Researcher' concept should be introduced in universities that gives academicians the opportunity to concentrate on research related activities with low/ no teaching workload. This would also affect related technology transfer and entrepreneurial activities positively.

Academic promotion and reward system should take into account indicators regarding technology transfer and commercialization activities such as joint projects with industry, joint thesis, consultancy, licensing and spin-off firm creation.

The legal framework of 'Research University' concept should be developed. Within this scope, the mission, roles and functioning of research universities should be clearly defined in such a way that focus heavily on research and related technology transfer and entrepreneurial activities.

Working as full time researcher at RIs within the Law No. 6550 should be encouraged for academicians that wants to concentrate more in research activities.

- In recent years, there is an increasing concern regarding developing economic and social impact of public research generated at universities and RIs in Turkey. In this respect in the survey, researchers' attitude regarding 'commercialization' and motivational and deterring factors for their commercialization behavior were analyzed in depth. Nearly 60% of researchers 'neither agree nor disagree" or 'disagree' that commercialization is an important part of their job. On the other hand, nearly 66% of them indicate that they intend to commercialize in the future. These results suggest that for most of them the most probable reason for not viewing commercialization as an important part of their job is that because of their workload or lack of innovative capabilities they can not engage in commercialization activities.

- Most of the researchers (nearly 80%) mention that their university and RI gives importance and supports commercialization activities. However, when they were asked whether their university and RI has a 'clear' policy about commercialization, a lower ratio of them state that their university and RI has a clear policy (55% and 60% respectively). Also nearly 30% of researchers 'are not sure or do not know whether their university or RI has a clear policy. These findings imply that there could be insufficiency of identifying, communicating and implementing clear policies on universities and RIs' side as well as lack of interest on the researchers' side.

  On the other hand, the interviews with RI directors reveal that RIs have adopted policies regarding increasing RI-university interaction and KTT activities and also

they have introduced some new mechanisms such as establishing new units/departments, including KTT indicators both in the employment process and performance evaluation process.

Policy Recommendations: Since institutional policies are very influential in researchers' commercialization behavior, universities and RIs should develop clear policies and reward system. For instance, mission of the university/RI; sharing of IP rights and rewards between university/RI and researchers should be clearly defined and documented.

More emphasis should be put on communicating the KTT policies of the RIs to the researchers and their awareness about KTT activities and processes should be raised.

- When RI directors were asked to mention the policies, strategies and tools that they adopted in order to promote KTT and commercialization in the RI, all of the directors mentioned that they give importance and adopt policies to increase KTT and commercialization performance of the RI. Some points they emphasized could provide valuable insights for KTT public policies:
    - Working with the industry starting from the early stages of the projects increases the compatibility between industry and the RI in terms of needs and expectancy and thus increases the commercialization possibility.
    - New support program of TUBITAK, namely 1004 High Technology Platforms Support Program, is an important facilitator to develop the cooperation between different stakeholders such as other RIs and universities and industry in terms of R&D and commercialization activities.
    - Research field and/or sector of the RI is a critical factor that affects the KTT performance, types of the KTT activities conducted, KTT mission and policies of the RI.

Policy Recommendations: 'Co-creation' with industry should be adopted as a policy in the projects of the RIs in order to increase the compatibility between the RIs and industry in terms of needs, capacity and capabilities.

The new support scheme of TUBITAK, namely '1004 High Technology Platforms Support Program' is a successfully designed support tool since it has the power to increase the cooperation between the university/RI and industry and facilitate the technology transfer and commercialization activities between university/RI and industry since forming such a platform composed of different stakeholders is a 'prerequisite' of this program. The number of platforms that are supported within this program should be increased and this type of support programs that are based on 'cooperative action' of different stakeholders in the national innovation system should be extended.

Technology transfer and commercialization policies and support programs should consider the different characteristics of the RIs regarding their research type (basic, applied etc.), mission and sector. In this respect the performance evaluation system of the RIs within the 6550 Law should take into account the different characteristics of the RIs (research type, sector etc.) in the performance assessment process of KTT.

- In order to be able to develop proper policies and support mechanisms to promote commercialization activities in RIs, it is critical to understand attitude and perceptions of the researchers since their willingness or motivation is critical in this process. Therefore, in the survey, researchers were asked to assess the importance of various factors that could stimulate them for commercialization behavior. The three most important motivating factors for researchers' commercialization action include; (i) developing new and high-value added products, (ii) additional income for research and (iii) contributing to national and regional development. Thus, for researchers, research related achievements and societal benefits are more important than personal gains or other factors.

Policy Recommendations: Policies towards promoting commercialization activities of researchers should not be limited to personal financial rewards. Policy measures should be diversified by taking into account the different concerns of researches.

- Determining perceived obstacles for researchers' commercialization activities is also critical in order to identify appropriate policy tools. The three most significant deterrent factor for researchers' commercialization behavior are; (i) insufficient time because of the intensity of academic and scientific activities', (ii) 'Firms' lack of interest or knowledge about R&D' is regarded as the most significant deterring factor by researchers. It is closely followed by. The third significant deterrent factor is mentioned as 'Mismatch between the culture and expectations of firms and RIs'. It is closely followed by 'lack of personal knowledge and experience about commercialization' and 'usage of new innovative products are found to be risky by public and/or firms'.

  The most significant discouraging factor that is lack of time because of the intensity of academic and scientific activities, also strengthens the above mentioned remarks about university and academic promotion system in Turkey. Another noteworthy issue about perceived obstacles by researchers is that the second and third most significant deterring factors mentioned by them is about firms' lack of interest and R&D capacity and mismatch in terms of culture and expectations.

  Knowledge and technology transfer includes bi-directional knowledge flow both from university/RI- industry and industry to university/RI. When researchers were asked at what degree they use the knowledge and R&D results of the industry. Nearly 39% of researches mention that they never used industrial knowledge, while 32% and 20.5% state that they use rarely and sometimes, respectively. As these results suggest knowledge flow from industry to researchers is insufficient.

Policy Recommendations: Intensity of 'teaching', 'research' and 'commercial' roles and responsibilities of academicians should be defined clearly both at university/RI level and national level.

In order to overcome the mismatch between the culture and expectations of the firms and the RIs and facilitate the knowledge flow among them, both the RI managements and intermediary bodies such as technology transfer offices should function more effectively and develop tools and mechanisms to match the needs and capabilities of each side.

Each RI should have units dedicated to the increasing and improving industry relations and facilitating technology transfer and commercialization activities.

In order to develop researchers' capabilities and skill about KTT activities, mentoring, consulting and training services should be provided at the RI and university level.

- When researchers were asked in the last 5 years at what frequency they used the services of the TTO in their universities. 20.5 % of researchers say that they never used TTO services while 11.4% mention that they 'rarely' used and 36.4% of them say they 'sometimes' benefited from TTO services. These results suggest that researches' utilization level of TTO services is insufficient. This could be the result of both the lack of capacity of TTOs in serving effective services and lack of interest on the researchers' side regarding technology transfer and commercialization activities. In Turkey TTOs are still at the developing stage, their performance is quite varying and their performance in terms of patenting and licensing is very insufficient. There is a need to develop their structure and personnel capacity in order to increase the role of these bodies in technology transfer and commercialization.

Policy Recommendations: The structure and personnel capacity of TTOs should be strengthened and their role in technology transfer and commercialization processes should be developed.

TTOs should have tailor-made services for increasing technology transfer and commercialization activities of the RIs since they are the main provider of new knowledge and technology in the universities and have high potential to make new inventions and commercialize them.

In conclusion, it could be argued that since the legal framework of RIs is relatively new, the survey results reflects both the preliminary effects of the new system and the impact of the higher education system in general and previous settings in the RIs. On the other hand, attitudes and views of researchers and remarks of RI directors suggest that the RI Law has positive preliminary effects on the RIs in terms of facilitating KTT activities and processes. Remarks of RI directors emphasize that within the new system introduced by the Law, recently they have adopted new policies and mechanisms to increase KTT activities such as establishing new units and teams for KTT processes, including KTT indicators in their employment and performance evaluation processes and engaging in joint projects with industry and other stakeholders.

Table 28. Wrap-Up of the Main Policy Recommendations and Related Policy Tools/Measures

Main Policy Aim: Increase Knowledge and Technology Transfer Between Research Infrastructures and Industry	
Policy Recommendation	**Policy Tools/Measures**
Reliable and relevant official statistics should be developed in order to assess the performance and effectiveness of various KTT channels at national and RI/university level.	• Official statistics regarding KTT activities such as patenting, licensing, spin-offs should be gathered regularly at RI and university level. • Country level surveys aiming to analyze technology transfer and commercialization between universities/RIs and industry should be carried out.
Role and impact of various KTT channels on RI-industry cooperation should be analyzed in detail and considered while developing policies.	• Policy studies and surveys should not neglect KTT activities such as consultancy, joint projects, joint educational activities etc.
Joint educational activities of firms and RIs such as joint thesis, graduate studies, joint publications should be promoted.	• Number of projects supported within the support program of TUBITAK, namely 2244 Industry Doctorate Program should be increased. • Key performance indicators regarding joint publications and joint thesis should be included in the performance assessment of the Law No. 6550.

Table 28 (continued)

Joint projects of RIs and firms should be promoted.	• The number of projects supported within the new support program of TUBITAK, namely 1004-High Technology Platforms Support Program, should be increased. • A new support program that aims to provide financial support to firms that get service from RIs for their small scale R&D and innovation projects should be implemented.
Researchers' perceptions and views about university/RI-industry interaction and different KTT activities should be improved.	• Awareness raising and training programs should be developed to views and attitudes about different KTT mechanisms.
Higher education and academic promotion and reward systems should be designed in a way that fosters 'research' and 'entrepreneurial' activities of academicians and researchers.	• Intensity of 'teaching', 'research' and 'commercial' roles and responsibilities of academicians should be defined clearly both at university/RI level and national level. • 'Academic Researcher' concept should be introduced in universities that gives academicians the opportunity to concentrate on research and related KTT activities with low/ no teaching workload. • Academic promotion and reward system should take into account indicators regarding technology transfer and commercialization activities such as joint projects with industry, joint thesis, consultancy, licensing and spin-off firm creation.

	• The legal framework of 'Research University' concept should be developed. Within this scope, the mission, roles and functioning of research universities should be clearly defined in such a way that focus heavily on research and related technology transfer and entrepreneurial activities. • Working as full time researcher at RIs within the Law No. 6550 should be encouraged for academicians that wants to concentrate more in research activities.
Universities and RIs should develop clear commercialization policies and reward system and communicate these policies effectively to the researchers.	• Mission of the university/RI; sharing of IP rights and rewards between university/RI and researchers should be clearly defined and documented. • Much emphasis should be put on communicating the KTT policies of the RIs to the researchers and their awareness about KTT activities and processes should be raised.
Technology transfer and commercialization policies and support programs should consider the different characteristics of the RIs regarding their research type (basic, applied etc.), mission and sector.	• The performance evaluation system of the RIs within the 6550 Law should take into account the different characteristics of the RIs (research type, sector etc.) in the performance assessment process of KTT.

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Table 28 (continued)

Policies towards promoting commercialization activities of researchers should not be limited to personal financial rewards. Policy measures should be diversified by taking into account the different concerns of researches.	
New mechanisms should be developed to overcome the mismatch between the culture, expectations and capabilities of the firms and researchers.	• Intermediary bodies such as RIs and technology transfer offices should function more effectively and develop tools and mechanisms to match the needs and capabilities of researchers and firms. • Each RI should have units dedicated to the increasing and improving industry relations and facilitating technology transfer and commercialization activities. • 'Co-creation' with industry should be adopted as a policy in the projects of the RIs in order to increase the compatibility between the RIs and industry in terms of needs, capacity and capabilities.
Personal skills and capabilities of researchers about technology transfer and commercialization processes should be enhanced.	• Mentoring, consulting and training services regarding technology transfer and commercialization processes should be provided to the researchers both at the RI level and university level.

Table 28 (continued)

The role of TTOs in facilitating KTT activities of RIs should be increased.	• The structure and personnel capacity of TTOs should be strengthened. • TTO staff should have both market and industry knowledge and links and also be in close contact with researchers. Their skills and capabilities should be developed continuously by training programs. • TTOs should have tailor-made services for increasing technology transfer and commercialization activities of the RIs.

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APPENDICES

APPENDIX A: ONLINE QUESTIONNAIRE

1- At which Research Infrastructure are you employed or affiliated with.

ODTU MEMS
IBG
UNAM
SUNUM

2- Please indicate your academic title.
Professor
Associate Professor
Assistant Professor
Post-Doc Researcher
No Academic Title
Other (Please Specify)

3- Please indicate your gender
Female
Male

4- Please indicate your age.
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60 or more

5- For how many years have you been working at this RI?

Less than 1 year
1-3 years
3-5 years
5-8 years
8-10 years
More than 10 years

6- Please indicate the number of your academic publications listed in SCI
0
1-9

10-19
20-39
40-59
60-79
80-99
100 or more than 100

Explanatory note:
Knowledge and **technology transfer** between universities/RIs and firms should be understood as any activities aimed at exchanging knowledge and technology between these actors.

7- Do you own any patents?
Yes
No
No,but have an application under review

8- If Yes, Please indicate the number of your patents. (The applications of the same patent in different countries/regions should be counted as one)

1
2-5
6-10
More than 10

9- Do you have any licensing agreement with a firm regarding your patent.

Yes, with a local firm
Yes, with an international firm
No

10- Did you set up a company or become a partner of a firm in order to commercialize your research results?

Yes
No

11- Main knowledge and technology transfer channels and forms are listed below. By considering YOUR activities in the last 5 years, please indicate how frequently you engage in these activities and select and rank the 3 most IMPORTANT channels (1=Most Important)

	Never	Rarely	Sometimes	Frequently	Very Frequently
Academic publishing					
Providing R&D, test and analysis services to firms					
Joint projects with firms, funded by firms					

Joint projects with firms, funded by public funds					
Consultancy to firms					
Joint thesis/doctoral studies/projects with firms					
Joint publications with researchers in firms					
Personal relations with graduates/employees in firms					
Training/seminar/conference for/with firms					
Licensing activities					
Spin-off firm creation					
Other (Please indicate)					

	Most Important (1)	Second Most Important (2)	Third Most Important (3)
Academic publishing			
Providing R&D, test and analysis services to firms			
Joint projects with firms, funded by firms			
Joint projects with firms, funded by public funds			
Consultancy to firms			
Joint thesis/doctoral studies/projects with firms			
Joint publications with researchers in firms			
Personal relations with graduates/employees in firms			
Training/seminar/conference for/with firms			
Licensing activities			
Spin-off firm creation			

12- Please indicate the degree of your agreement with the below mentioned statements about commercialization.

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
My research results are sufficiently utilized through academic publishing					
Commercialization activities are an important part of my job					
University places importance on/ supports commercialization					
Research Infrastructure places importance on/ supports commercialization					

Working in/being affiliated to a RI affects my commercialization activities positively					

13- Please state your views regarding the questions below regarding commercialization.

	No	Not Know/ Not Sure	Yes
Do you intend to commercialize your research results			
Does your university have a clear policy/strategy regarding commercialization			
Does your RI have a clear policy/strategy regarding commercialization			

14- Please state how important the below listed factors to motivate you for engaging in commercialization activities and select and rank the 3 MOST IMPORTANT motivating factors (1= most important).

	Very Unimportant	Unimportant	Neither Important Nor Unimportant	Important	Very Important
Additional Income For Research					
Additional Personal Income					
Application/Exploitation of Research Results					
Increase Job Opportunity For Students and Graduates					
Contribute National and Regional Development					
Develop New and High-Value Added Products					
Contribute dissemination of knowledge and technology					
Meet the requirements of the funding institutions or get advantage for public funds					
Increase Personal/RI Reputation					
Access to firms' knowledge and R&D results					
Other					

	Most Important	Second Most Important	Third Most Important
Additional Income For Research			
Additional Personal Income			
Application/Exploitation of Research Results			
Increase Job Opportunity For Students and Graduates			
Contribute National and Regional Development			
Develop New and High-Value Added Products			
Contribute dissemination of knowledge and technology			
Meet the requirements of the funding institutions or get advantage for public funds			
Increase Personal/RI Reputation			
Access to firms' knowledge and R&D results			

15- Below listed the factors that could discourage or deter your engagement in commercialization activities. Please assess the degree that these factors discourage or deter your commercialization activities. Additionally please select the 3 most significant deterring factors for your commercialization actions.

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
Inapplicability of research studies to practice					
Insufficient time because of the intensity of academic and scientific activities					
Insufficient support from the RI management					
Insufficient support from the university					
Low effect of commercialization activities for academic promotion and incentives					
Firms' lack of interest or knowledge about R&D					
Firms' lack of R&D capacity					
Mismatch between the culture and expectations of firms and RIs					
Usage of new innovative products are found to be risky by public and/or firms.					

Lack of personal knowledge and experience about commercialization					
Financial risks of commercialization					
Insufficient in intellectual property regulations					
Uncertainties regarding sharing of IPR rights					
Insufficient intermediary institutions and bodies					
Insufficient public support in terms of number and quantity					
Insufficient public support in terms of quality (application/assessment procedures etc.)					
Difficulties in access to finance such as venture capital, bank credits etc.					
Ineffective service and supports at technoparks					

16- How do you assess your <u>Research Infrastructure</u> in terms of technology transfer and commercialization.

Very Poor	Poor	Fair	Good	Very Good

17- How do you assess your <u>University</u> in terms of technology transfer and commercialization?

Very Poor	Poor	Fair	Good	Very Good

18- In the last 5 years, how often did you use the services of the technology transfer office in your university.

Never	Rarely	Sometimes	Frequently	Very Frequently

19- Knowledge can also flow from industry to university/RIs. How often do you use the knowledge and R&D results of the industry in your works in the RI.

Never	Rarely	Sometimes	Frequently	Very Frequently

APPENDIX B: INTERVIEW QUESTIONS

1. Do you have clear policy about promoting and increasing knowledge and technology transfer from the RI and what are your strategies and policy tools.

2. Do you have specialized policies regarding commercialization.

3. What is your opinion about the most important challenges/obstacles about technology transfer and commercialization?

4. Do recruitment policy, performance assessment and reward system in the RI include criteria regarding technology transfer and commercialization activities?

5. What are your comments about the public policies and supports regarding promoting and developing technology transfer and commercialization?

APPENDIX C: HUMAN RESEARCH ETHICS COMMITTEE AUTHORIZATION LETTER

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
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25 Haziran 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof.Dr. Erkan ERDİL

Danışmanlığını yaptığınız yüksek lisans öğrencisi Aycan YÜKSEL'in **"Araştırma Altyapılarından Bilgi ve Teknoloji Transferi ile Ticarileştirme"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2018-SOS-124** protokol numarası ile **26.06.2018 - 30.12.2018** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Ş. Halil TURAN
Başkan V

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Doç. Dr. Yaşar KONDAKÇI
Üye

Doç. Dr. Zana ÇITAK
Üye

Doç. Dr. Emre SELÇUK
Üye

Dr. Öğr. Üyesi Pınar KAYGAN
Üye

APPENDIX D: TURKISH SUMMARY/TÜRKÇE ÖZET

Araştırma ve yenilik, bilgi tabanlı ekonomilerde sürdürülebilir kalkınma ve küresel rekabetçiliğin en önemli faktörü olarak görülmekte olup ülkeler, bilgi üretme ve yenilik kapasitelerinin ve yeteneklerinin geliştirilmesine özel önem vermektedir. Bu çerçevede son yıllarda hükümetler, bilgi üretme ve bilgi transferi sistemlerinin geliştirilmesi ve ulusal yenilik kabiliyetlerinin artırılmasına yönelik politikalara ağırlık vermektedir.

Büyük ölçüde kamu kaynaklarıyla finanse edilen ve üniversiteler ile araştırma kuruluşları tarafından gerçekleştirilen araştırma faaliyetleri, tüm dünyada önemli buluş ve yeniliklerin temel kaynağı durumundadır. Dolayısıyla, üniversite/araştırma kuruluşları ile sanayi arasındaki işbirliklerinin geliştirilmesi ve araştırma sonuçlarının sosyo-ekonomik faydalarının artırılması önemli politika öncelikleri haline gelmiştir.

Bu kapsamda, ülkeler üniversite-sanayi işbirliklerinin geliştirilmesi ile bilgi ve teknoloji transferinin artırılması amacıyla hukuki düzenlemelerin yanı sıra çeşitli politika araçları ile destek programlarını hayata geçirmişlerdir. Bu politika araçları üniversite sisteminde yapılan reformlar, finansal destek mekanizmaları geliştirme, teknoloji transfer ofisleri, inkübatörler gibi yeni kurumsal yapılar ve aracı kuruluşlar oluşturma gibi çok farklı nitelikte uygulamayı içermektedir.

Bilgi ve teknoloji transferi, çok farklı tanımlara sahip olmakla birlikte genel olarak bilgi, teknoloji ve yeteneklerin resmi veya resmi olmayan yöntemlerle bir kurumsal yapıdan diğerine aktarımı olarak tanımlanabilmektedir (Roessner, 1993). Ticarileştirme, bilgi ve teknoloji transferinin bir çeşidi olup araştırma sonuçlarının ürün ve faydaya dönüştürülmesi olarak tanımlanmaktadır. Bu çerçevede, ticarileştirme faaliyetleri temel olarak patentleme, lisanslama ve spin-off firma kurulumunu içermektedir.

Bilgi ve teknoloji transferi, akademik yayın, konferans, ortak proje, sözleşmeli proje, danışmanlık, personel değişimi, lisanslama, firma kurulumu gibi çeşitli yöntemlerle gerçekleştirebilmektedir. Kullanılacak bilgi ve teknoloji transferi yöntemlerini, araştırmacıların ve kurumların nitelikleri ile araştırma alanının özellikleri gibi faktörler etkilemektedir.

Bir kurumun bilgi ve teknoloji transferi sistemi ve performansı, ulusal ve kurumsal yasal altyapı, kurumsal yapılanma ve özellikler, araştırmacıların niteliği ve motivasyonları, bilim ve teknoloji politikalarının etkinliği, sanayinin niteliği ile aracı kurumların etkinliği gibi birçok faktörden etkilenmektedir (OECD, 2013).

Literatürde bilgi ve teknoloji transferine ilişkin yapılan çalışmalarda, özellikle 1980 yılında ABD'de kabul edilen Bayh-Dole Yasası sonrasında patenletme, lisanslama ve spin-off firma kurulumu gibi faaliyetlerin analizine ağırlık verilmiştir. Bu durum büyük ölçüde, söz konusu faaliyetlerde bu dönemde yaşanan artış ve bu faaliyetlere ilişkin istatistiki veriye erişimin kolay olmasından kaynaklanmıştır (Beyhan, 2011).

Diğer taraftan, son yıllarda yapılan çalışmalar, patent, lisans ve spin-off firma kurma faaliyetlerinin en önemli bilgi ve teknoloji transferi yöntemi olmadığını hatta birçok durumda bu faaliyetlerin bilgi ve teknoloji transfer sürecinin küçük bir bölümünü oluşturduğunu, diğer yöntemlere göre daha az tercih edildiğini veya araştırmacılar tarafından daha önemsiz görüldüğünü ortaya koymaktadır (D'Este & Patel, 2007; Perkmann et. al (2012); D'Este & Perkmann, 2009). Dolayısıyla literatürde, üniversite/araştırma altyapıları ile sanayi arasındaki bilgi ve teknoloji transferi sürecine yönelik analizlerin yalnızca ticarileştirme faaliyetleriyle sınırlı olarak ele alınmaması gerektiği ifade edilmektedir.

Araştırma altyapıları, üniversiteler ile birlikte yenilik sisteminin odağında yer almakta olup yeni bilgi, teknoloji ve nitelikli insan kaynağının temel sağlayıcısı konumundadırlar. Araştırma altyapıları, tüm dünyada farklı şekilde tanımlanmakta olup yönetim ve kurumsal yapıları, işleyişleri, misyonları ve fonlama mekanizmaları

açısından da farklılıklar göstermektedirler. Bu farklılıklara rağmen tüm dünyada araştırma altyapılarında ‘mükemmeliyet’ ve ‘bağlantılılık’ ile bu yapıların ekonomik ve sosyal faydalarının artırılması, önemli politika yaklaşımları olarak ön plana çıkmaktadır (OECD, 2011).

AB Komisyonu, araştırma altyapılarını bilim topluluklarının faaliyet alanlarında ileri düzey araştırmalar yapmak için kullandıkları mekânlar, kaynaklar ve hizmetler olarak tanımlanmaktadır. Bu tanım makine ve cihazların yanı sıra bilgi ve iletişim teknolojisi imkânlarını ve bilimsel veri, arşiv gibi bilgi temelli sermayeyi de kapsamaktadır. Araştırma altyapıları tek bir merkezde veya fiziki olarak farklı mekânlarda yerleşik araştırma birimlerinden oluşabildiği gibi sanal altyapılar da bu kapsamda değerlendirilmektedir.

AB’deki araştırma altyapılarına yönelik politikaların stratejik yaklaşımla oluşturulması, ülkeler arasında bilimsel entegrasyonun sağlanması ve çok taraflı işbirliklerinin geliştirilmesi amacıyla AB Komisyonu kararıyla 2002 yılında Avrupa Araştırma Altyapıları Stratejik Forumu (ESFRI) oluşturulmuştur. 2006 yılında ESFRI tarafından ilk Araştırma Altyapıları Yol Haritası açıklanmış ve 2008 ve 2010 yıllarında bu yol haritası güncellenmiştir. 2016 yılı Mart ayında da yeni ESFRI Yol Haritası açıklanmış ve 2018 yılında da güncelleme yapılmıştır.

Son yıllarda araştırma altyapılarının sayısında ve bütçesinde yaşanan artış nedeniyle söz konusu altyapıların uzun dönemli sürdürülebilirliğinin sağlanması AB’nin önemli bir politika önceliği haline gelmiştir. Bu çerçevede, yapılan çalışmalar sonucunda araştırma altyapılarının sürdürülebilirliğinin sağlanabilmesi için; araştırma altyapılarında bilimsel mükemmeliyetin sağlanması, altyapıların yenilik potansiyelinin geliştirilmesi, sosyo-ekonomik etkilerinin ölçülmesi, etkin yönetim ve sürdürülebilir finansmanın sağlanmasına yönelik düzenlemelerin yapılması ve uluslararası erişimin artırılması önemli politika alanları olarak öne çıkmaktadır.

Literatürde, üniversiteler/araştırma altyapıları ile sanayi arasındaki bilgi ve teknoloji transferine yönelik çalışmalarda ağırlıklı olarak patent, lisans, atıf ve spin-off firma verilerinin analizi gerçekleştirilmiştir. Son yıllarda üniversite/araştırma altyapıları ve sanayi arasındaki işbirliklerini etkileyen faktörlerin analizine yönelik çok sayıda ampirik çalışma da yapılmaya başlanmıştır. Bu çalışmaların çoğunda üniversite-sanayi işbirlikleri, firma yönüyle veya üniversite/fakülte tarafından ele alınarak analiz edilmiş olup 'araştırmacıyı' odağa alan çalışmalar göreceli olarak daha kısıtlı düzeydedir (D'Este & Patel, 2007; Tahvanainen & Tuomo, 2018; Closs et al.,2013). Son yıllarda bilgi ve teknoloji transferi süreçlerinde araştırmacıların istekliliğinin, kabiliyetlerinin ve motivasyonunun kritik rol oynadığı anlaşılmış olup yapılan çalışmalar araştırmacıların davranış ve yaklaşımlarını analiz etmeye odaklanmaya başlamıştır.

Araştırmacıların bilgi ve teknoloji transferine yönelik eğilimleri ve davranışları üzerinde yaş, cinsiyet, akademik tecrübe gibi *kişisel faktörler*; kurum kültürü, misyonu, vizyonu gibi *kurumsal faktörler* ile etkin politika ve destekler, fikri mülkiyet hakları mevzuatı gibi *çevresel/dışsal faktörler* etkili olmaktadır.

Çalışma kapsamında incelenen ampirik çalışmalardaki bilgi ve teknoloji transferini etkileyen faktörlere ilişkin temel tespitleri şu şekilde özetlemek mümkündür:

- Araştırmacılar, diğer bilgi ve teknoloji transferi araçlarına kıyasla ticarileştirme faaliyetlerini daha az gerçekleştirmektedirler (Landry et al. 2007); P.D. Este et al., 2007; Moutinho et al., 2007).
- Araştırma faaliyetlerinin niteliği ve üniversitenin/araştırma altyapısının misyonu ve vizyonu araştırmacıların bilgi ve teknoloji transferi faaliyetleri üzerinde önemli bir etkiye sahiptir (Arvanitis et al., 2008; Bozeman, 2000).
- Araştırmacıların ticarileştirme faaliyetlerinde bulunmasında, akademik başarı ve itibar, sosyal faydalar, araştırma sonuçlarının uygulamaya geçirilmesi ve araştırmalar için ilave gelir sağlanması gibi faktörler bireysel gelir

sağlanmasından daha etkili olmaktadır (Lam, 2011; Tahvanainen et al.,2011; Closs et al, 2013; Baldini et al., 2007; Abreu et al., 2009).

- Araştırmacıların ticarileştirme faaliyetlerini olumsuz etkileyen faktörler, arasında zaman sıkıntısı/eğitim, araştırma ve ticarileştirme faaliyetleri arasında zamanı dengeleme sorunu, yetersiz finansman ve teşvikler ile firmaların isteksizliği ön plana çıkmaktadır (Tahvanainen et al.,2011; Closs et al.,2013; Arvanitis et al., 2008; Baldini et al., 2007; Abreu et al., 2009).

Son yıllarda Türkiye'de de üniversite ve araştırma altyapılarından bilgi ve teknoloji transferinin sağlanması önemli bir politika önceliği haline gelmiş ve bu amaçla birçok politika ve destek programı uygulamaya geçirilmiştir. Türkiye'de üniversitelerdeki araştırma altyapıları 2000'li yıllardan itibaren kamu desteğiyle kurulmaya başlanılmıştır. Bu kapsamda, 2019 yılı itibarıyla kamu yatırım programları aracılığıyla yaklaşık 7,9 milyar TL kaynak tahsis edilmiştir. Söz konusu desteklerle Tematik Araştırma Merkezi ve Merkezi Araştırma Laboratuvarı olarak iki tür araştırma merkezinin kurulumu desteklenmiştir.

Tematik araştırma merkezleri, belli bir bilimsel alanda uzmanlaşmış ve bu alanda ulusal ve bölgesel düzeyde araştırma faaliyeti yürütme kapasitesine sahip araştırma birimleridir. 2019 yılı itibarıyla 131 tematik araştırma merkezi projesi tamamlanmış, 109 proje ise desteklenmeye devam etmektedir.

Merkezi araştırma laboratuvarları ise devlet üniversitelerinin farklı birimlerinin araştırma altyapısı ihtiyaçlarının ortak olarak karşılandığı araştırma birimleri olarak tanımlanmaktadır. 2019 yılı itibarıyla 58 merkezi araştırma laboratuvarı tamamlanmış, 38'inin ise kurulumu devam etmektedir.

Son yıllarda yapılan analiz ve çalışmalar, kurulmuş olan merkezlerin yönetim, finansman ve işleyişinde çeşitli sorunlar yaşandığını ve yapılan çalışmaların yeterince ekonomik ve sosyal faydaya dönüşemediğini ortaya koymuştur. Tespit edilen sorunların giderilebilmesi ve merkezlerin etkin ve sürdürülebilir bir şekilde faaliyet

gösterebilmesi amacıyla bir yasal çerçeve hazırlığı yapılmış ve 6550 sayılı Araştırma Altyapılarının Desteklenmesine Dair Kanun 10/07/2014 tarihli Resmi Gazetede yayımlanarak yürürlüğe girmiştir.

Kanunun temel amacı; araştırma altyapılarını kendi yönetimi, bütçesi ve personel sistemi olan, sanayi ile yakın işbirliği içinde çalışan bir yapıya dönüştürerek etkinliklerini ve sürdürülebilirliklerini artırmaktır. Kanun temel olarak, araştırma altyapılarının performans esaslı olarak desteklenmesine ilişkin bir sistem getirmektedir. Ayrıca Kanun, araştırma altyapılarının sanayi ile işbirliklerinin ve bilgi ve teknoloji transferi faaliyetlerinin artırılmasına yönelik birçok yeni düzenleme getirmektedir. Buna göre; Kanun kapsamında desteklenen araştırma altyapılarının yönetim kurullarında özel sektör ve/veya sektörel sivil toplum kuruluşlarının yer alması gerekmektedir. Altyapılara yönelik gerçekleştirilen performans değerlendirmesinde sanayi işbirliği ile bilgi ve teknoloji transferi faaliyetlerine ilişkin göstergeler dikkate alınmaktadır. Ayrıca Kanun, araştırma altyapılarının teknoloji geliştirme bölgeleri, sanayi siteleri gibi alanlarda ve özel sektör ortaklığında kurulumuna imkân sağlamaktadır.

2019 yılı Mayıs ayı itibarıyla Kanun kapsamında 4 adet araştırma altyapısı desteklenmektedir: İzmir Biyotıp ve Genom Merkezi (İBG), ODTÜ Mikro Elektro Mekanik Sistemler Araştırma Merkezi (ODTÜ-MEMs), Sabancı Üniversitesi Nanoteknoloji Araştırma ve Uygulama Merkezi (Sabancı-SUNUM) ve Bilkent Üniversitesi Ulusal Nanoteknoloji Araştırma Merkezi (UNAM). Bu merkezler, Ağustos 2017 tarihinde yeterlik alarak Kanun kapsamında desteklenmeye başlanmıştır.

Bu çalışma, Araştırma Altyapılarının Desteklenmesine Dair Kanun çerçevesinde desteklenmekte olan 4 araştırma altyapısındaki araştırmacılara odaklanmaktadır. Bu çerçevede çalışmanın temel amacı, araştırmacıların bilgi ve teknoloji transferine ilişkin davranış ve yaklaşımlarının analiz edilmesi ile ticarileştirme faaliyetlerinde bulunma konusunda onları motive eden ve engelleyen faktörleri tespit etmektir.

Türkiye'de son yıllarda Ar-Ge sonuçlarının ticarileştirilmesinin artırılması önemli bir politika önceliği haline gelmiştir. Bu nedenle, çalışmada araştırmacıların ticarileştirme faaliyetlerine ilişkin tutum ve davranışları detaylı olarak ele alınmıştır. Diğer taraftan, çalışmanın kapsamı sadece ticarileştirilme faaliyetleriyle kısıtlı tutulmamış olup araştırmacıların diğer bilgi ve teknoloji transferi faaliyetlerinde bulunma sıklığı ve bu faaliyetlere ilişkin yaklaşımları da incelenmiştir.

Çalışmada, araştırmacılara yönelik anket çalışmasından elde edilen nicel veriler ile araştırma altyapı müdürleriyle yapılan mülakatlardan elde edilen nitel veriler kullanılmıştır. Bu çerçevede 44 araştırmacıyla anket çalışması gerçekleştirilmiştir. Anket çalışması dört bölümden oluşmakta olup ilk bölümde araştırmacıların genel niteliğini anlamaya yönelik olarak akademik unvan, yaş, cinsiyet, akademik yayın sayısı gibi bilgilere ilişkin sorular yer almaktadır. İkinci bölümde, araştırmacıların patent, lisans, spin-off firma kurma faaliyetlerine, farklı bilgi ve teknoloji transferi yöntemlerini gerçekleştirme sıklıklarına ve bu yöntemlerin önemine ilişkin görüşlerine yönelik sorular bulunmaktadır. Anketin üçüncü bölümü araştırmacıların ticarileştirme konusundaki görüş ve yaklaşımlarına, onları motive eden ve engelleyen/kısıtlayan faktörlere ve araştırma altyapıları ile üniversitelerin ticarileştirme süreçlerindeki etkisine ilişkin sorular yer almaktadır. Anketin son bölümü ise araştırmacıların, araştırma altyapısı ve üniversitenin bilgi ve teknoloji transferi faaliyetlerindeki rolü ve etkinliğine ilişkin görüşlerine ilişkin soruları içermektedir.

Çalışma kapsamındaki anket ve mülakatların temel araştırma bulgularını aşağıdaki şekilde özetlemek mümkündür:

- Bilgi ve teknoloji faaliyetleri arasında, araştırmacılar en çok akademik yayın yapılması faaliyetinde bulunmuşlardır. İkinci sırada firmadaki çalışan ve mezunlarla kişisel bağlantı yoluyla iletişim kurulması ve üçüncü sırada sanayiyle ortak, kamu fonlu proje yapılması gelmektedir.
- Akademik yayın dışında aktif olarak herhangi bir bilgi ve teknoloji transferi faaliyetinde bulunan araştırmacı oranı yüzde 10'un altındadır.

- Sırasıyla araştırmacıların yüzde 80'i ve yüzde 71'i daha önce sanayiyle hiç ortak tez çalışması ve ortak yayın yapmadıklarını ifade etmiştir. Bu durum, araştırmacılarla sanayi arasında ortak eğitim faaliyetlerinin dok düşük düzeyde olduğunu göstermektedir.
- Ticarileştirme faaliyetleri (lisanslama ve spin-off firma kurma) araştırmacıların en düşük yoğunlukta gerçekleştirdiği bilgi ve teknoloji transferi yöntemleridir. Bu sonuç, literatürdeki çalışmalarla benzerlik göstermektedir. (Landry et al. 2007; P.D. Este et al., 2007; Moutinho et al., 2007)
- Araştırmacıların yarısından fazlası akademik yayın yapılmasının araştırma sonuçlarının faydaya ve değere dönüşmesi açısından yeterli olduğunu belirtmektedir.
- Sırasıyla araştırmacıların yüzde 55 ve yüzde 60'ı bulundukları üniversite ve araştırma altyapısının ticarileştirmeye yönelik belirgin bir politikası bulunduğunu ifade etmiştir. Diğer taraftan, araştırmacıların yaklaşık yüzde 30'u bu konuda bilgi sahibi olmadıklarını veya kararsız olduklarını belirtmişlerdir.
- Araştırma altyapı müdürlerinin tamamı, bilgi ve teknoloji transferi ve ticarileştirme faaliyetlerini artırmaya önem verdiklerini ve bu amaca yönelik politikalar benimsediklerini belirtmişlerdir.
- Araştırma altyapı müdürlerinin vurguladığı aşağıdaki hususların politika önerileri için önemli girdi teşkil ettiği değerlendirilmektedir:
    - Projelerin ilk aşamalarından itibaren sanayiyle birlikte çalışmak, sanayi ile araştırmacılar arasındaki beklenti ve uyumu geliştirmekte olup ticarileştirme potansiyelini artırmaktadır.
    - TÜBİTAK'ın 2018 yılında başlatmış olduğu 1004- Yüksek Teknoloji Platformları destek programı araştırma altyapılarıyla sanayi arasındaki işbirliklerinin artırılmasında önemli bir rol üstlenmektedir.
    - Araştırma altyapısının alanı ve sektörü, yürütülen bilgi ve teknoloji transferi faaliyetlerinin niteliğini, bu alandaki performansı ve politikaları etkilemektedir.
- Araştırmacıları ticarileştirme faaliyetlerinde bulunma konusunda teşvik eden en önemli faktör 'yeni ve yüksek katma değerli ürün geliştirmek'tir. İkinci önemli

motivasyon faktörü ‘araştırmalar için ilave gelir yaratılması’, üçüncü önemli faktör ise ‘araştırma sonuçlarının uygulamaya dönüştürülmesidir. ‘İlave bireysel gelir elde edilmesi’ dördüncü sırada gelmekle birlikte daha az yoğunlukta dile getirilmiştir. Dolayısıyla, araştırmacıların ticarileştirme faaliyetlerinde bulunmasında araştırmaya ilişkin başarı ve kazanımlar ile sosyal faydaların bireysel gelir ve diğer faktörlere göre daha önemli olduğu anlaşılmaktadır.

- Araştırmacıların ticarileştirme faaliyetlerinde bulunmasında onları engelleyen ve kısıtlayan en önemli üç faktör ise şu şekilde sıralanmaktadır. (i) akademik ve bilimsel faaliyetlerin yoğunluğu nedeniyle ticarileştirme faaliyetlerine yeterli zaman ayrılamaması, (ii) özel sektörün Ar-Ge konusunda isteksiz olması veya bilgi sahibi olmaması ve (iii) özel sektör ve araştırma altyapısının farklı kurumsal kültür ve beklentilere sahip olması. Bu faktörleri ‘ bireysel bilgi ve tecrübe eksikliği’ ile ‘yeni ürünlerin kamu ve sanayi tarafından kullanılmasının riskli bulunması’ faktörleri izlemektedir.
- Araştırmacıların yüzde 20,5’i daha önce teknoloji transfer ofisi hizmetlerinden hiç yararlanmadığını, yüzde 11’i ‘nadiren’ yararlandığını, yüzde 36’sı ise ‘arada sırada’ yararlandığını ifade etmiştir.
- Araştırmacıların yaklaşık yüzde 39’u daha önce hiç sanayi kaynaklı bilgi ve Ar-Ge sonuçlarını kullanmadığını, sırasıyla yüzde 32’si ve yüzde 20,5’i ise ‘nadiren’ ve ‘arada sırada’ kullandığını belirtmiştir.

Yukarıda ifade temel bulgular çerçevesinde Türkiye’de araştırma altyapıları ile sanayi arasındaki bilgi ve teknoloji transferinin artırılması temel amacına yönelik geliştirilen politika önerileri ile politika/ uygulama araçları aşağıdaki tabloda yer almaktadır.

Politika Önerileri	**Politika/Uygulama Aracı Önerileri**
Bilgi ve teknoloji transferi faaliyetlerine ilişkin düzenli ve güvenilir resmi istatistiklerin ulusal düzeyde ve üniversite/araştırma	• Patentleme, lisanslama, spin-off firma kurulumu gibi verilere ilişkin olarak araştırma altyapısı ve üniversite

altyapısı düzeyinde derlenmesi gerekmektedir.	düzeyinde resmi istatistikler derlenmelidir. • Üniversite/araştırma altyapıları ile sanayi arasındaki teknoloji transferi ve ticarileştirmenin analizine yönelik ulusal düzeyde araştırma çalışmaları yürütülmelidir.
Farklı bilgi ve teknoloji transferi faaliyetlerinin araştırma altyapısı-sanayi işbirliği üzerindeki etkisi analiz edilerek, politika oluşturma süreçlerinde dikkate alınmalıdır.	• Politika çalışmaları ve araştırmaları danışmanlık, ortak proje, ortak eğitim faaliyetleri gibi bilgi ve teknoloji transferi yöntemlerini de içermelidir.
Araştırma altyapıları ile sanayi arasındaki ortak eğitim faaliyetleri geliştirilmelidir.	• TÜBİTAK 2044- Sanayi Doktora Programı kapsamında desteklenen proje sayısı artırılmalıdır. • 6550 sayılı Kanun kapsamında yapılan performans değerlendirmesinde ortak yayın, ortak tez gibi göstergeler de dikkate alınmalıdır.
Araştırma altyapıları ile sanayi arasındaki ortak projeler desteklenmelidir.	• TÜBİTAK 1004 Yüksek Teknoloji Platformları destek programı kapsamında desteklenen proje sayısı artırılmalıdır.
Yükseköğretim sistemi ile akademik yükselme ve teşvik sistemi bilgi ve teknoloji transferini geliştirecek şekilde yeniden düzenlenmelidir.	• 'Araştırmacı Akademisyen' kavramı oluşturularak akademisyenlere ders yükünün azaltılması/kaldırılması suretiyle 'araştırma' ve 'teknoloji transferi' faaliyetlerine odaklanma imkânı getirilmelidir.

	• Akademik yükselme ve teşvik sistemi sanayiyle ortak proje, danışmanlık, lisanlama, spin-off firma kurma gibi farklı bilgi ve teknoloji transferi faaliyetlerini de dikkate almalıdır. • Araştırma üniversitesine ilişkin yasal altyapı oluşturularak bu üniversitelerin misyonu, rolleri ve işleyişi araştırma ile bilgi ve teknoloji transferi faaliyetlerine odaklanacak şekilde tanımlanmalıdır. • 6550 sayılı Kanun kapsamındaki araştırma altyapılarında akademisyenlerin tam zamanlı araştırmacı olarak istihdam edilmeleri özendirilmelidir.
Araştırma altyapıları ve üniversiteler ticarileştirmeye ilişkin belirgin politika ve destek mekanizmaları geliştirmelidir.	• Araştırma altyapılarının/üniversitelerin misyonları ve fikri mülkiyet haklarının paylaşımına ilişkin politikaları belirgin bir şekilde tanımlanmalıdır. • Araştırmacıların oluşturulan politikalara ilişkin bilgi ve bilinç düzeylerinin artırılmasına yönelik iletişim faaliyetleri yürütülmelidir.
Teknoloji transferi ve ticarileştirmeye yönelik politika ve destek programlarında araştırma altyapılarının alanları/sektörleri, araştırma türleri ve misyonlarına ilişkin farklılıkları dikkate alınmalıdır.	• 6550 sayılı Kanun kapsamındaki performans değerlendirmesinde araştırma altyapılarının farklı nitelikleri göz önünde bulundurulmalıdır.

Araştırmacılar ile sanayi arasındaki kültür, beklenti ve kabiliyet farklılıklarını gidermeye yönelik mekanizmalar geliştirilmelidir.	• Araştırma altyapı yönetimleri ve teknoloji transfer ofisleri gibi aracı kurum ve yapılar daha etkin faaliyet göstererek araştırmacılar ile firmaların ihtiyaç ve yeteneklerini uyumlaştırmaya yönelik mekanizmalar geliştirmelidir. • Araştırma altyapıları, sanayiyle işbirliklerinin ve bilgi ve teknoloji transferi faaliyetlerinin artırılmasına yönelik birimler oluşturmalıdır.
Araştırmacıların bilgi ve teknoloji transferi süreçlerine ilişkin bilgi ve kabiliyetlerinin artırılması sağlanmalıdır.	• Araştırmacılara, bilgi ve teknoloji transferi süreçlerine ilişkin eğitim, danışmanlık ve mentör hizmeti sağlanmalıdır.
Teknoloji transfer ofislerinin, araştırma altyapılarının bilgi ve teknoloji transferi süreçlerindeki rolü ve etkinliği artırılmalıdır.	• Teknoloji transfer ofislerinin yapısı ve personel kapasitesi güçlendirilmelidir. TTO personelinin niteliği sürekli eğitimlerle geliştirilmedir. • Teknoloji transfer ofisleri araştırma altyapılarına özgü, teknoloji transfer ve ticarileştirme faaliyetlerinin artırılmasına yönelik yeni hizmetler geliştirmelidir.

APPENDIX E: TEZ İZİN FORMU/ THESIS PERMISSION FORM

TEZ İZİN FORMU / THESIS PERMISSION FORM

ENSTİTÜ / INSTITUTE

Fen Bilimleri Enstitüsü / Graduate School of Natural and Applied Sciences [ ]

Sosyal Bilimler Enstitüsü / Graduate School of Social Sciences [X]

Uygulamalı Matematik Enstitüsü / Graduate School of Applied Mathematics [ ]
Enformatik Enstitüsü / Graduate School of Informatics [ ]

Deniz Bilimleri Enstitüsü / Graduate School of Marine Sciences [ ]

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TEZİN ADI / TITLE OF THE THESIS (**İngilizce** / English) :
ANALYSIS OF KNOWLEDGE AND TECHNOLOGY TRANSFER BETWEEN RESEARCH INFRASTRUCTURES AND INDUSTRY IN TURKEY

TEZİN TÜRÜ / DEGREE: Yüksek Lisans / Master [X] **Doktora** / PhD [ ]

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