ODTÜ-TEKPOL
BİLİM VE TEKNOLOJİ POLİTİKALARI ARAŞTIRMA MERKEZİ

METU-TEKPOL
RESEARCH CENTER FOR SCIENCE AND TECHNOLOGY POLICIES

SCIENCE AND TECHNOLOGY POLICIES RESEARCH CENTER
TEKPOL Working Paper Series
STPS-WP-16/06

Firm Level Absorptive Capacity and the Success of International Technology Transfer: the Case of Aerospace Industry in Turkey

Başar Seçkin

TEKPOL | Science and Technology Policies Research Center
Middle East Technical University
Ankara 06531 Turkey
http://www.stps.metu.edu.tr

FIRM LEVEL ABSORPTIVE CAPACITY AND THE SUCCESS OF INTERNATIONAL TECHNOLOGY TRANSFER: THE CASE OF AEROSPACE INDUSTRY IN TURKEY

Başar Seçkin, Ph.D. [1]

This paper is based on the Ph.D. dissertation with the same name, December 2015, Department of Science Technology and Policy Studies, Middle East Technical University, Ankara, Turkey.

This paper aims to figure out the relation between firm level absorptive capacity (AC) and the success of international technology transfer (ITT). Additionally, effects of determinants on the success of ITT other than firm level AC are examined. The research is focused on aerospace industry in Turkey by considering the transferee country's point of view, as well as the developing country perspective.

The research stands at a position to answer the question of "what forms AC" in a holistic way. In this context, variables that affect the formation of AC of a company are gathered under three categories; "Knowledge Production", "Knowledge Flow within the Company" and "Knowledge Flow within the Sectoral Innovation System (SIS)". Although the study is focused on firm level capabilities, the variables are extracted and evaluated from the viewpoint of SIS.

In order to identify and measure relevant determinants, questions are generated and ITT projects with varying scope together with firm level AC have been evaluated by industrial experts over a questionnaire. This research introduced a metric to quantify the sophistication level of ITT project considering the technical support provided by the transferor party.

---

[1] Department of Science Technology and Policy Studies, Middle East Technical University, Üniversiteler Mahallesi, Dumlupınar Bulvarı No:1, 06800, Çankaya-Ankara / Turkey. basarseckin@gmail.com.

The results of econometric analysis designate that there exists a direct relation between the explanatory variables and the performance of ITT. Accordingly, there is an opportunity of making estimations for the future success of ITT projects based on the maturity of firm level absorptive capacity.

The introduced variables and the questionnaire can be used as an effective tool in the planning phase of ITT projects. It can be implemented to a wide variety of high-technology areas in developing countries and may provide valuable inputs to policy makers on the eve of ITT projects.

Keywords: International technology transfer, firm level absorptive capacity, technology assessment, technology development plans, aerospace industry.

1 INTRODUCTION

In modern economies, as the pace of innovation is very high, the importance of tangible and intangible knowledge assets becomes more recognizable. Therefore, such economies are called as knowledge economies. In compliance with the maturity level achieved in the notion of knowledge economics, the concept of absorption of knowledge has been given more attention in the recent years. The importance of "Absorptive Capacity" (AC) has been noted in the technology management field and tools to develop AC have been broadly studied. Most widely cited definition of AC was offered by Cohen and Levinthal (1990). They have denoted AC as the firm's ability to value, assimilate, and apply new knowledge.

Acquiring knowledge, from whatever sources, entails cognition and complex integration processes. Besides, new knowledge is confronted and articulated with previous experience. The cognitive capabilities of individuals will determine the way in which knowledge is acquired and accumulated as processing knowledge is highly personal. However, at the firm level the formation of knowledge is strongly dependent on the nature of the organizational collective devices.

Innovation, has to be treated as a process effected by multi-players, rather than a single act of a single actor, involving complementary activities and is expected to end up with an economic success. Innovation activities can be summarized as; coming up with an idea, invention, design, production, marketing (with identification of demands), utilizing existing science and technology knowledge base, inter-firm relations (relations between different departments, or vertical intervention of top-management) and external relations. Innovation involves the use of existing knowledge, as well as the ability to generate and acquire new knowledge. Absorptive capacity makes the firm open to acquiring and assimilating external knowledge and can lead to convert knowledge into innovation.

One of the aims of this research is to figure out the mechanisms of knowledge production at the firm level and to understand internal and external paths for knowledge flow. Although a firm level research is conducted, evaluations are carried out considering the relations between the firm and the relevant sectoral innovation system. Aerospace industry is chosen in order to make optimal use of author's experience in this field and his intimate knowledge of how incremental innovation proceeds in the aerospace industry. Besides, aerospace industry is very important in terms of knowledge diffusion, therefore relations between the firm and the relevant innovation system are supposed to be highly developed.

In Turkey, the aerospace subsectors engaged in the research, development, and manufacture of military aircrafts, rocket and missile systems, and spacecraft involve greater knowledge-based activities when compared with the rest of the subsectors. Therefore, this research is focused on this aforementioned portion of the aerospace industry.

Another major topic of this research is international technology transfer (ITT). ITT utilizes the advantages of being backward and provides an alternative way to indigenous efforts in obtaining a certain level of technological capability. However, in order to institute the scope of an ITT project, transferee of the technology has to be aware of what should be expected from the transferor. This requires an existing technological maturity in the relevant technology area.

Increasing the quality of human assets would certainly provide a higher level of technical capability and maturity prior to ITT project. A culture of "systematically searching for external knowledge" through memberships to journals, digital sources or by following newly published books in the area of interest would also be useful to increase initial maturity. "Knowing what to request" improves the quality and scope of the contractual documents of ITT project. Based on these examples it can be stated that there has to be a relation between firm level absorptive capacity and the future performance of an ITT project.

Besides, efficient utilization of ITT as a tool of technological development requires a sophisticated harmonization of the overall process, such that, national efforts and the benefits of technology transfer have to be coupled in an optimized way. In other words, some determinants other than firm level absorptive capacity also affect the success of ITT project. The policy environment in the transferee country, existence of a national technological roadmap in the area of research, motivation of the transferor or response of third parties can be some examples of such determinants.

Even though firm level absorptive capacity is a critical determinant for the successful utilization of an ITT project, and despite these subjects is studied substantially on an individual basis, there is no developed literature on the relationship. The existing literature on ITT is mainly based on transferor's point of view; as a result, studies conducted by developing country perspective are so rare.

This research aims to figure out the relation between firm level absorptive capacity and the success of international technology transfer. Additionally, effects of determinants on the success of ITT other than firm level absorptive capacity are intended to be examined. The research is conducted by considering the transferee country's point of view, which in turn involves developing country dynamics. In this context, this research is supposed to provide insights into research questions mentioned below.

Research Question-1:

Is there a relation between firm level absorptive capacity and the success of international technology transfer in aerospace projects?

Research Question-2:

Are there any determinants affecting the success of international technology transfer other than firm level absorptive capacity?

Research Question-3:

What kind of measures can be taken to increase the possibility of success of international technology transfer projects?

The implemented methodology throughout the research is explained below.

Step-1 (Theoretical Background):

As a first step, literature related to absorptive capacity is reviewed. In compliance with the maturity level achieved in the notion of knowledge economics, the concept of absorption of knowledge has been given more attention in the recent years. The importance of "Absorptive Capacity" (AC) has been noted in the technology management field and tools to develop AC have been broadly studied.

Additionally, in compliance with the research questions, literature related to international technology transfer is also reviewed. Mechanisms of international technology transfer and the reasons for a nation (or a company) to take part in an ITT project are evaluated. Existing literature on ITT is mainly based on home party's (transferor) point of view and less attention is paid to the effectiveness and performance of ITT considering host party (transferee) concerns. This area is rarely studied probably because the topic is more important for developing countries than the developed countries. Nevertheless, determinants that are related to the performance of an ITT project are revealed from the literature.

Step-2 (Conceptualization):

Literature review provided an understanding of the ways of knowledge production and the mechanisms of knowledge flow, which are then conceptualized in sub-groups merged under the title of "Factors Affecting Absorptive Capacity". This part of the conceptualization has been carried out with a firm-level perspective. Similarly, on the topic of the ITT projects; relevant nomenclature, principals and performance evaluations that are extracted from the literature inspired the conceptualization of "Determinants and Success Indicators of ITT Projects".

Step-3 (Semi-Structured Interviews):

The concepts that were generated in Step-2 are improved by the help of views and suggestions provided by industrial professionals as well as experts from various stakeholders of the innovation system. For this purpose, a question set (Semi-Structured Interview Questions) is prepared based on the results of Step-1 and Step-2. The questions are structured in such a way that; methods for developing indigenous technologies, ways of accessing knowledge as well as the structure of sectoral innovation system are able to be examined. Additionally, the question set was intended to investigate the main concerns regarding ITT projects and the types of such projects in terms of scope and target.

Experts from the aerospace industry who had previously participated in ITT projects contributed to research under the guidance of the "Semi-Structured Interview Questions". These experts were from one of the biggest aerospace company in Turkey, coming from different engineering disciplines with an experience varying between 5 to 25 years in the industry. The evaluated company is engaged in defense and space business with around 2000 employees.

In addition to firm level interviews and discussions, it was possible to participate in meetings with state experts during which planning activities for varying forthcoming ITT projects have been conducted. During these meetings it was possible to discuss with experts from varying stakeholders of SIS in Turkey, which helped to enhance the scope of extracted variables. Moreover, suggestions for improving the defined variable through promising firm level strategies or policy measures were also discussed.

After the completion of Step-3, 47 variables are determined, elaborated and categorized under the conceptualized framework. Consequently, conceptualization has been improved by means of defining subgroups under predefined titles as given below.

Factors Affecting Absorptive Capacity;

- Knowledge Production (10 variables)
- Knowledge Flow within the Company (6 variables)
- Knowledge Flow within the Sectoral Innovation System (6 variables)

Determinants and Success Indicators of ITT Projects;

- Preparations for the ITT Project (9 variables)
- Conducting the ITT Project (12 variables)
- Performance of the ITT Project (4 variables)

Step-4 (Questionnaire):

The variables defined at the end of Step-3 are utilized to understand the relations between firm level absorptive capacity and the determinants/success indicators of ITT projects. For this purpose, it is required to quantify these variables for specific conditions; firm level specific environment and evaluation of the completed ITT projects within this environment. Therefore, in order to identify and measure relevant variables, questions are generated and these questions are gathered in a form of questionnaire. At the end of Step-4, a total number of 74 evaluations regarding ITT projects were obtained.

Step-5 (Quantitative Analysis):

Multiple ordinary least-squares (OLS) regression analysis has been used to analyze the relation between variables. Since there is a large number of variables (47 variables) when compared to the number of observations (74 evaluations of ITT projects), variables are gathered under 6 variable groups to have higher degrees of freedom in the econometric model. In order to gather variables in groups, "representing variables" are generated to be used in regression analysis. The explanatory variables and the dependent variable used in the regression are given in Table 1.

Table 1 Explanatory and dependent variables

Explanatory Variables	
Factors Affecting Absorptive Capacity	1) Knowledge Production
	2) Knowledge Flow within the Company
	3) Knowledge Flow within the Sectoral Innovation System
Determinants of Success for ITT Project	4) Preparations for the ITT Project
	5) Conducting the ITT Project
Dependent Variable	
Success Indicators of ITT Projects	6) Performance of the ITT Project

Step-6 (Recommendations for Firm Level Strategies and Policy Implications):

After highlighting the most statistically significant variables that affect the success of ITT projects, suggestions on firm level strategies and national level policies are provided with an aim to enhance the boosting effects of evaluated variables on the success of ITT projects.

2 A BRIEF INTRODUCTION TO AEROSPACE INDUSTRY

The term aerospace is derived from the words aeronautics and spaceflight. Aerospace industry is defined as the manufacturing concerns that deal with vehicular flight within and beyond Earth's atmosphere. The aerospace industry is engaged in the research, development, and manufacture of flight vehicles, including unpowered gliders, fixed-wing and rotary-wing airplanes, military aircrafts, missiles (rocket and missile system), space launch vehicles, and spacecrafts (manned and unmanned).

The aerospace industry is one of the largest high-technology employers in advanced countries. By 2000, there were 1,220,000 aerospace employees in the world, of whom 49% were in the USA, 35% in the European Union, 7.5% in Canada, 2.7% in Japan and

5.7% in the rest of the world. Within this industry, the civil aviation manufacturing sub-sector has the biggest portion. In 2000, 66% of European aviation manufacturing employees were in civil production and 33% in the military sector. The figures in the USA were 59% and 41%, respectively (Niosi and Zhegu, 2010).

For civil aviation production in advanced industries, most large aerospace clusters consist of one or several OEMs surrounded by hundreds of small and medium-sized suppliers of components and parts. In such aerospace clusters, knowledge spillovers are technology based and centered on supply chain management linking the OEMs and their suppliers.

In contrast, for military sector there exist barriers to internationalization through international knowledge spillovers, due to the differences between defense industry and civilian industry. The governments are decision makers in defense industry projects; therefore government level regulations have major influence on the structure and dynamics of cooperation in relevant fields. In addition, there are several regulations that affect the international knowledge flow, and hence the architecture of ITT projects like International Traffic in Arms Regulations (ITAR) and the Missile Technology Control Regime (MTCR).

The aerospace industry has some highly distinctive features. Aerospace industry-related tasks, which include development, manufacturing, assembly, integration and testing are highly capital intensive. For each sub-sector there are only a few global competitors and competition between main players is very strong. Besides, patents are less meaningful indicators in aerospace industry as compared to other high-technology industries such as biotech, since innovations are preferred to be protected by secrecy, which is a rather efficient way.

In the aerospace industry, barriers to entry are very high due to physical and human capital commitments required to design and produce aerospace products. New entrants have to face a steep learning curve. In aerospace industry, access to technology for latecomers is limited by the immense costs of entry rather than patents. The industry is characterized by imperfect competition, non-homogeneous products and economies of scale. To overcome the underinvestment in new technology, manufacturers rely on some sort of government support through export subsidies, military procurement or market protection. However, even government supports the industry, this may not serve to solve human capital shortage.

Aerospace industry requires advanced technological capabilities even at the earliest stages of the emergence of the industry. Starting from the initial stages, manufacturers need to comply with high international technological standards. This makes this industry distinctive such that classical theories of catch-up may not be appropriate to analyze the evolution of this industry in latecomer economies. According to Vertesy and Szirmai (2010), the emerging economies that have succeeded in catching up in aerospace are those that have established a competitive industrial sector with a sectoral innovation system, which is able to adapt flexibly to radically changing circumstances.

Civil aviation manufacturing sub-sector has the biggest portion in terms of financial figures and number of employees within the global aerospace industry. Concordantly, in Turkey, capabilities in public air transport has been developed, which made Turkey one of the main countries in airway passenger transportation, airport construction and management. Turkish airline companies have been developed in capacity and improved their position in competition with the others.[2]

The main players of the civil aviation in Turkey are the airline companies; including airport and terminal operators, aircraft repair, maintenance and renovation companies. Besides, ground service companies, catering companies and means of air-traffic control are complementary actors of the civil aviation sector. The number of employees is more than 150,000 and the revenue is over 15 billion USD in this sector in Turkey.[2] However, even these figures are seem to be comparable to the figures of leading countries, when we consider producing knowledge and pursuing new technologies, civil aviation is not the leading sub-sector of aerospace industry in Turkey.

---

[2] Turkish Civil Aviation Assembly Sector Report 2012, TOBB

In Turkey, the sub-sectors other than civil aviation are engaged in the research, development, and manufacture of military aircrafts, rocket and missile systems, and space crafts. Moreover, development efforts on satellite launch vehicles are initiated in 2013 to gain the satellite launch capability with the aim of supporting the sustainability of the Turkish Satellite Programs and reaching the space independently.[3] When compared to civil aviation, abovementioned sub-sectors of aerospace industry involves greater knowledge-based activities in Turkey and this research is focused on this portion of aerospace industry.

Aerospace industry is characterized by some significant features like imperfect competition, non-homogeneous products and economies of scale. Therefore, in order to cope with the underinvestment in new technology, manufacturers rely on government support. In Turkey, main players in the public sector are;

- Undersecretariat for Defense Industries under the Ministry of National Defense (*Savunma Sanayi Müsteşarlığı* - referred to as "SSM" in Turkish)
- Ministry of Transport, Maritime Affairs and Communication

Turkey has been allocated the highest funds from the budget to defense industry for many years. The 2023 vision of the government is to be ranked in the first ten countries in defense industry and to manufacture all ground vehicles, marine vessels and unmanned aerial vehicles domestically. Accordingly, in the recent years Turkey changed the supply policies for the military requirements and focused on indigenous production policies.

[3] http://www.ssm.gov.tr/home/projects/Sayfalar/proje.aspx?projeID=222 accessed on January 31, 2015

3 THEORETICAL BACKGROUND & CONCEPTUALIZATION

Most widely cited definition of AC was offered by Cohen and Levinthal (1990). They have denoted AC as the firm's ability to value, assimilate, and apply new knowledge. Their conceptualization of AC was based on an intention to understand firms' behavior. Cohen and Levinthal argued that, in addition to the availability of external knowledge within the firm's environment, the ability to successfully intake external knowledge depends on prior related knowledge or problem solving experience.

According to Ernst and Kim (2002), knowledge diffusion is completed only when transferred knowledge is internalized and translated into the capability of the local suppliers. These researchers focused on the relation between AC and the learning process.

Mowery and Oxley (1995) focused on the tacit dimension of the imported knowledge and depicted AC as tools to possess this knowledge. They concentrated on a country level AC definition instead of firm level AC and achieved results indicating that countries investing in building their AC have significant national innovation and greater productivity. They gave specific attention to human capital in terms of skill level of personnel, trained R&D personnel as percent of population and trained engineering graduates.

According to Kim (1998) AC is the capacity to learn and solve problems. Learning capability is depicted as the capacity to assimilate knowledge (imitation) and problem-solving skill is defined as the capacity to create new knowledge (innovation). AC is accepted to be a component of the organizational learning system and it depends on the prior knowledge and intensity of efforts. But it dynamically develops through the process of proactive crisis building.

Zahra and George (2002) focused on the effect of AC on the sustainability of a firm's competitive advantage and recognized AC as a dynamic capability improving economic performance. They defined AC as a set of organizational routines by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability. Although these constituents were introduced by former researchers, Zahra and George (2002) highlighted the dynamic feature of AC and introduced “potential” and “realized” absorptive capacities. Later, researchers like Jansen et al. (2005) used these definitions to conduct firm level studies and factors affecting AC are numerically evaluated.

According to Crispolti and Marconi (2005), innovative activities today are still highly concentrated in few industrialized countries. Generally, when compared to leading countries, developing countries do not engage in relevant amounts of R&D. Most of the time, they are technological followers whose technical progress eventually relies upon the ability to adopt appropriate innovations produced by the advanced countries. Hence, understanding international technology spillovers through International Technology Transfer (ITT) projects becomes a crucial issue in explaining economic development.

ITT is not as simple as the purchase of a capital good or even as the acquisition of blueprints. Recipients are supposed to dedicate significant amount of resources to assimilate and adapt the transferred technology. Since the technical knowledge includes imperfect understanding, inadequate obtainability, and limitability or in other words tacitness, its successful utilization depends on firms’ and countries’ own technological capabilities. Formal mechanisms of international technology transfer are foreign direct investment, foreign licensing, joint ventures and technical consultancy. However, informal knowledge transfer can be through local capabilities in assimilating, adapting and improving imported technology.

Hikino and Amsden (1994) highlighted the importance of managerial and organizational skills in developing countries. According to their research, making incremental improvements in the cost, quality, and performance of processes and products are essential. Forbes and Wield (2003) emphasized the importance of national environment for the development of science and technology as the national policy environment determines growth rate of value-added. Similarly, Kim and Lee (2009) carried out their research on the state interventions and policies related to ITT.

Forbes and Wield (2003) defined developing countries' advantages for technological leap frogging and highlighted the importance of innovation and long term planning. They stated that catching up requires incremental innovation at a faster pace than in the leader. Abramovitz (1986) introduced the term "social capability" and stated that potential for rapid growth is strong when the country is technologically backward but socially advanced. The content of education in a country and the character of its industrial, commercial and financial organizations are important for productivity growth. For Abramovitz (1986), there is an interaction between social capability and technological opportunity.

Ramanathan (1999) introduced Pre-ITT term for the period before signing the deal of ITT project. In this period "partner selection" assessments, "possible transfer returns and costs" assessments, assessments of "manufacturing fitness for technology transfer", "gap" assessments etc. are performed. According to Öner and Kaygusuz (2007), ‘‘assessment of the absorptive capabilities of host country’’ seems to be the most critical issue of the Pre-ITT period. Reddy and Zhao (1993) highlighted the importance of negotiation by the two parties and posted that a successful ITT can be achieved through a negotiation phase executed successfully between the home and the host countries.

ITT projects can be designed in such a way that makes it possible to use the opportunities of being a latecomer, and at the same time accelerates the technological development of a developing country. However, firm level absorptive capacity is an important tool for technological development and also for the success of implemented ITT projects. In the light of existing literature, one can state that there are vast amount of determinants that affect the development of firm level absorptive capacity and these variables are supposed to affect the success of an ITT project, in a direct or indirect manner.

Literature review provided an understanding of the ways of knowledge production and the mechanisms of knowledge flow, which are then conceptualized in sub-groups merged under the title of "Factors Affecting Absorptive Capacity". The reviewed literature on absorptive capacity (AC) mainly aims to answer the question "what are the forms of AC" and deals with AC in specific frameworks such as; relative absorptive capacity, as devised by Lane and Lubatkin (1998), or absorptive capacity as a dynamic capability introduced by Zahra and George (2002). Others deeply investigated the concept of AC in different dimensions such as; relationship between absorptive capacity and organizational learning in terms of recognition the value of new knowledge, adopting that information and applying that knowledge to commercial products (Cohen and Levinthal, 1990), organizational arrangements (Van den Bosch et al., 1999), or organizational learning system (Kim, 1998).

This research stands at a position to answer the question of "what forms AC" in a holistic way. In this context, variables that affect the formation of absorptive capacity of a firm are presumed to be grouped under the categories mentioned below in the light of existing literature;

- Knowledge Production
- Knowledge Flow within the Company
- Knowledge Flow within the Sectoral Innovation System

The conceptualized groups of variables are given together with the relevant literature in Table 2.

Table 2 Factors affecting absorptive capacity based on the relevant literature

Factors Affecting Absorptive Capacity	**Relevant Literature**	**Keywords/Explanations**
Knowledge Production	Dosi and Nelson (2010), Perez (2001), Bernard and Ravenhill (1995), Spender (1996), Mathews (2004)	Technology paradigm, technology trajectories, technological advance as an evolutionary process, planning technology development projects, interdependence, R&D strategies, systematic exploitation routines, strategic management
	Ancori et al. (2000), Carlsson (2006), Dolfsma (2008), Omidvar (2013), Abramovitz (1986), Mowery and Oxley (1995)	Cognitive abilities, workforce skills, investment on human capital
	Cohen and Levinthal (1990), Kim (1998), Zahra and George (2002), Jansen et al. (2005), Lane and Lubatkin (1998), Van den Bosch et al. (1999)	Different conceptualizations of absorptive capacities, variables affecting AC, past experience and prior knowledge, diversity in prior investments, set of organizational routines, firm's memories, openness to technological change, retrieving knowledge, coordination-systems-socialization capabilities
	Foray (2004), Simon (1999), Brynjolfsson and Hitt (2000), Hikino and Amsden (1994), Scherrer (2005), Zahra and George (2002)	Codification of knowledge, ICT investments, organizational skills & firm's routines related to codification
	Akgün et al. (2009)	Emotional capability
Knowledge Flow within the Company	Romer (1986), Lall (1992), Malerba (1992), Forbes and Wield (2003), Bathelt et al. (2002)	Endogenous forms of learning
	Katz (1999), Dutrénit (2004)	Micro level economic forces-related to the learning strategy of each individual firm, Building up of technological capabilities
	Polanyi (1969), Dosi and Nelson (2010), Morone and Taylor (2010), Dolfsma (2008), Balconi et al. (2007), Ancori et al. (2000), Hey (2004), Mowery and Oxley (1995), Szulanski (1996)	Sharing of tacit knowledge, collective learning, shared vision
	Jansen et al. (2005), Dutrénit (2004)	Mechanisms associated with coordination capabilities, participation in decision making, organizational capabilities

Table 2 Factors affecting absorptive capacity based on the relevant literature (Cont'd)

Factors Affecting Absorptive Capacity	Relevant Literature	Keywords/Explanations
Knowledge Flow within the Sectoral Innovation System	Romer (1986), Bathelt et al. (2002), Chaudhuri and Tabrizi, (1999), Christensen (1997), Foray (2004), Morone and Taylor (2010), Ernst and Kim (2002)	Externalities, knowledge spillovers
	Katz (1999), Mowery and Oxley (1995)	Meso/macro level economic forces: competitive and technological regime in each particular industry / regulatory systems, institutions and public policies, country level absorptive capacity
	Ancori et al. (2000), Lane and Lubatkin (1998)	Common classification, common language
	Shariff (2006), Metcalfe (1997), Kline and Rosenberg (1986), Carlsson (2006), Malerba and Mani (2009), Bergek et al. (2005), Vertesy and Szirmai (2010), Vermeulen and Barkema (2001)	Innovation Systems, innovation models, inter-organizational relationships
	Crispolti and Marconi (2005), Korhonen (1994), Akamatsu (1962), Kasahara (2004), Vernon (1971), Abramovitz (1986), Mathews (2004), Teitel (1984), Scherrer (2005)	Catching up, following global leaders, technological change efforts in developing countries, threats of being path dependent
	Porter (1998), Bathelt et al. (2002), Özman (2009), Granovetter (1983)	Clusters, networks

Similarly, on the topic of the ITT projects; relevant nomenclature, principals and performance evaluations that are extracted from the literature inspired the conceptualization of "Determinants and Success Indicators of ITT Projects". Previously it was stated that the reasons that force nations to transfer technology through ITT projects were discussed and it was concluded that the motivations of the home party and the host party are totally different. From the perspective of the host company, as the transferee of external technology, there are many variables that affect the performance of ITT projects. These can be considered within the lifespan of ITT projects, which also covers the preparation period prior to ITT project.

The determinants and success indicators related to the ITT project are conceptualized within below mentioned groups;

- Preparations for the ITT Project
- Conducting the ITT Project
- Performance of the ITT Project

The conceptualized groups of variables that are related to ITT projects are given together with the relevant literature in Table 3.

Table 3 Determinants and Success Indicators of ITT projects based on the relevant literature

Determinants and Success Indicators of ITT Projects	Relevant Literature	Keywords/Explanations
Preparations for the ITT Project	Forbes and Wield (2003), Kim and Lee (2009), Gerschenkron (1962), Akamatsu (1962), Korhonen (1994)	Policy environment, strategic sectors & role of governments, well-coordinated government intervention, technology development difficulties in advanced industries of developing countries
	Forbes and Wield (2003), Hikino and Amsden (1994), Dutrénit (2004)	Technological roadmap, incremental improvement, managerial and organizational skills, technology-in-development paradigms
	Ramanathan (1999), Öner and Kaygusuz (2007), Reddy and Zhao (1993)	Pre-ITT, partner selection, technological gap assessment, assessment of the absorptive capabilities of the host party, importance of negotiation
	Mansfield and Romeo (1980), Balconi et al. (2007)	Quality of transferred technology, machines with embedded knowledge
	Baranson (1978), Krugman (1979), Mansfield and Romeo (1980), McCulloch and Yellen (1982), Wilking (1974)	ITT from the perspective of the home party
Conducting the ITT Project	Reddy and Zhao, (1990), Mansfield (1975)	Different levels of technology transfer
	Öner and Kaygusuz (2007)	Localization of technology or product
Performance of the ITT Project	Aharoni (1991), Forbes and Wield (2003), Reddy and Zhao (1990), Öner and Kaygusuz (2007)	Successful ITT project from the perspective of the home party

It is conceptualized that, abovementioned categories directly or indirectly affect the performance of ITT project and moreover there exist relations and interactions between these defined categories. A preliminary schematization of this concept is given in Figure 1.

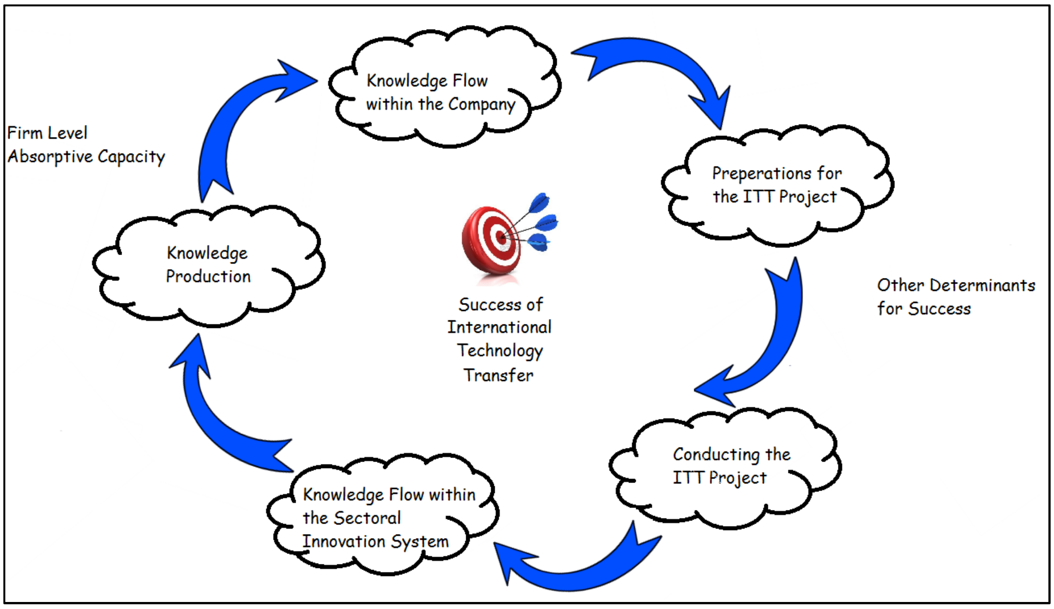

Figure 1 Determinants for the Success of ITT Projects (initial version)

The main goal of this research, as designated as a research question, is to discover whether there is a relation between firm level absorptive capacity and the performance indicators of the ITT project. Consequently, it is aimed to make further evaluations based on the results and to suggest appropriate policy measures.

The research is developed within the abovementioned conceptualized framework and afterwards improved by the help of views and suggestions provided by industrial professionals as well as experts from various stakeholders of the innovation system. For this purpose, a question set (Semi-Structured Interview Questions – Appendix A) is prepared based on the conceptualized framework. The questions are structured in such a way that; methods for developing indigenous technologies, ways of accessing knowledge as well as the structure of sectoral innovation system are able to be examined. Additionally, by this question set it was intended to investigate the main concerns regarding ITT projects and the types of such projects in terms of scope and target.

Experts from the aerospace industry who had previously participated in ITT projects contributed to the research under the guidance of the "Semi-Structured Interview Questions" (this is the Step-3 of the research). These experts were from one of the biggest aerospace company in Turkey coming from different engineering disciplines with an experience varying between 5 to 25 years in the industry. The evaluated company is engaged in defense and space business with around 2000 employees. Furthermore, the author has been working in this company for more than 15 years, and gained experience in various departments such as design, development and project management. He is currently employed as a manager, which gives him the opportunity to make internal evaluations and discussions with colleagues. Consequently, he found the chance to discuss the issues pointed in "Semi-Structured Interview Questions" within his working hours without getting stuck to interview duration and probably it would not be possible to achieve such results through ordinary interviews.

In addition to firm level interviews and discussions, it was possible to participate in meetings with state experts during which planning activities for varying forthcoming ITT projects have been conducted. During these meetings it was possible to discuss with experts from varying stakeholders of SIS in Turkey, which helped to enhance the scope of extracted variables.

After the completion of Step-3, 47 variables are determined, elaborated and categorized under the conceptualized framework. A summary of these variables are given in Table 4 and the schematization has been improved as indicated in Figure 2.[4]

---

[4] Discussions on these variables can be found in the Ph.D. dissertation "Firm Level Absorptive Capacity and the Success of International Technology Transfer: the Case of Aerospace Industry in Turkey", December 2015, Department of Science Technology and Policy Studies, Middle East Technical University, Ankara, Turkey.

Table 4 Variables related to AC and ITT projects

Variable Groups		Variables
Factors Affecting Absorptive Capacity	1) Knowledge Production	• Setting academic goals for universities, • Hiring graduates of the top universities, • Access to world literature, • Culture of utilizing patent databases, • Firm level strategic plan and technology roadmap, • Intra-firm technology development projects, • Development of indigenous design and analysis tools, • Fringe benefits, • Emotional capability.
	2) Knowledge Flow within the Company	• Coordinating intra-firm knowledge creation activities, • Culture of codification within the company, • Culture of implementing systems engineering approach within the company, • Utilizing codified procedures and processes within the company, • Face-to-face intra-firm communication.
	3) Knowledge Flow within the Sectoral Innovation System	• Interactions with national players, • Solid interactions with universities, • Well-organized training to reach external knowledge, • Improving capabilities of sub-contractors, • Interactions with players outside national borders.
Determinants of ITT Projects	4) Preparations for the ITT Project	• Strong political will, • ITT fills a gap in the technology roadmap, • Significant strategic benefits of the ITT, • Selection Process of Home Company, • Transferred technology is not practically obsolete, • Motivation of the Home Party, • Response of developed countries and big companies, • Well-prepared contractual documents.
	5) Conducting the ITT Project	• Benefits of “design phase”, • Benefits of “equipment installation and commissioning phase”, • Benefits of “ground development tests phase”, • Benefits of “manufacturing phase”, • Mechanisms for effective absorption, • Implementing systems engineering approach by Home Company, • Various sources for raw materials, • Benefits of the “equipments” provided, • Benefits of the “in-house softwares” provided, • Benefits of the “training” provided, • Managing the language constraints.
Success Indicators of ITT Projects	6) Performance of the ITT Project	• Fulfilling contractual requirements, • Reduced external dependency, • Obtained design capability is verified and validated • Preventing “brain drain”

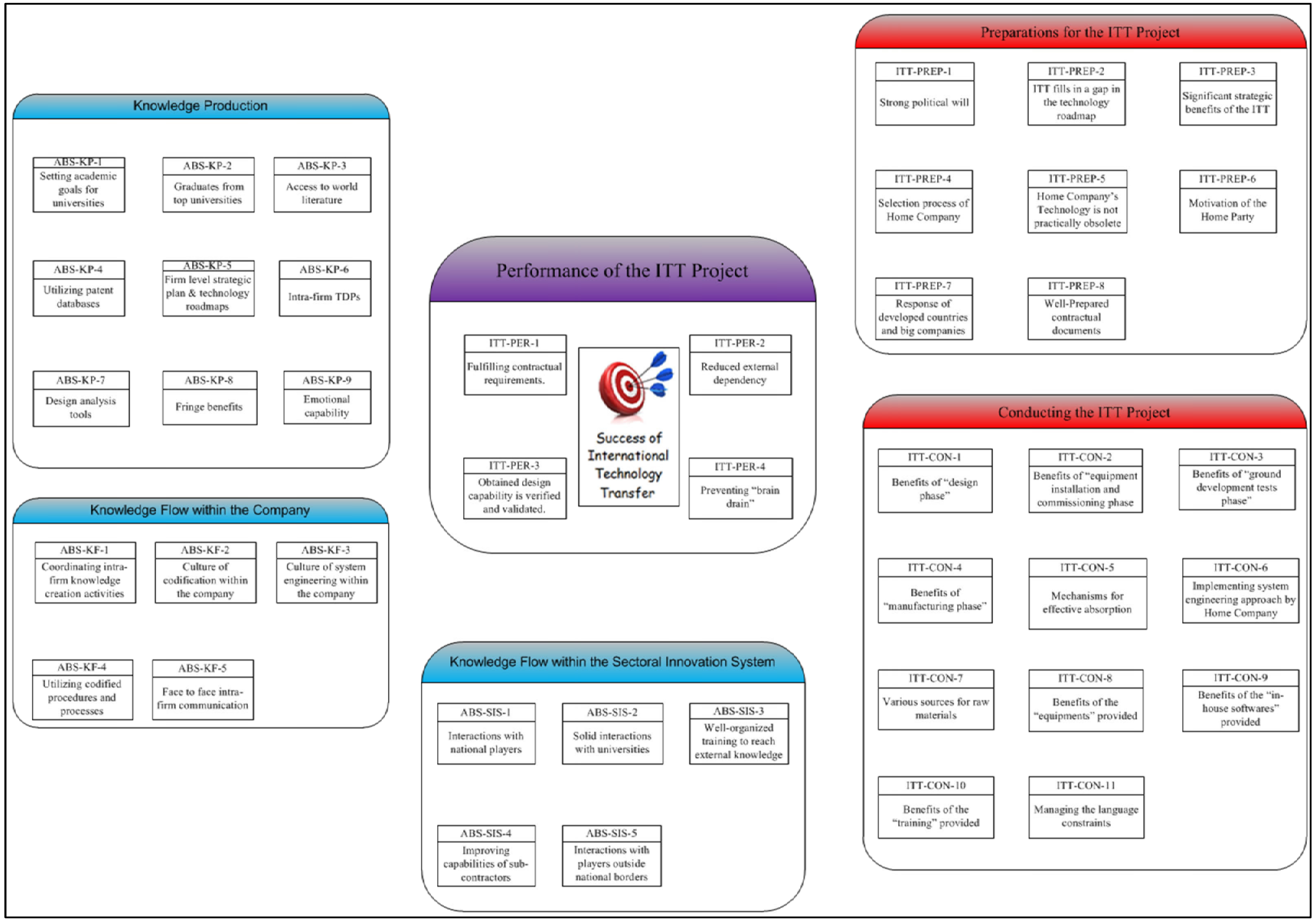

Figure 2 Determinants for the Success of ITT Projects (improved version)

4 QUANTITATIVE ANALYSIS

The variables defined at the end of Step-3 are utilized to understand the relations between firm level absorptive capacity and the determinants/success indicators of ITT projects. For this purpose, it is required to quantify these variables for specific conditions; firm level specific environment and evaluation of the completed ITT projects within this environment. Therefore, in order to identify and measure relevant variables, questions are generated and these questions are gathered in a form of a questionnaire (Appendix B).

The questionnaire involves two parts both of which are based on Likert scale. First part of the questionnaire is composed of questions that aim to figure out firm level environment (the quality of human capital, existence of a strategic plan for technology development, appropriateness of the organizational structure and culture of the firm to conduct innovative activities, etc.). The second part of the questionnaire asks experts to evaluate an ITT project that they had participated in terms of different aspects, such as, the political will in the related area, planning and conducting periods of the ITT project and the evaluation of the achievements of the ITT project.

The questionnaire has also provided information regarding the sophistication level of the evaluated ITT projects in terms of the technical support provided by the transferor of the technology. For this purpose, a method for quantifying “Sophistication Level of ITT Project” is developed. In order to quantify this variable, “Functional Capability” and “Level of Product” are questioned within the questionnaire.

The questionnaire is applied to 20 experts having 10-25 years of experience and who have participated in aerospace ITT projects. These experts were employed within the same company, which is one of the biggest and leading aerospace companies of Turkey. Experts evaluated ITT projects that they had previously participated. At the end of Step-4, a total number of 74 evaluations regarding ITT projects were obtained.

In addition to the abovementioned variables, the types of capabilities achieved through ITT projects in terms of “Functional Capability” and “Level of Product” were also surveyed within the questionnaire. The sophistication level of ITT project in terms of the technical support provided by the home party varies according to “Functional Capability” and “Level of Product”. Accordingly, a method for quantifying “Sophistication Level of ITT Project” is required to be designed. For that reason, a post processing method as indicated below is proposed and a variable (sophist_level) is generated.

Firstly, the alternatives for “Functional Capability” and “Level of Product” that can be covered within an ITT project are labeled as given in Table 5.

Table 5 Labels defined for "Functional Capability" and "Level of Product"

Functional Capability	To design	FC1
	To manufacture	FC2
	To test	FC3
	To assembly and integrate	FC4
Level of Product	Component and/or material level	LP1
	Sub-system level	LP2
	System-level	LP3

Then, the combinations of Functional Capability (FC) – Level of Product (LP) couples are designated. Because in one ITT project any forms of Functional Capability and Level of Product can be covered, the domain of such combinations will consist of 105 different combinations. Sophistication Levels for these combinations are labelled within a scale of 1-10 with a method given in Appendix D. Examples for quantifying the “Sophistication Level of ITT Project” are given in Table 6. ITT projects involving system-level efforts (LP3) and design tasks (FC1) are designated with higher values of sophistication. The infrastructure requirements (including design capabilities) for system-level products are generally much more sophisticated when compared to other levels of product. Because of the difficulties in transferring knowledge related to design capability due to the tacit component of knowledge, the complexity of capability related to design increases with the increasing level of product.

Table 6 Examples for "Sophistication Level of ITT Project" for projects with different scopes

Types of capabilities achieved through ITT projects		**Sophistication Level of Technical Support Through ITT Project**
Functional Capability	**Level of Product**	
FC1, FC2, FC3, FC4	LP1, LP2**, LP3**	10
FC1, FC2	LP1, LP2**, LP3**	9
FC2, FC3	LP1, LP2, **LP3**	8
FC1	LP1, LP2, **LP3**	7
FC3	LP1, LP2, **LP3**	6
FC2, FC3	LP1, LP2	5
FC3	LP2, **LP3**	4
FC2	LP1, LP2	3
FC2	**LP3**	2
FC2	LP2	1

The variables obtained from the questionnaire and the variable generated to quantify the "Sophistication Level of ITT Project" are used to build up the data set, which is going to be utilized in STATA®. One row in the generated dataset can be denoted as shown in Figure 3.

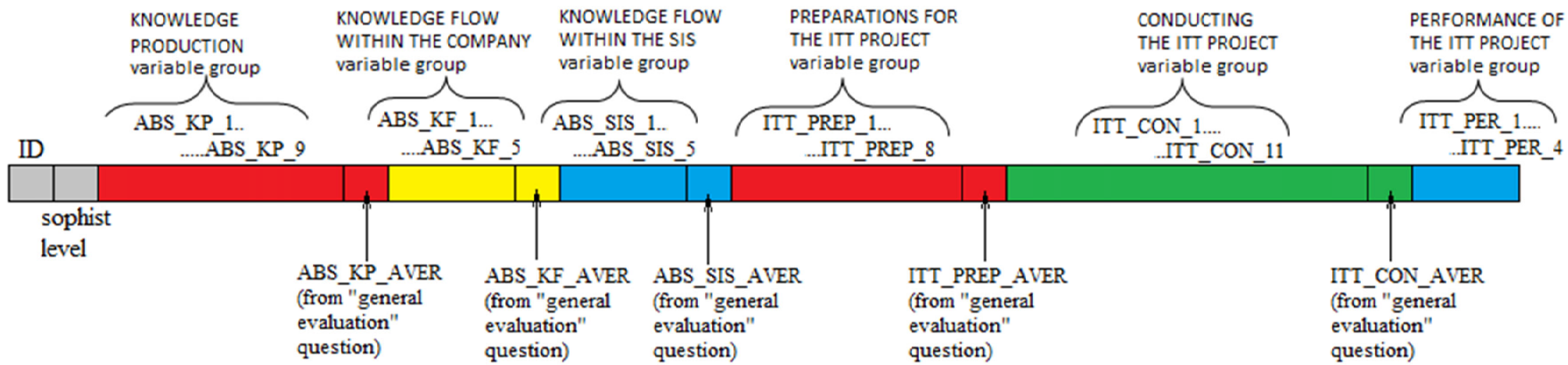

Figure 3 Schematization of the structure of a row in the dataset

Multiple OLS regression analysis method has been used to analyze the relation between variables. Two different regressions are modeled as described below;

- Regression Analysis-1; as there is a large number of variables (47 variables) when compared to the number of observations (74 evaluations of ITT projects), variables are gathered under 6 variable groups, in accordance with conceptualized approach with an aim of achieving higher degrees of freedom. For this purpose "representing variables" are generated.

- Regression Analysis-2; variables are gathered under 6 variable groups, but this time regression model is formed by using the answers to the "general evaluation questions" as explanatory variables instead of using generated "representing variables". Results of Regression Analysis-2 are intended to validate the results of Regression Analysis-1.

The variables used in Regression Analysis-1 are given in Table 7. Among these variables, MEAN_ITT_PER is considered as the dependent variable.

Table 7 Variables used in the Regression Analysis-1

Variable	*Definition*	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
MEAN_ABS_KP	Knowledge Production	74	3.67	0.34	2.78	4.44
MEAN_ABS_KF	Knowledge Flow within the Company	74	3.38	0.38	2.60	4.60
MEAN_ABS_SIS	Knowledge Flow within the SIS	74	3.31	0.63	1.67	4.60
MEAN_ITT_PREP	Preparations for the ITT Project	74	3.71	0.52	2.63	4.88
MEAN_ITT_CON	Conducting the ITT Project	74	3.51	0.57	2.38	4.63
MEAN_ITT_PER	Performance of the ITT Project	74	3.68	0.66	1.67	5.00

In Regression Analysis-1; MEAN_ITT_PER is regressed on explanatory variables and the equation of the regression model is formed as follows.

$$MEAN\_ITT\_PER = \beta_0 + \beta_1 MEAN\_ABS\_KP + \beta_2 MEAN\_ABS\_KF + \beta_3 MEAN\_ABS\_SIS + \beta_4 MEAN\_ITT\_PREP + \beta_5 MEAN\_ITT\_CON + e$$

The severity of multicollinearity between the variables is examined through Pearson's correlation and the results are given in Table 8.

Table 8 Correlation table for variables (Regression Analysis-1)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) MEAN_ABS_KP	1.0000					
(2) MEAN_ABS_KF	0.2631*	1.0000				
(3) MEAN_ABS_SIS	0.4225*	0.4283*	1.0000			
(4) MEAN_ITT_PREP	-0.0219	0.1225	0.0212	1.0000		
(5) MEAN_ITT_CON	-0.0674	-0.0083	0.1103	0.7799*	1.0000	
(6) MEAN_ITT_PER	0.1115	0.1155	0.0755	0.8252*	0.7089*	1.0000

* Correlation is significant at 5%

According to the correlation table, it seems that there is a significant correlation between MEAN_ITT_PREP and MEAN_ITT_CON. Hence, in order to avoid multicollinearity, regression is repeated by including variables to the regression model separately.

Additionally, there seems to be relatively weak correlation between MEAN_ABS_KP & MEAN_ABS_KF, MEAN_ABS_KP & MEAN_ABS_SIS, MEAN_ABS_KF & MEAN_ABS_SIS. Although correlations are weak, different regression models have been formed by separating related variables. The regression results for these models are given in Table 9.

Table 9 Regression results (Regression Analysis-1)

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6	(7) Model 7
MEAN_ABS_KP	0.284**	0.248**	0.306**				
	(0.122)	(0.120)	(0.146)				
MEAN_ABS_KF	0.0104			0.0254	0.211**		
	(0.0996)			(0.0858)	(0.104)		
MEAN_ABS_SIS	-0.0266					0.0601	-0.00284
	(0.0621)					(0.0529)	(0.0755)
MEAN_ITT_PREP	0.850***	1.040***		1.034***		1.035***	
	(0.142)	(0.0817)		(0.0884)		(0.0853)	
MEAN_ITT_CON	0.221*		0.823***		0.812***		0.811***
	(0.112)		(0.0894)		(0.0938)		(0.0948)
Constant	-1.239**	-1.084*	-0.328	-0.238	0.122	-0.354	0.846**
	(0.576)	(0.605)	(0.660)	(0.419)	(0.547)	(0.396)	(0.399)
Observations	74	74	74	74	74	74	74
R-squared	0.712	0.698	0.528	0.681	0.517	0.684	0.503

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

This table indicates that, MEAN_ABS_KP (Knowledge Production) and MEAN_ITT_PREP (Preparations for the ITT Project) are found out to be significantly affecting the performance of ITT in all regression models they are included. MEAN_ITT_CON (Conducting the ITT Project) has similar figures for most of the models, but for Model-1 it has $p<0.1$.

As a common feature of all regression models, significant relations have positive sign indicating a positive relation between the explanatory variable and the dependent variable. In other words when the value of explanatory variable increases the value of the dependent variable also increases.

For the regression models, Model 2 to Model 7, we are sure that there are no correlations between the included explanatory variables. The results of these regression models indicate that one of the most statistically significant explanatory variables is MEAN_ITT_PREP. This variable is also the one with the biggest constant. For example, according to Model 2, for each unit increase in MEAN_ITT_PREP (Preparations for the ITT Project), MEAN_ITT_PER (Performance of the ITT Project) increases by 1.04 units.

The second most statistically significant explanatory variable is found out to be MEAN_ITT_CON (Conducting the ITT Project), again with a relatively big constant. For Model 3, 5 and 7, for each unit increase in MEAN_ITT_CON (Conducting the ITT Project), MEAN_ITT_PER (Performance of the ITT Project) increases more than 0.8 units. This is an expected result as there is a strong correlation between MEAN_ITT_PREP and MEAN_ITT_CON, as shown in Table 8.

The results of Model-2 and Model-3 indicate that there is a statistically significant relation between MEAN_ABS_KP (Knowledge Production) and the Performance of the ITT Projects. However, this explanatory variable is not as dominant as MEAN_ITT_PREP and MEAN_ITT_CON ($p<0.05$).

Similarly, according to the results of Model-5, MEAN_ABS_KF (Knowledge Flow within the Company) is found out to be affecting the dependent variable but with smaller constant when compared to the others. However, results of Model-4 do not show the same indications, so the relation between MEAN_ABS_KF and the performance of ITT project is ambiguous.

According to the results of regression, it is found out that there is no statistically significant relation between MEAN_ABS_SIS (Knowledge Flow within the SIS) and the Performance of the ITT Projects, which is a surprising result as a relation would be expected according to the existing literature. Accordingly, it can be stated that the relevant Sectoral Innovation System is not mature enough in Turkey to utilize. In other words, the Sectoral Innovation System in Turkey does not seem to be working properly and effectively.

In Regression Analysis-1, row-mean of the variables were used assuming that they represented the relevant variable group. Alternatively in Regression Analysis-2, regression model is formed using the answers to the "general evaluation questions" instead of using generated "representing variables" as explanatory variables (see Figure 3). Similar to row-mean variables of Regression Analysis-1, this time the answers to the general evaluation questions represent the relevant variable group. The results of Regression Analysis-2 are intended to validate the results of Regression Analysis-1 by using alternative explanatory variables.

The summary of the dataset that is used in Regression Analysis-2 is given in Table 10. Among these variables, MEAN_ITT_PER is considered as the dependent variable.

Table 10 Variables used in the Regression Analysis-2

Variable	*Definition*	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
ABS_KP_AVER	Knowledge Production	74	3.69	0.55	2.00	5.00
ABS_KF_AVER	Knowledge Flow within the Company	74	3.45	0.62	2.00	4.00
ABS_SIS_AVER	Knowledge Flow within the SIS	74	3.65	0.67	3.00	5.00
ITT_PREP_AVER	Preparations for the ITT Project	74	3.66	0.80	2.00	5.00
ITT_CON_AVER	Conducting the ITT Project	74	3.61	0.87	1.00	5.00
MEAN_ITT_PER*	Performance of the ITT Project	74	3.68	0.66	1.67	5.00

Note that as there was no general evaluation question in the questionnaire for the "Performance of the ITT Project", MEAN_ITT_PER is used as the representative variable for this variable group. Using the same dependent variable in both Regression Analysis-1 and Regression Analysis-2 provided a common ground for comparing the results.

In Regression Analysis-2; MEAN_ITT_PER is regressed on explanatory variables and the equation of the regression model is formed as follows.

$$MEAN\_ITT\_PER = \beta_0 + \beta_1 ABS\_KP\_AVER + \beta_2 ABS\_KF\_AVER + \beta_3 ABS\_SIS\_AVER + \beta_4 ITT\_PREP\_AVER + \beta_5 ITT\_CON\_AVER + e$$

The multicollinearity between the variables is examined through Pearson's correlation and the results are given in Table 11.

Table 11 Correlation table for variables (Regression Analysis-2)

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) ABS_KP_AVER	1.0000					
(2) ABS_KF_AVER	0.1712	1.0000				
(3) ABS_SIS_AVER	-0.0030	0.4787*	1.0000			
(4) ITT_PREP_AVER	-0.0242	0.0868	0.0055	1.0000		
(5) ITT_CON_AVER	-0.0864	0.2000	0.1593	0.8096*	1.0000	
(6) MEAN_ITT_PER	0.1682	0.1698	0.0974	0.7078*	0.6332*	1.0000

* Correlation is significant at 5%

The correlation matrix is similar to the matrix of Regression Analysis-1 (Table 8) with few exceptions. Again it seems that there is a significant correlation between ITT_PREP_AVER and ITT_CON_AVER. Similarly weak correlations are identified between ABS_KP_AVER & ABS_SIS_AVER, ABS_KF_AVER & ABS_SIS_AVER. However, this time no correlation is identified between ABS_KP_AVER & ABS_KF_AVER, which is different than the results of Regression Analysis-1. According to the correlation matrix, different regression models have been formed by separating related variables. The regression results for these models are given in Table 12.

Table 12 Regression results (Regression Analysis-2)

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
ABS_KP_AVER	0.232**	0.206*	0.270**	0.223**	0.270**
	(0.101)	(0.104)	(0.117)	(0.104)	(0.118)
ABS_KF_AVER	0.0278	0.0837	0.00100		
	(0.103)	(0.0949)	(0.0997)		
ABS_SIS_AVER	0.0528			0.0921	-0.00591
	(0.0912)			(0.0845)	(0.104)
ITT_PREP_AVER	0.466***	0.580***		0.586***	
	(0.120)	(0.0617)		(0.0597)	
ITT_CON_AVER	0.134		0.491***		0.492***
	(0.119)		(0.0752)		(0.0682)
Constant	0.353	0.511	0.915	0.381	0.935
	(0.608)	(0.561)	(0.565)	(0.581)	(0.617)
Observations	74	74	74	74	74
R-squared	0.555	0.541	0.451	0.544	0.451

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

The results of Regression Anaysis-2 indicate that, ABS_KP_AVER (Knowledge Production) and ITT_PREP_AVER (Preparations for the ITT Project) are found out to be significantly affecting the performance of ITT in all regression models they are included. This is a similar result with the result obtained in Regression Anaysis-1.

Similar to the results of Regression Anaysis-1, as a common feature of all regression models, significant relations have positive sign indicating a positive relation between the explanatory variable and the dependent variable.

For the regression models, Models 2 to Model 5, we are sure that there are no correlations between the explanatory variables. The results of these regression models indicate that one of the most statistically significant explanatory variables is ITT_PREP_AVER. This variable is also the one with the biggest constant. This result is also matching with the results of Regression Analysis-1.

Similar to the results of Regression Analysis-1, the second most statistically significant explanatory variable is found out to be ITT_CON_AVER (Conducting the ITT Project), again with a relatively big constant.

The results of the analysis indicate that there is a significant relation between ABS_KP_AVER (Knowledge Production) and the Performance of the ITT Projects. However, this explanatory variable is not as dominant as ITT_PREP_AVER and ITT_CON_AVER.

For a second time, in harmony with the results of Regression Analysis-1, it is found out that there is no statistically significant relation discovered between ABS_SIS_AVER (Knowledge Flow within the SIS) and the Performance of the ITT Projects.

5 CONCLUSION

5.1 Research Findings and Recommendations for Firm Level Strategies

The main goal of this research, designated as the first research question, is to discover whether there is a relation between firm level absorptive capacity and the performance indicators of the ITT project in aerospace industry. For this purpose a conceptualization is introduced, which provided an understanding on the pillars that support the firm level absorptive capacity. Accordingly, absorptive capacity concept is discussed within three groups; “Knowledge Production”, “Knowledge Flow within the Company and “Knowledge Flow within the Sectoral Innovation System”.

Additionally, variables affecting the success of international technology transfer other than firm level absorptive capacity are also examined to figure out the answer to the second research question. Such determinants are grouped under conceptualized variable groups namely, “Preparations for the ITT Project” and “Conducting the ITT Project”.

Success indicators of ITT projects are gathered under the variable group of “Performance of the ITT Project” and this group is used as the dependent variable in the regression models.

The results of the quantitative analysis indicated the significance of the relationship between the explanatory variable groups and the success of ITT projects. These results are discussed for each explanatory variable group separately in the following pages. Recommendations for firm level strategies to improve the identified weaknesses are also provided together with the discussions. These recommendations are inspired by the results of Step-3 of the research. Besides, the discussions are given as an answer to the relevant research question in such a way that;

- "Knowledge Production", "Knowledge Flow within the Company" and "Knowledge Flow within the Sectoral Innovation System" are discussed under Research Question-1,
- "Preparations for the ITT Project" and "Conducting the ITT Project" are discussed under Research Question-2.

<u>Research Question-1:</u> *Is there a relation between firm level absorptive capacity and the success of international technology transfer in aerospace projects?*

<u>Knowledge Production (KP):</u>

According to the results of quantitative analysis, both Regression Analysis-1 and Regression Analysis-2 indicate that "Knowledge Production" is a significant variable group affecting the Performance of the ITT Project.

Step-3 of this research provided the components that form this variable group, as given below.

- Setting academic goals for universities
- Hiring graduates of the top universities
- Access to world literature
- Culture of utilizing patent databases
- Firm level strategic plan and technology roadmap
- Intra-firm technology development projects
- Development of indigenous design and analysis tools

- Fringe benefits
- Emotional capability

Based on the results of quantitative analysis, one can state that the abovementioned variables directly affect the performance of an ITT project. This conclusion is also in line with the literature. The importance of cognitive abilities of a firm, workforce skills and investment on human capital are highlighted by many researchers like Ancori et al. (2000), Carlsson (2006), Dolfsma (2008), Omidvar (2013), Abramovitz (1986), Mowery and Oxley (1995). Many researchers like Foray (2004), Simon (1999), Brynjolfsson and Hitt (2000), Hikino and Amsden (1994), Scherrer (2005), Zahra and George (2002) discussed the improving effects of codification of knowledge, ICT investments, organizational skills and routines of a firm on its knowledge production capability. There are also many studies that focused on technological advance considering it as an evolutionary process. In this context, researchers like Dosi and Nelson (2010), Perez (2001), Bernard and Ravenhill (1995), Spender (1996) and Mathews (2004) highlighted the importance of strategic management, R&D strategies, systematic exploitation routines and planning of technology development projects.

Thanks to the questionnaire, it is possible to obtain firm specific evaluations for the abovementioned variables as summarized in Appendix C. Accordingly, weaknesses and strengths of the evaluated aerospace company in terms of “Knowledge Production” can be assessed. Thus, it can be stated that, the capacities of the evaluated aerospace company on “Hiring graduates of the top universities” and “Development of indigenous design and analysis tools” are strong. However, “Fringe benefits” and “Emotional capability” are found out to be the weaknesses.

It can be argued that, as the human resources are the major asset for the firms in the era of knowledge economies, success of the firms depends on the commitment of employees. Companies have to provide an appealing working environment with fringe benefits, fair wage policy and equal opportunities in order to encourage their employees to their highest potential. Furthermore, employees who can show their emotions and share their ideas in a way helping to create commitment and deep loyalty would have a significant effect on the development of new products, services and processes, or in other words on the innovativeness of the firm. For this purpose, it is important to level up members of the company to develop a shared vision, which can be obtained through systematic meetings with top management or through some other mechanisms ensuring to receive and evaluate suggestions, wishes and complaints generated by employees.

Knowledge Flow within the Company (KF):

The results of the quantitative analysis indicate that, the relation between "Knowledge Flow within the Company" and the Performance of ITT Project is ambiguous. According to Regression Analysis-1 and Regression Analysis-2, although some regression models indicated there is a relation, it is not statistically possible to label KF as a statistically significant variable.

Step-3 of this research provided the components that constitute KF variable group, as given below.

- Coordinating intra-firm knowledge creation activities
- Culture of codification within the company
- Culture of implementing systems engineering approach within the company
- Utilizing codified procedures and processes within the company
- Face-to-face intra-firm communication

Although the results of the analysis do not explicitly indicate that there is a relation between the abovementioned variables and the performance of an ITT project, there are numerous past research studies that suggested the improvement of these variables for capability building purpose. Romer (1986), Lall (1992), Malerba (1992), Forbes and Wield (2003), Bathelt et al. (2002) indicated the importance of endogenous forms of learning. Polanyi (1969), Dosi and Nelson (2010), Morone and Taylor (2010), Dolfsma (2008), Balconi et al. (2007), Ancori et al. (2000), Hey (2004), Mowery and Oxley (1995), Szulanski (1996) highlighted the significance of sharing of tacit knowledge, collective learning and shared vision. While Katz (1999) introduced the micro level economic forces-related to the learning strategy of each individual firm, Jansen et al. (2005) and Dutrénit (2004) focused on the mechanisms associated with coordination capabilities, participation in decision making, organizational capabilities.

According to Appendix C, weaknesses and strengths of the evaluated aerospace company in terms of "Knowledge Flow within the Company" are assessed. It is found out that the capacity of the evaluated aerospace company on "Culture of implementing systems engineering approach within the company" is strong. This capability is most probably developed as a result of strong expectations of the demand side. However, "Coordinating intra-firm knowledge creation activities" seems to be a significant weakness of the company in terms of "Knowledge Flow within the Company".

The ambiguous relation between KF and the Performance of ITT Project can be interpreted as a result of "need to know" approach, which is specific to aerospace and defense industry. Since this protective approach is common in aerospace industry and is used with the aim of preventing leakage of knowledge, it can be claimed that, most likely it is also hindering an explicit and obvious relation between KF and the Performance of ITT Project. The weakness of the capability of "Coordinating intra-firm knowledge creation activities" supports this assessment.

In general, the proposed solution to avoid the problems that may occur as a result of "need to know" approach is to establish dedicated organizational structures within the company. Such structures should have functional roles to coordinate the technology management efforts of whole company and to assure the storage of organizational memory with a holistic way instead of guarding a specific project's need.

Additionally, as it was previously stated, in order to provide a suitable environment for tacit knowledge to flow, much more than written forms of knowledge like reports, procedures and process definitions etc. is needed. Besides, it can be argued that "over-embeddedness" may also occur at firm level as a result of repeated interactions between individuals. In order to facilitate effective transfer of tacit knowledge and to prevent over-embeddedness, establishment of environments that provide face-to-face interaction between individuals is essential. The abovementioned organizational structures should certainly use the benefits of face-to-face interaction as coordination tools.

Knowledge Flow within the Sectoral Innovation System (SIS):

According to the results of the quantitative analysis, both Regression Analysis-1 and Regression Analysis-2 indicate that there is no statistically significant relation between "Knowledge Flow within the Sectoral Innovation System" and the Performance of ITT Projects. This is a surprising result as a relation would be expected according to the existing literature.

As described before, one of the most important advantages of having external relations is to have a chance to benefit from the externalities. Romer (1986), Bathelt et al. (2002), Chaudhuri and Tabrizi, (1999), Christensen (1997), Foray (2004), Morone and Taylor (2010) and Ernst and Kim (2002) highlighted the importance of externalities and knowledge spillovers for a latecomer firm.

Many researchers studied the merits and advantages of a mature Sectoral Innovation System. Shariff (2006), Metcalfe (1997), Kline and Rosenberg (1986), Carlsson (2006), Malerba and Mani (2009), Bergek et al. (2005), Vertesy and Szirmai (2010), Vermeulen and Barkema (2001) are only examples of such researchers who emphasized the importance of inter-organizational relationships. Moreover, Ancori et al. (2000) and Lane and Lubatkin (1998) underlined the significance of common classification and common language. Porter (1998), Bathelt et al. (2002), Özman (2009) and Granovetter (1983) discussed the terminology of value chain and the advantages of being a part of a cluster or network for a company. On the contrary, some researchers like Scherrer (2005) indicated the possible threats of being path dependent and Granovetter (1983) introduced the economic sociology term of "embeddedness". From this point of view, it is difficult to gather "new" knowledge from the ones very close. Distant connections may be more important considering the "new" type of knowledge.

So, according to the relevant literature it can be stated that inter-organizational relationships are important to have a continuous pace in technological development, under the condition that the level of embeddedness is taken care of.

Step-3 of this research provided the components that form this variable group, as given below.

- Interactions with national players
- Solid interactions with universities
- Well-organized training to reach external knowledge
- Improving capabilities of sub-contractors
- Interactions with players outside national borders

According to Appendix C, weaknesses and strengths of the evaluated aerospace company in terms of “Knowledge Flow within the Sectoral Innovation System” are assessed. It is found out that the capacity of the evaluated aerospace company on “Solid interactions with universities” and “Interactions with national players” are strong. However, “Improving capabilities of sub-contractors” and “Well-organized training to reach external knowledge” are seem to be a significant weakness of the company in terms of “Knowledge Flow within the Sectoral Innovation System”. Moreover, capability regarding “Interactions with players outside national borders” seems to be undeveloped. As we consider high technology areas like aerospace industry with highly sophisticated products, relations with external players outside the national borders become much more important. Therefore, it is necessary to evaluate the maturity of innovation systems by considering the relations beyond the national borders.

Consequently, although the results of the quantitative analysis indicate that there is no statistically significant relation between “Knowledge Flow within the Sectoral Innovation System” and the Performance of ITT Projects, it is better to interpret these results in such a way that, the relevant Sectoral Innovation System is not mature enough in Turkey to utilize. In other words, the Sectoral Innovation System in Turkey does not seem to be working properly and effectively.

In the following pages, recommendations for firm level strategies to improve the identified weaknesses regarding the “Knowledge Flow within the Sectoral Innovation System” are given. Moreover, policy recommendations regarding this issue is also discussed and provided.

For an aerospace company, which acts as the main contractor in aerospace projects, it is vital to have broad international and local supply networks. Having a strong and reliable network of suppliers is very important for succeeding in firms' commitments to customers. Therefore, the subcontractors are supposed to react and perform tasks with the required high standards. Supplier selection and evaluation procedures have to provide the qualification of the vendors as reliable partners. In long-term the repeated cooperation develops the capabilities of sub-contractors and strengthens the sectoral innovation system. This serves to both national and company level goals in aerospace industry. For an aerospace company in a developing country, most of the national suppliers to the main contractor are small and mid-sized enterprises (SME). Main contractor is responsible for developing the capabilities of the sub-contractors, especially for their initial attempts on aerospace products, and hence they have to provide planned spillovers to their subcontractors. This can be through on the job training, providing technical support or sharing infrastructure.

Furthermore, it is crucial for an aerospace company that the vision of the company has to be aligned with the national goals in order to benefit from state investments and incentives effectively. Companies need to harmonize their long-term master plans and company level technology roadmaps with the national vision. Similarly, it is important to make the subcontractors aware of strategic goals of the main contractor company as well as about the national goals. By this way vendors can make appropriate investment scheduling for medium-term to long-term.

As we consider the weakness related to the capability on "Well-organized training to reach external knowledge", it is necessary to recall the importance of human resources. Continuous development of human assets can be possible through training programs and promoting personal progress within the scope of carrier planning. In order to systematically plan and utilize the results of training programs, it is a common approach used by aerospace companies to have dedicated training departments within their organizational structure. This department has to continuously search for external sources of knowledge, based on the requirements of different departments within the company and in a way that meets the strategic goals of the company.

Moreover, well-organized training to reach external relevant knowledge will provide the necessary prior knowledge related to equipment before starting an ITT project. By this way, transferee will be familiar with relevant technology and it will be possible to take precautions at the very early steps to reach utmost level of self-dependence for the period after the ITT project. These measures have to target maintainability and flexible logistic support apart from the home party. Even the host party may choose to "make" instead of to "buy" for future self-dependence.

In order to improve the capability regarding the "Interactions with players outside national borders", as a first step it is necessary to establish the pathways for knowledge to flow. Attending international events, such as conferences and exhibitions, is one of the most effective ways that would serve that purpose as they provide the chance to establish new contacts. International conferences are places for latecomers to witness and extract the experiences of leaders and generally may inspire followers to reach untried solutions. It can be possible to figure out the matured results of tests and analysis works, which are only on the very early stages in the developing country.

Another way of building such international communication channels is to take part in international technology development programs. European Union Framework Programs (FPs) provide this opportunity for latecomers. FPs are the main programs of the European Union by which multinational research and technology development projects are supported. The main targets of the FPs are; strengthening the scientific and technological base of Europe, supporting the industrial competition and encouraging the collaboration between the member states and associated countries. Even a small role in an international consortium under the scope of FPs, provides lots of benefits to latecomer companies in terms of accessing varying forms of knowledge.

In Turkey, in order to encourage national aerospace industry to take part in FPs, information days, coordination and information meetings have been organized systematically by the state. However, firms are supposed to make an effort to take part in FPs. For this purpose dedicated departments in the organization have to systematically search for possible cooperation areas in line with company strategies and closely follow the opportunities in FPs.

Moreover, such departments have to work jointly with the business development departments in order to increase the proportion of external knowledge flow from international collaborators. Offset regime applied by Undersecretariat for Defense Industries (SSM) forces foreign investors to make technological collaboration with Turkish defence industry and has to be utilized in line with this purpose.

Research Question-2:

Are there any determinants affecting the success of international technology transfer other than firm level absorptive capacity?

Preparations for the ITT Project:

According to the results of the quantitative, both Regression Analysis-1 and Regression Analysis-2 indicate that, "Preparations for the ITT Project" is the most statistically significant variable group affecting the Performance of the ITT Projects.

According to the achievements of Step-3 of this research, the components that form this variable group, were found out to be as given below.

- Strong political will
- ITT fills a gap in the technology roadmap
- Significant strategic benefits of the ITT
- Selection Process of Home Company
- Transferred technology is not practically obsolete
- Motivation of the Home Party
- Response of developed countries and big companies
- Well-prepared contractual documents

Based on the results of the quantitative analysis, it can be stated that the abovementioned variables directly affect the performance of an ITT project. This conclusion is an expected outcome according to the relevant literature. There are many researchers who had emphasized the importance of the policy environment. For example, Forbes and Wield (2003), Kim and Lee (2009), Gerschenkron (1962), Akamatsu (1962) and Korhonen (1994) indicated strategic sectors and role of governments and well-coordinated government intervention. Forbes and Wield (2003) indicated the importance of having a technological roadmap while Hikino and Amsden (1994) and Dutrénit (2004) referred to incremental improvement as well as managerial and organizational skills. Ramanathan (1999), Öner and Kaygusuz (2007) and Reddy and Zhao (1993) focused on Pre-ITT Project period, partner selection, technological gap assessment and importance of negotiation. Moreover, many researchers like Baranson (1978), Krugman (1979), Mansfield and Romeo (1980), McCulloch and Yellen (1982) and Wilking (1974) studied ITT from the perspective of the home party.

According to Appendix C, weaknesses and strengths of the evaluated ITT project in terms of "Preparations for the ITT Project" are evaluated. It is found out that "Transferred technology is not practically obsolete" and "Selection Process of Home Company" are evaluated as strong features. This indicates that the process of selection of the home party is evaluated as a developed capability, which is mainly under the control and guidance of Undersecretariat for Defense Industries (SSM).

On the other hand, the variable related to the national technology roadmap, namely "ITT fills a gap in the technology roadmap" is evaluated as a weak feature of this variable group. It was previously stated that, ITT is an important tool for developing countries to be used as technology capability gap filler. However, achieving the aimed technology through an ITT project may not be enough for long-term development if there is not an accurate and well-designed technology roadmap. Researchers like Forbes and Wield (2003), Hikino and Amsden (1994), Dutrénit (2004) highlighted the importance of technological roadmap and incremental improvement.

The aim of technology transfer is to reach a certain level of capability in the relevant field. The type of technology transfer project can differ in terms of the final goal of intended technological capability. A technology roadmap, on the other hand, is a plan that matches technological goals or targeted technological capabilities, with specific technology solutions to reach these goals. Having a firm level technology roadmap would provide the target of the ITT project to be set in such a way that serves to a bigger picture and certainly will improve the scope of contractual expectations.

Performing intra-firm technology development projects in line with the firm level technology roadmap will be a rewarding approach. Even the modest attempts for developing in-house capabilities will offer an awareness and openness to the related technology. However, sustainability of such efforts (in terms of management and enabling funding mechanisms) has to be prioritized. Additionally, continuous development of indigenous design and analysis tools as well as encouraging and appreciating the development of indigenous design and analysis tools within the company would provide an improvement in the scope of the ITT project. Dedicated specialized organizational structures and mechanisms would help to improve the capabilities of the in-house tools.

Actively taking part in events that paves the way for interactions with state organizations, universities, research centers and rivals such as national technology platforms as well as project planning, feasibility studies and proposal preparation activities in a continuous manner would enable the company to reach valuable knowledge generated nationally. Additionally, such relations within the national boundaries would certainly help reaching a common mind on technical expectations that are going to be indicated in the ITT project's contractual documents. In other words, this would provide a national level technology assessment to define the technological gaps at national level. Moreover, this would probably help to accelerate the process of persuasion of decision-makers and fund suppliers.

Abovementioned efforts would help the company to make a reliable technology assessment, both at the firm level and national level. Consequently, it would be possible for the company to define the technological gaps within the technology roadmap and plan the ITT project accordingly, in such a way that ITT project fills a technological gap.

According to Appendix C, another weakness of the evaluated ITT projects appears to be in the subject of "Response of developed countries and big companies". As it was previously mentioned, the intentional international cooperation in the form of technology transfer may bother developed companies and rivals. This may lead to obstacles to emerge preventing the realization of the project. From the perspective of a developing country, international lobbying (at the level of state and companies) in order to convince developed part of the world is of vital importance.

In the previous pages, recommendations for firm level strategies to improve the identified weaknesses regarding the "Preparations for the ITT Project" are given. Moreover, policy recommendations regarding this issue is also discussed and provided in the following pages.

<u>Conducting the ITT Project:</u>

In this research a new metric to quantify the "Sophistication Level of ITT Project" is introduced. According to this approach, technical support provided by the transferor party varies according to "Functional Capability" and "Level of Product". The ITT projects evaluated within this research are categorized according to this new approach. When we consider ITT projects in aerospace industry, instead of US-originated technology readiness levels (TRL), this two dimensional technological maturity categorization is used in order to be more distinctive. TRL metric, is especially designed to measure the maturity level throughout the development process. But when it is applied to technology transfer projects, it is not as distinctive as the new metric introduced. According to TRL approach, a technology is developed step by step and the targeted maturity level requires the accomplishment of the previous levels. In contrast, in an ITT project, targeted level of technological maturity is not achieved step by step. It is similar to targeting to learn how to write a book without previously learning the alphabet. Hence, for an ITT Project, instead of utilizing the TRL scale, a new metric which is based on "Sophistication Level of ITT Project" has been introduced.

The number of ITT projects that were evaluated within the sample according to their calculated Level of Sophistication is given in Figure 4. It can be seen that the diversity within the sample is quite high. The sample includes 6 of 10 predefined sophistication indexes. It can be interpreted that, the proportions shown are in compliance with the nature of ITT projects in aerospace industry and this can also be presented as a reason for not having any ITT projects with Level-9 and Level-10. This consequence is based on the difficulties of configuring and initiating such complicated international cooperation projects, which cover almost all types "functional capabilities" and "level of products".

The biggest portions of evaluated ITT projects belong to Level-6 and Level-7. As presented in Appendix D, these levels of sophistication indicate daring attempts to obtain capabilities through ITT projects. The evaluated ITT projects within the sample dominantly involves "to manufacture", "to test", "to assembly and integrate" type of functional capabilities for "sub-system" and "system" level of products.

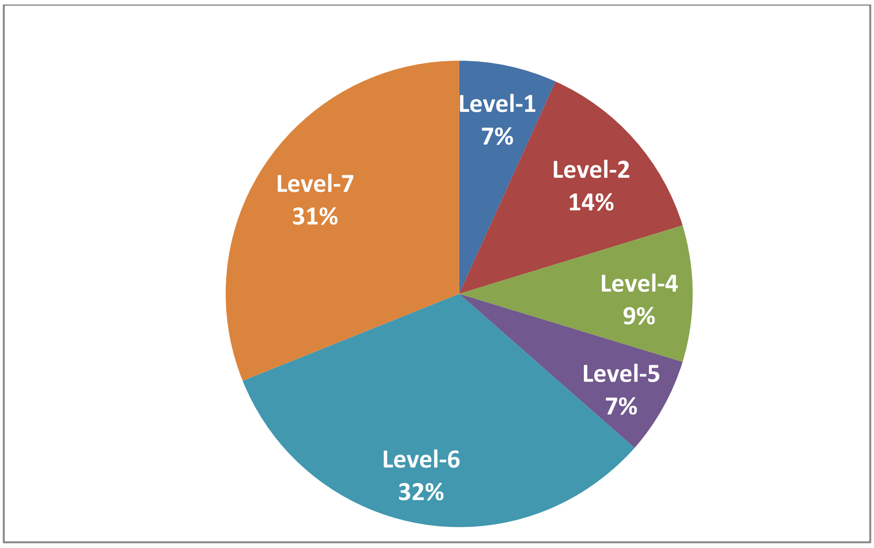

Figure 4 Proportion of ITT projects within the sample according to the Level of Sophistication

According to the results of the quantitative analysis, both Regression Analysis-1 and Regression Analysis-2 indicate that, "Conducting the ITT Project" is a statistically significant variable group affecting the Performance of the ITT Projects. This is an expected result as there is a strong correlation between "Conducting the ITT Project" and "Preparations for the ITT Project" variable groups and the latter is found out to be the variable group that affects the Performance of ITT Project most significantly.

Step-3 of this research provided the components that form this variable group, as given below.

- Benefits of “design phase”
- Benefits of “equipment installation and commissioning phase”
- Benefits of “ground development tests phase”
- Benefits of “manufacturing phase”
- Mechanisms for effective absorption
- Implementing systems engineering approach by Home Company
- Various sources for raw materials
- Benefits of the “equipments” provided
- Benefits of the “in-house softwares” provided
- Benefits of the “training” provided
- Managing the language constraints

The results of the quantitative analysis results indicate that the abovementioned variables directly affect the performance of an ITT project.

According to Appendix C, none of these variables is distinguished in terms of its high level of maturity for the evaluated ITT project. However, the variable indicating “Various sources for raw materials” is apparently evaluated as the weakest variable of all variables. This result is directly related to the nature of aerospace and defense projects. As it was introduced before, there are international regulations like Missile Technology Control Regime (MTCR), which can act as a barrier to internationalization. Such regulations can make it very difficult to diversify the source of supply for some specific materials and may force the host party to rely upon some limited sources of supply. Therefore, it is very important to map out the ITT projects to target a flexible design in such a way that would prevent supply related shortcomings like the ones mentioned. Sometimes such an approach can only be possible at the cost of performance degradation.

Alternatively, a better approach would be to figure out the critical materials and implement independent technology development projects in order to develop such materials indigenously. However, this would require a well-planned technology roadmap. Moreover, even it is possible to develop and establish the production infrastructure for pilot production of such high-technology materials, when the scale production is considered, it is generally beyond the means of companies and has to be handled by the state. Policy recommendations regarding this issue are given in the following pages. Recommendations for firm level strategies to improve the identified weaknesses within the explanatory variable groups are summarized in Table 13.

Table 13 Summary of recommended firm level strategies to improve identified weaknesses

Weakness within the Variable Group	**Brief Explanation for Recommended Firm Level Strategies**
Knowledge Production (KP):	
• Fringe benefits	• Appealing working environment
• Emotional capability	• Shared vision, systematic meetings
Knowledge Flow within the Company (KF):	
• Coordinating intra-firm knowledge creation activities	• Preventing the unfavorable effects of "need to know" approach through dedicated organizational structures
Knowledge Flow within the Sectoral Innovation System (SIS):	
• Improving capabilities of sub-contractors	• Repeated cooperation, planned spillovers to the subcontractors (through on the job training, providing technical support, sharing infrastructure), making the subcontractors aware of the strategic goals
• Well-organized training to reach external knowledge	• Continuous development of human assets, dedicated training departments
• Interactions with players outside national borders	• Attending international events (such as conferences and exhibitions), taking part in international technology development programs, dedicated departments that follow closely the opportunities in European Union Framework Programs, making use of the offset regime applied by SSM

Table 13 Summary of recommended firm level strategies to improve identified weaknesses (Cont'd)

Weakness within the Variable Group	**Brief Explanation for Recommended Firm Level Strategies**
Preparations for the ITT Project (PREP):	
• ITT fills a gap in the technology roadmap	• Having a firm level technology roadmap, performing intra-firm technology development projects, continuous development of indigenous design and analysis tools, reliable technology assessment both at the firm level and national level, defining technological gaps
• Response of developed countries and big companies	• International lobbying
Conducting the ITT Project (CON):	
• Various sources for raw materials	• Mapping out the ITT projects targeting a flexible design, conducting technology development projects for developing high-technology materials

As we recall the research questions and summarize the research findings given in the previous pages, we can briefly answer the research questions as given below;

- Brief Answer to Research Question-1: There is a relation between firm level absorptive capacity and the success of international technology transfer in aerospace projects. However, discovered relation is obvious only for "Knowledge Production" component of firm level absorptive capacity. The relation between "Knowledge Flow within the Company" and the Performance of ITT Project is ambiguous. Furthermore, there is no statistically significant relation observed between "Knowledge Flow within the Sectoral Innovation System" and the Performance of ITT Projects.

- Brief Answer to Research Question-2: There are other determinants affecting the success of international technology transfer other than firm level absorptive capacity. Such determinants are grouped under conceptualized variable groups "Preparations for the ITT Project" and "Conducting the ITT Project" and it is observed that both groups have significant effects on the success of ITT projects. This result indicates that, standalone efforts by the company for improving firm level absorptive capacity are not enough for the success of ITT projects.

The research findings indicate that there is an opportunity to exploit the conceptualization to make estimations for the future success of international technology transfer projects based on the maturity of firm level absorptive capacity. The evaluation of current situation of the company especially in terms of "Knowledge Production" would offer this opportunity. Moreover, the evaluations of the variables under the variable group of "Preparations for the ITT Project" will enhance the results of such estimation. In other words, the conceptualization and evaluation method introduced in this research make it possible to predict the possibility of success of an ITT project in advance.

5.2 Concluding Remarks and Policy Implications

Previously, research findings were provided together with suggestions on firm level strategies, which are supposed to improve the identified weaknesses. It was concluded that standalone efforts by the company for improving firm level absorptive capacity are not enough for the success of ITT projects. In other words, policy tools are required to be suggested to improve the possibility of success of ITT projects.

Research Question-3:

What kind of measures can be taken to increase the possibility of success of international technology transfer projects?

Policy recommendations are discussed based on the results of the research and as an answer to the relevant research question as follows:

- Promoting indigenous development of technologies: Analysis results indicate that, "Knowledge Production" component of firm level absorptive capacity is significantly affecting the success of an ITT project. Therefore, policy measures to enhance this component are suggested.

- Promoting knowledge flow within the sectoral innovation system: Based on the findings of this research, there is no statistically significant relation observed between "Knowledge Flow within the Sectoral Innovation System" and the Performance of ITT Projects. This is interpreted as the relevant Sectoral Innovation System is not mature enough in Turkey to utilize and SIS does not seem to be working properly and effectively. Policy measures are suggested to improve the maturity and functionality of the relevant SIS in Turkey.
- Ensuring a high level of readiness prior to starting an ITT project: The analysis results indicate that "Preparations for the ITT Project" has statistically significant effects on the success of ITT projects. In addition, there is a strong correlation between "Preparations for the ITT Project" and "Conducting the ITT Project", which also has a statistically significant effect on the performance of ITT project. As a result, policy measures are suggested to enhance the maturity of preparations prior to an ITT project.

5.2.1 Promoting Indigenous Development of Technologies

Innovating capacity is one of the most important assets that a company should have for sustainable long-term growth. In other respects, obtained analysis results indicate that aerospace industry needs to be nourished by the innovation system in order to develop its innovative capacity.

OECD (2011) highlights that in order to enhance the innovation environment proposed policies shall aim targets such as; the quality and adaptability of the workforce; the capacity to attract and retain talent; development of high value-added production and services; entrepreneur and creative population; the demand for new products and services; the quality of regional interactions and global connections.

The policy instruments introduced by OECD (2011) to pursue abovementioned targets are as follows:

- promoting ways of talent attraction and retention,
- establishment of science and technology parks,

- funding for research infrastructure,
- encouraging the formation of clusters, networks, competitiveness poles and competence centers,
- promoting innovation advisory services for existing SMEs to assist them for innovation,
- supporting innovative start-ups.

Policy tools proposed by OECD (2011) can be implemented to promote innovation in aerospace industry in Turkey, but only up to a certain extent. Country dynamics in Turkey and industry specific conditions require more attentive and dedicated measures to be taken. Therefore, under this policy proposal, five policy measures are produced.

Policy Measure-1: Renovating university curriculum according to the needs of aerospace industry

Generally, in aerospace companies in Turkey, majority of the employees are graduated from national universities with high reputation. Although most of the relevant undergraduate programs are covering a huge variety of related technical topics, the need of the aerospace industry is focused on some specific issues that are not directly covered in undergraduate programs. If the needs of aerospace industry are explicitly declared, it may show a path for universities for further studies. For this purpose aerospace companies have to set academic goals for graduate programs and support the students enrolled in these programs. Besides, having solid interactions with national universities in aerospace fields will enable building the paths for bilateral knowledge flow. These relations can be established through performing common projects, knowledge & technology transfer offices, researchers training programs, lectures provided by company experts in universities, etc. Moreover, research centers within universities can be established in collaboration with industry to reinforce knowledge flow. Consequently, it is suggested that the state may encourage aerospace companies and universities to collaborate in continuous renovation of university curriculum by introducing relevant technical elective courses according to the needs of aerospace industry.

Policy Measure-2: Establishment of a central authority responsible for technology management with broader authorization

In developed countries, the mechanisms for technology management are quite sophisticated in terms of planning the roadmap, technology readiness assessment and linking developed technologies and system-level development projects. For example, in the US, Department of Defense has adopted evolutionary acquisition as a strategy to deliver an operational capability over several increments, where each increment is dependent on a sufficiently defined technological maturity level. Each increment is defined by a set of objectives, entrance and exit criteria. This extracts the R&D efforts out of system-level development projects and specific milestones are supposed to be accomplished to continue incremental development. What makes this approach sophisticated is that, a comprehensive way of managing stakeholders within the innovation system is required, which can only be possible with appropriate organizational structure, sufficient technological knowledge as well as suitable legislation and funding mechanisms. Therefore, state organizations responsible for managing this process have to be well equipped with knowledge and high quality employees. This comes with the fact that, the human capital is not only important for the industry but also for the state organizations for overall success.

In Turkey, there is an attempt to pursue such an incremental approach and there are dedicated structures within Ministry of Defense and Ministry of Transport, Maritime Affairs and Communications. However, technology assessment methodologies have to be reinforced in line with the system-level requirements. Establishment of a central authority responsible for technology management with broader authorization through appropriate legislation and precautions for improving its human capital, might lead to more fruitful and beneficial results. Improvement of demand side will certainly improve the efficiency of innovation system. This centralized authority might also be responsible for harmonizing outputs of projects conducted by different national players and managing international relations in the relevant fields.

Policy Measure-3: Formulating flexible legislation for funding R&D projects that can be adjusted according to the scope and type of the projects

In Turkey, for system-level development type of aerospace projects, typically the customer is the state. In general, R&D is a desired and esteemed portion of such projects and supposed to be performed by national players in order to increase the local content of the final product. However, in these projects, research aspect within the R&D becomes a contractual obligation to be fulfilled within the defined period of the project. As it was indicated previously, it is not possible to innovate under performance obligations.

As the projects may vary according to their sophistication in terms of functionality and end product, the legislation for supply also has to be flexible, as one size does not fit all. This flexibility has to ensure and ease the state organization that is responsible for supply to freely search for administrative solutions instead of forcing industry to comply, which might end up with lock-in. Similarly, repealing penalties for R&D projects or increasing the scope of tax exemptions will encourage industry to take part in challenging projects.

Policy Measure-4: Formulating legislation to force aerospace companies in creating more innovative environments

As the aerospace industry of a developing country matures and consequently sets more challenging goals to take part in the league of superior players, the need for new approaches and tools arises for sustainability and continuous growth other than state support. Although state support is indispensable and the state is responsible for improving the innovative environment, companies must take innovative steps for further development.

In developed countries, the active participation of private sector is an indicator of forthcoming strong leap in the development of the industry and relevant market as it was in civil aerospace industry in the first half of 20^{th} century. Today there is a similar case in the US space industry. The role of NASA has been changed in recent years and in line with the US space policy, many private companies started to take significant responsibilities. For instance, SpaceX as a private company obtained the capability of launching satellites, which is a very technically sophisticated part of space business. Obviously, while reaching this admirable success, the role of state policies and matured innovation system are undeniable.

It was previously discussed that the goal of policy must be to encourage firms to build technical capability (Forbes and Wield, 2003). This statement can be elaborated and rephrased as the proposed policy measure- *formulating legislation to force aerospace companies in creating more innovative environments*. Such legislation may contain below mentioned approaches;

- supporting companies in funding graduate education abroad,
- encouraging firms to fund a portion of working time, which is not directly related to an ongoing project but instead dedicated to creative undefined activities.

Motivating employees, providing benefits to attract human capital and creating innovative environments within the company are company level responsibilities. However, the state may intervene and encourage these attempts by creating awareness. Legislation can be promoted to stimulate companies to create more innovative environments. For instance, the state may invent legislation to force companies to use a portion of their profit in funding abovementioned activities.

Additionally, mobility of employees is a source for diversity and through fruitful combination of different approaches, continuous development might be possible. However, companies may be reluctant to encourage mobility. State may design and implement regulations encouraging controlled mobility between stakeholders in order to foster innovation.

In addition, rewarding mechanisms can be implemented within the abovementioned legislation in such a way that encourages aerospace companies;

- to set academic goals for graduate programs and supporting the students enrolled in these programs,

- to provide facility of access to world literature via highly equipped libraries or membership to digital libraries,
- to elaborate technology roadmaps,
- to initiate intra-firm technology development projects funded by own resources,
- to develop indigenous design and analysis tools,
- to implement systems engineering approach in compliance with international standards.

Policy Measure-5: Defining areas of interests with well-defined boundaries for big aerospace companies

Although there are a large number of companies performing in the aerospace industry in Turkey, the number of bigger companies is limited. Encouraging competition may not be a correct policy measure for aerospace industry of a developing country, as it may hinder improvement. Instead, especially for the big companies, defining areas of interests with well-defined boundaries may help these companies to thrive in cooperation and develop and may give them chance to be global players.

5.2.2 Promoting Knowledge Flow within the Sectoral Innovation System

Regression analysis results show that, there is no statistically significant relation observed between "Knowledge Flow within the Sectoral Innovation System" and the Performance of ITT Projects. This is interpreted as the relevant Sectoral Innovation System is not mature enough in Turkey to utilize and SIS does not seem to be working properly and effectively. In order to improve the maturity and functionality of the relevant SIS in Turkey, three policy measures are proposed.

Policy Measure-1: Organizing national technology platforms in aerospace fields in a continuous manner

For an aerospace company in a developing country, it is crucial that the vision of the company has to be aligned with the national goals in order to effectively benefit from state investments and incentives. Companies need to harmonize their long-term master plans and company level technology roadmaps with the national vision. Additionally, interactions with other national sources of knowledge like knowledge institutes and universities enable companies to reach valuable knowledge generated nationally.

Companies need to take part in events that paves the way for interactions with state organizations, universities, research centers and rivals in a continuous manner. Therefore, a policy measure is suggested to foster such an environment through state intervention. Organizing national technology platforms in aerospace fields in a continuous manner with the attendance of state organizations, universities and research centers as well as encouraging aerospace companies to actively take part in such events would help promoting the knowledge flow within the Sectoral Innovation System.

Policy Measure-2: Establishing and promoting channels through which aerospace companies and national universities can develop solid interactions

As it was previously mentioned, there are already existing channels in Turkey in order to stimulate establishment of channels through which industry and national universities can develop interactions. These channels can be summarized as university - industry cooperation programs; knowledge transfer offices; technology transfer offices; researchers training programs for the industry.

In order to promote knowledge flow within the related Sectoral Innovation System, the abovementioned channels of interaction have to be handled in accordance with the needs of aerospace industry. A policy measure in order to reinforce the functionality of the existing channels can be formulated by implementing rewarding mechanisms. Through these channels the activity of both universities and aerospace companies can be annually measured by specific indicators which is in turn evaluated by state organizations and systematically rewarded.

Policy Measure-3: Encouraging aerospace companies for effective knowledge flow

This research conceptualized the firm level absorptive capacity in three branches one of which was related to knowledge flow within the sectoral innovation system. Research findings indicated the related weaknesses and in order to improve them firm level strategies were recommended previously. In addition to firm level efforts, this policy measure is suggested to improve the effectiveness of knowledge flow within the sectoral innovation system. Rewarding mechanisms or contractual requirements, like the *offset regime* implemented by SSM, can be used within this policy measure in order to encourage aerospace companies;

- to provide training, technical support or infrastructure to sub-contractors,
- to attend international events,
- to take part in international technology development projects (like European Union Framework Programs).

State policies should not be locked-in only around existing main players, but should rather focus on the diffusion of the innovation culture in the sector through other players. Nowadays, the development and upgrading of clusters, which can be defined as dense network between economic agents, is an important agenda for governments, companies and other institutions. This subject is studied by many researchers like Porter (1998), Bathelt et al. (2002) and Özman (2009).

The most important notion in clusters is "value chain" and it is important to keep in mind that supply chain is not sufficient. Value chain is developed as a result of repeated interactions. Clusters provide the suitable environment for successful spillover, which is an externality of knowledge transfer from external sources received via pipelines. It would be wise to implement a policy considering the possibilities of stimulating pipeline development rather than to make extensive efforts in generating clusters. Besides, as clusters cannot be created, the successful policy regarding clusters might be focused on governance of the clusters aiming the establishment of pipelines which provide access to external knowledge.

5.2.3 Ensuring a High Level of Readiness Prior to Starting an ITT Project

International technology transfer is an alternative tool in obtaining a certain level of technological capability. However, in order to institute the scope of an ITT project, transferee of the technology has to be aware of what should be expected from the transferor. "Knowing what to request" improves the quality and scope of the prepared contractual ITT project documents and this requires an existing technological maturity in the relevant technology area.

Previously this requirement was discussed from the perspective of firm level absorptive capacity and in order to improve related weaknesses, firm level strategies were recommended previously. However, research findings show that there are determinants other than firm level absorptive capacity affecting the efficient utilization of an ITT project. Consequently, for the purpose of improving the readiness prior to starting an ITT project, two policy measures are proposed.

Policy Measure-1: Setting the area of research as a technological priority area as an indication of strong political will

The importance of having strong political will in the relevant technological area was previously described. This policy measure is proposed under the condition of having strong political will and the aim of the measure is to make use of this will through setting the area of research as a technological priority area.

In addition to other numerous positive effects, determination of higher state authorities also encourages different lower-level state organizations to conduct focused events through which the national stakeholders find the chance to interact in regular bases. Continuous monitoring of the outputs of these interactions will definitely increase the boosting effect of such interactions.

As we consider this topic from the perspective of reaching a strong and solid ITT project contract, having strong political will is expected to ensure major contributions to the scope and structure of the contract. Especially in ITT projects with high level of sophistication, government to government relations in various subjects (probably other than the field of ITT project) might enhance the negotiation process to progress on behalf of the host party. Government and related state organizations are supposed to use diplomatic channels, economic relations and other tools to enhance the scope of contract. This would also help to balance between the selection process of the home company, precautions to increase the motivation of the home party and to make provisions for possible responses of developed countries and big global companies.

Policy Measure-2: Establishing a national technology road map with explicitly defined technological steps, relations between sub-technologies and technological gaps

In order to configure the ITT project in such a way that it fills a gap in the national technology roadmap and it provides significant strategic benefits, the state is supposed to coordinate national actors of knowledge production in order to explicitly predefine technological steps and relations between sub-technologies. Consequently, ITT project has to be constructed in harmony with the national technology roadmaps. This attentive way of planning approach enables to have rigid and meaningful expectations to be included in the contractual documents as expectations from the ITT project. In order to succeed, continuous and repeated interactions between the actors have to be conducted through technology panels, monitoring of the stakeholders, brainstorming in think tank groups, etc. under the supervision of state organizations.

Firm level advances such as "having firm level strategic plan and technology roadmap"; in conjunction with this roadmap, continuously performing intra-firm technology development projects and continuous development of indigenous design and analysis tools will provide valuable information for decision makers. Firm level knowledge generated, as long as effectively coordinated with other national stakeholders through repetitive interactions, will definitely help ideas to be embraced by state organizations, which will incrementally develop into strong political will.

Another point regarding this proposed policy measure is that it would also enable the state to coordinate future actions that are beyond the means and influence area of aerospace companies. For instance, it was previously stated that for high-technology materials aerospace companies can develop and establish the production infrastructure for pilot production for most cases. However, generally the investment related to scale production of such materials has to be coordinated at the national level considering the needs of national industries other than aerospace industry.

A summary of policy recommendations and policy measures / tools, which are designated with the aim to increase the Performance of ITT Projects, are given in Table 14.

Table 14 Summary of policy recommendations

Policy Recommendation	Policy Measures / Tools
Promoting Indigenous Development of Technologies	Renovating university curriculum according to the needs of aerospace industry
	Establishment of a central authority responsible for technology management with broader authorization
	Formulating flexible legislation for funding R&D projects that can be adjusted according to the scope and type of the projects
	Formulating legislation to force aerospace companies in creating more innovative environments
	Defining areas of interests with well-defined boundaries for big aerospace companies (*instead of encouraging competition*)
Promoting Knowledge Flow within the Sectoral Innovation System	Organizing national technology platforms in aerospace fields in a continuous manner
	Establishing and promoting channels through which aerospace companies and national universities can develop solid interactions
	Encouraging aerospace companies for effective knowledge flow
Ensuring a High Level of Readiness Prior to Starting an ITT Project	Setting the area of research as a technological priority area as an indication of strong political will
	Establishing a national technology road map with explicitly defined technological steps, relations between sub-technologies and technological gaps

Forbes and Wield (2003) stated that, for technology-followers the future is already shaped and there is less uncertainty. According to them, a technology-follower is not concerned with the generation of new technology. Although, this argument may be rational for many industries, industries like aerospace industries are well beyond this generalization and continuous innovation is vital for the companies in developing regions.

There are many differences between developed and developing countries in terms of technology development environment. For instance, in the case of Turkey, high-educated diversified labor pool is not available as it is in a developed country, or structure of market is totally different regarding economic and cultural aspects. Therefore, it is not possible to imitate the same model for Turkey, which worked for developed countries. Instead of using the existing terminologies, new and country specific terms have to be introduced for successful interventions.

In order to respond to the last research question, suggestions on firm level strategies and national level policies are provided in the previous pages and summarized in Table 13 and Table 14 respectively. These measures are supposed to increase the possibility of success of ITT projects.

In sum, success of ITT projects in aerospace industry requires a policy mix among science, technology and innovation policies; sectoral strategy policies; higher education policies as well as company level strategies. If a good interaction between these policies and strategies is obtained then it would be possible to have successful steps in the development of aerospace industry.

For a developing country, international technology transfer is an alternative for indigenous efforts in obtaining a certain level of technological capability. By utilizing ITT, it might be possible to proceed with increased pace towards the defined technological goal. However, usage of international technology transfer requires a sophisticated harmonization of the overall process, such that, national efforts and the benefits of technology transfer have to be coupled in an optimized way. ITT has to be regarded as a tool, instead of the main purpose, on the road to achieve ultimate goal of development and self-dependence.

5.3 Directions for Further Research

This research generates some significant contributions to the existing literature on firm level absorptive capacity and ITT performance. One of the major contributions of the research is the extracted determinants and indicators through discussions with experts from aerospace industry who have participated in broad range of ITT projects. These variables are distilled in such a way that, an important portion is uniquely related to aerospace industry. Although the study is focused on firm level capabilities, the variables are extracted and evaluated from the viewpoint of sectoral innovation system. Instead of the question "what are the forms of AC", that is mostly addressed in the relevant literature, this research stands at a position to answer the question of "what forms AC".

There is no such comprehensive study in the literature that examines this topic from the point of view of transferee country. This research is one of the first attempts in the literature to examine the field of aerospace industry keeping in mind developing country concerns. Moreover, this study is probably the first attempt in Turkey to explore the linkages between firm level dynamics and sectoral innovation system in the relevant field, both of which simultaneously affect the performance of ITT projects.

The conceptualization and evaluation method introduced in this research make it possible to predict the possibility of success of an ITT project in advance. The determinants affecting firm level absorptive capacity and the performance of ITT projects as well as the evaluation approach introduced in this research may be utilized in different application areas. First of all, the research examines a portion of aerospace industry, mainly the knowledge intensive military part. The evaluated company is one of the biggest companies in this area in Turkey. Hence, it is possible to state that the evaluation based on this company represents the circumstances in military aerospace industry in Turkey. However, if the scope is expanded to cover the civil part of aerospace industry, most likely different results would be obtained. Similarly, in other high-technology civil industries, in which barriers to internalization are not so strong, variables based on economic concerns can be found out to be more significant than political determinants.

When the "Sophistication Level of ITT Project" is considered, within the evaluated sample there are no ITT projects with Level-9 and Level-10. This was interpreted as a result based on the difficulties of configuring and initiating such international cooperation projects in aerospace field. However, in other high-technology industries there might be such ITT projects. Besides, for low-technology civil industries, managing the language constraints might be an important issue, for the reason that the number of employees with the knowledge of a second language in the transferee country would be probably lower. As a result, more translators might be needed and lack of their technical knowledge may give rise to complications.

The metrics developed within this research can be utilized in a repeatable manner. The questionnaire that was used in the research demands answers in two parts; one is dedicated to the absorptive capacity of the company and the other one is dedicated to the evaluation of an ITT project. Experts are asked to evaluate past ITT projects they have participated in, some of which were completed years ago. However, while evaluating the absorptive capacity of the company, they possibly tended to consider the current status of the company instead of the status at the time of conducting the evaluated ITT project. Repeating the first part of the questionnaire on a regular basis in time would enable to monitor the change in absorptive capacity of the company and might give more precise estimations for the future success of international technology transfer projects based on the maturity of firm level absorptive capacity. In addition, absorptive capacity evaluations of different departments can provide valuable information regarding the weaknesses and strengths within the company.

A sample with higher number of observations would most likely increase the reliability of regression analysis. Additionally, it would be possible to include the variable related to "Sophistication Level of ITT Project" in the econometric model to obtain results that can be statistically interpreted in terms of the sophistication level of the ITT projects. When we consider increasing the number of observations, this may be possible through evaluating other aerospace companies. However, this would practically be possible when conducted with the support of a state organization. If the state coordinates such an extensive study, the companies would not hesitate to contribute and hence obtained results would certainly be very fruitful. Moreover, in an extensive study, which would aim to obtain more observations, the definition of "Sophistication Level of ITT Project" can also be extended with additional questions like the number of personnel who had participated in the ITT project or the number of output documents generated at the end of the ITT project. Such an approach would enable to make more extensive interpretations for the relation between the sophistication level and the rest of the variables.

REFERENCES

Abramovitz, M. (1986). Catching Up, Forging Ahead, and Falling Behind. *The Journal of Economic History,* 46(2), 385-406.

Aharoni Y. (1991). Education and Technology Transfer: Recipient Point of View. *in: Agmon, T., Glinow, M.A.W.(Eds.).Technology Transfer in International Business.* Oxford Press, New York.

Akamatsu, K. (1962). A Historical Pattern of Economic Growth in Developing Countries. *Journal of Developing Economies*, 1(1), 3–25.

Akgün, A. E., Keskin, H., Byrne, J. (2009). Organizational emotional capability, product and process innovation, and firm performance: An empirical analysis. *Journal of Engineering and Technology Management,* 26, 103-130.

Ancori, B., Bureth, A., Cohendet, P. (2000). The Economics of Knowledge: The Debate about Codification and Tacit Knowledge. *Industrial and Corporate Change*, 9(2), 255-287.

Balconi, M., Pozzali, A., Viale, R. (2007). The "Codification Debate" Revisited: a Conceptual Framework to Analyze the Role of Tacit Knowledge in Economics. *Industrial and Corporate Change*, 16(5), 823-849.

Baranson, J. (1970). Technology Transfer through the International Firm. *The American Economic Review*, 60(2), 435-440.

Baranson, J. (1978). Technology Transfer: Effects on U.S. Competitiveness and Employment. *in: Dewald, W.G, Gilman, H., Grubert, H., Wipf, L. The Impact of International Trade and Investment on Employment.* U.S. Department of Labor, Washington, DC, 177-203.

Bathelt, H., Malmberg, A., Maskell, P. (2002). Clusters and Knowledge: Local Buzz, Global Pipelines and the Process of Knowledge Creation. *DRUID Working Paper*, 02(12).

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S.,Rickne, A. (2005). Dynamics of Industry and Innovation: Organizations, Networks and Systems. *DRUID Tenth Anniversary Summer Conference*, Copenhagen, Denmark, June 2005.

Bernard, M., Ravenhill, J. (1995). Beyond Product Cycles and Flying Geese: Regionalization, Hierarchy and the Industrialization of East Asia. *World Politics*, 47(2), 171-209.

Brynjolfsson, E., Hitt, L. M. (2000). Beyond Computation: Information Technology, Organizational Transformation and Business Performance. *The Journal of Economic Perspectives*, 14(4), 23-48.

Carlsson, B. (2006). Internationalization of Innovation Systems: a Survey of the Literature. *Research Policy*, 35, 56-67.

Chaudhuri, S., Tabrizi, B. (1999). Capturing the real value in high-tech acquisitions. *Harvard Business Review,* 77(5), 123-130.

Christensen, C. (1997). The innovator's dilemma: When new technologies cause great firms to fail. *Cambridge, Harvard Business School Press*.

Cohen, W. M., Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly,* 35, 128-152.

Crispolti, V., Marconi, D. (2005). Technology transfer and economic growth in developing countries: an econometric analysis. *No 564, Temi di Discussione (Economic working papers) from Bank of Italy*, Economic Research and International Relations Area.

Dolfsma, W. (2008). Knowledge Economies. Routledge.

Dosi, G., Nelson, R. R. (2010), Part 3 Technical Change and Industrial Dynamic as Evolutionary Processes. *Handbook of the Economics of Innovation*, 51-127.

Dutrénit, G. (2004). Building Technological Capabilities in Latecomer Firms: A Review Essay. *Science Technology & Society*, 9(2).

Foray, D. (2004). The Economics of Knowledge. The MIT Press.

Forbes, N., Wield, D. (2003). From Followers to Leaders Managing Technology and Innovation in Newly Industrializing Countries. Routledge.

Gerschenkron, A. (1962). Economic Backwardness in Historical Perspective. *in: Hoselitz, B. F. (Eds.), The Progress of Underdeveloped Areas,* The University of Chicago Press, 3-29.

Gerschenkron, A. (1962a). Economic Backwardness in Historical Perspective, Belknap Press.

Gibson, D. V., Smilor, R.W. (1991). Key variables in technology transfer: a field-study based empirical, *Journal of Engineering and Technology Management*, 8, 287-312.

Granovetter, M. (1983). The Strength of Weak Ties: A Network Theory Revisited. *Sociological Theory.* 1. 201-233.

Hakam, A.N., Chang, Z.Y. (1988). Pattern of technology transfer in Singapore: the case of the electronics and computer industry. *International Journal of Technology Management*, 3(1-2), 181-188.

Hey, J. (2004). The Data, Information, Knowledge, Wisdom Chain: The Metaphorical link. *Published at Intergovernmental Oceanographic Commission - OceanTeacher: a training system for ocean data and information management*.

Hikino, T., Amsden, A.H. (1994). Staying Behind, Stumbling Back, Sneaking Up, Soaring Ahead: Late Industrialization in Historical Perspective. *in: Baumol, W. J., Nelson, R.R., Wolff, E.N. (Eds.),Convergence of Productivity.* Oxford University Press, Inc., 285-315.

Jansen, J. J. P., Van den Bosch, F. A. J., Volberda, H. W. (2005). Managing potential and realized absorptive capacity: How do organizational antecedents matter? *Academy of Management Journal*, 48(6), 999–1015.

Kasahara, S. (2004). The Flying Geese Paradigm: a Critical Study of Its Application to East Asian Regional Development. *United Nations Conference on Trade and Development*. UNCTAD/OSG/DP/2004/3.

Katz, J. (1999). Structural Reforms and Technological Behavior: The Sources and Nature of Technological Change in Latin America in the 1990s. *Research Policy,* 30(1), 1-19.

Kedia, B.L., Bhagat, R.S. (1988). Cultural constraints on transfer of technology across nations: implications for research in international and comparative management, *Academy of Management Review*, 13(4), 559-571.

Keller, R. T., Chinta, R. (1990). International technology transfer: strategies for success, *Academy of Management Executive*, 4(2), 33-43.

Korhonen, P. (1994). The Theory of the Flying Geese Pattern of Development and Its Interpretations. *Journal of Peace Research*, 31(1), 93-108.

Kim, L. (1998). Crisis construction and organizational learning: Capability building in catching-up at Hyundai Motor. *Organization Science*, 9: 506-521.

Kim,Y., Lee, K. (2009). Making a Technological Catch-up in the Capital Goods Industry: Barriers and Opportunities in the Korean Case. *in: Malerba F., Mani, S.(Eds.), Sectoral Systems of Innovation and Production in Developing Countries.* Edward Elgar Publishing, Inc, 259–286.

Kline, S., Rosenberg, N. (1986). An Overview of Innovation. *In: Landau, R. Rosenberg, N. (Eds.), The Positive Sum Strategy: Harnessing Technology for Economic Growth*. Washington D.C., National Academy Press, 275-304.

Krugman, P. (1979). A Model of Innovation, Technology Transfer and the World Distribution of Income. *Journal of Political Economy*, 87, 253-266.

Lane, P. J., Lubatkin, M. (1998). Relative absorptive capacity and inter-organizational learning. *Strategic Management Journal*, 19, 461-477.

Malerba F., Mani, S. (2009) Sectoral Systems of Innovation and Production in Developing Countries. Edward Elgar Publishing.

Mansfield, E. (1975). International Technology Transfer: Forms, Resources, Requirements and Policies. *The American Economic Review,* 65(2), 372-376.

Mansfield, E., Romeo, A. (1980). Technology Transfer to Overseas Subsidiaries by U.S. Based Firms. *Quarterly Journal of Economics*, 737-750.

Mathews, J. A. (2004). Competitive Advantages of the Latecomer Firm: A Resource-Based Account of Industrial Catch-Up Strategies. *Asia Pacific Journal of Management*, 19, 467–488.

McCulloch, R., Yellen, J.L. (1982). Technology Transfer and the National Interest. *International EconomicReview,* 421-428.

Metcalfe, S. (1997). Technology Systems and Technology Policy in an Evolutionary Framework.*in: Archibugi, D., Michie, J. (Eds.), Technology, Globalisation and Economic Performance*. Cambridge University Press, 268–296.

Morone, P., Taylor, R. (2010). Knowledge Diffusion and Innovation. *Edward Elgar Publishing, Inc.*

Mowery, D. C., Oxley, J. E. (1995). Inward technology transfer and competitiveness: the role of national innovation systems. *Cambridge Journal of Economics,* 19, 67-93.

Niosi, J., Zhegu, M. (2010). Aerospace Clusters: Local or Global Knowledge Spillovers? *Industry and Innovation*, 12(1), 5-29.

OECD (2001). Cities and Regions in the New Learning Economy. OECD Publishing.

OECD (2011). Regions and Innovation Policy. *OECD Reviews of Regional Innovation.* OECD Publishing.

Omidvar, O. (2013). Revisiting Absorptive Capacity: Literature review and a Practice-based Extension of the Concept, *35th DRUID Celebration Conference 2013,* Barcelona, Spain, June 17-19

Öner, M. A., Kaygusuz, H. (2007). A New Model for Analyzing and Measuring the Success of International Technology Transfer (ITT) in Defense Joint Ventures - A Case Study from Turkey. *Yapı Kredi Economic Review*, 18(2), 83-104.

Özman, M. (2009). Inter-Firm Networks and Innovation: a Survey of Literature. *Economics of Innovation and New Technology*. 18(1), 39-67.

Perez, C. (2001). Technological Change and Opportunities for Development as a Moving Target. *CEPAL Review*, 75, 109-130.

PMBOK® Guide (2012). A Guide to the Project Management Body of Knowledge. Project Management Institute.

Polanyi, M. (1966). The Tacit Dimension. Routledge, University of Chicago Press.

Polanyi, M. (1969). Knowing and Being. Routledge, University of Chicago Press.

Porter, M. E. (1998). The Competitive Advantage of Nations. Free Press, New York, 1998.

Ramanathan, K. (1999). A Normative Model for Planning and Implementing International Technology Transfer, *Paper presented at PICMET99, PORTLAND International Conference on Management of Engineering and Technology*, Portland, Oregon, USA.

Reddy, N. M., Zhao, L. (1990). International Technology Transfer: A Review, *Research Policy,* 10, 285-307.

Reddy, N. M., Zhao, L. (1993). Managing International Technology Transfer Negotiation. *Technovation,*13 (6), 383 – 397.

Romer, P. (1986). Increasing Returns and Long Run Growth. *Journal of Political Economy*, 94(5), 1002-1037.

Scherrer, C. (2005). Beyond Path Dependency and Competitive Convergence: Institutional Transfer from a Discourse-Analytical Perspective. *in: Fuchs, G., Shapira, P. (Eds.), Rethinking Regional Innovation and Change: Path Dependency or Regional Breakthrough?* Springer Science + Business Media Inc., 1–21.

Seçkin, B., Arkun, U., Tınaztepe, H.T., Toker, K.A., (2005). Estimates for the Future Space Launcher Projects for Turkey. *RAST 2005, 2nd International Conference on Recent Advances in Space Technologies,* 852 – 856.

Sharif, N. (2006). Emergence and Development of the National Innovation Systems Concept.

Simon, H. (1999). The Many Shapes of Knowledge. *Revue d'économie industrielle,* 88(2e), 23-39.
Solow, R., M., (1957). Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*, 39(3), 312-320.

Spender. J-C. (1996). Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal*, 17, 45-62.

Spraggon, M., Bodolica, V. (2012). A Multidimensional Taxonomy of Intra-Firm Knowledge Transfer Processes. *Journal of Business Research,* 65, 1273-1282.

Şimşek, M. (1989). Üçüncü Dünya Ülkelerinde ve Türkiye'de Savunma Sanayii. *SAGEB Yayınları*, SAGEB-3, AR-GE-1.

Teitel, S. (1984). Technology Creation in Semi-Industrial Economies, *Journal of Development Economics* 16, 39-61.

Szulanski. G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal,* 17, 27-43.

Van den Bosch, F. A. J., Volberda, H. W., De Boer, M. (1999). Coevolution of Firm Absorptive Capacity and Knowledge Environment: Organizational Forms and Combinative Capabilities. *Organization Science*, 44, 551-568.

Vermeulen, F., Barkema, H.(2001). Learning through acquisitions. *Academy of Management Journal*, 44, 457-476.

Vernon, R. (1966). International Investment and International Trade in the Product Cycle. *The Quarterly Journal of Economics*, 80(2), 190-207.

Vernon, R. (1971). Sovereignty at Bay: the multinational spread of U.S. Enterprises. New York: Basic Books.

Vertesy, D., Szirmai, A. (2010). Interrupted Innovation: Innovation System Dynamics in Latecomer Aerospace Industries. *UNU-MERIT Working Papers*, ISSN 1871-9872.

Wilking, M. (1974). The Role of Private Business in the International Diffusion of Technology. *The Journal of Economic History,* 34(1), 166-168.

Zahra, S., George, G. (2002). Absorptive capacity: a review, reconceptualization, and extension. *Academy of Management Review*, 27, 185-203.

APPENDICES

APPENDIX A
SEMI-STRUCTURED INTERVIEW QUESTIONS

1. Who are the main players in aerospace industry in Turkey and what are their roles?
2. How is it possible to develop indigenous technologies? What are the mechanisms needed?
3. Are there specific pathways that make it possible for knowledge to flow within your company?
4. What kind of opportunities are there in your company to obtain knowledge generated externally?
5. What are the main factors affecting absorptive capacity in aerospace industry? What are the ways of improving them?
6. What kind of technology transfer projects did you take place?
7. What was the target of these projects in terms of Technology Readiness Level?
8. What are the main issues related to preparation phase for the ITT?
9. What can be the maximum support that can be obtained from the source of technology?
10. What are the main success indicators of international technology transfer in aerospace industry?

APPENDIX B
QUESTIONNAIRE

Part A: You are kindly asked to evaluate your company's absorptive capacity. Please put (x) in the selected cell.

PART-A **Evaluation of my company's Absorptive Capacity**	**No idea**	**1** Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
1 My company sets academic goals for graduate programs and supports the students enrolled in these programs.	☐	☐	☐	☐	☐	☐
2 My company commonly hires graduates of the top universities.	☐	☐	☐	☐	☐	☐
3 My company provides facility of access to world literature via highly equipped library or membership to digital libraries.	☐	☐	☐	☐	☐	☐
4 My company provides facility of access to patent databases and it is common to use this occasion while making literature survey.	☐	☐	☐	☐	☐	☐
5 My company has a strategic plan for technology development which is prepared in a form of technology roadmap. A dedicated department is responsible for planning the technology roadmaps as well as for coordinating and monitoring relevant activities.	☐	☐	☐	☐	☐	☐
6 My company initiates intra-firm technology development projects to reach a technological capability. If external funding mechanisms are not available, my company funds such projects using own financial sources.	☐	☐	☐	☐	☐	☐

PART-A **Evaluation of my company's Absorptive Capacity**	**No idea**	**1** Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
7 My company encourages and appreciates the development of indigenous design and analysis tools. There exist dedicated specialized organizational structures and mechanisms, which help to improve the capabilities of the in-house tools.	☐	☐	☐	☐	☐	☐
8 My company provides an appealing working environment with fringe benefits, a fair wage policy and equal opportunities as well as uses performance evaluation tools efficiently to encourage employees to their highest potential.	☐	☐	☐	☐	☐	☐
9 My company provides an environment where employees can show their emotions and share their ideas in a way helping to create commitment and deep loyalty.	☐	☐	☐	☐	☐	☐
In general, my company is successful in knowledge production.	☐	☐	☐	☐	☐	☐
10 My company has an organizational structure which coordinates overall knowledge creation activities within the company and prevents redundant development efforts in order to minimize unfavorable effects of "need to know" approach.	☐	☐	☐	☐	☐	☐
11 In my company there is a culture of reporting the results of conducted tasks and other employees utilize these reports as well as there are mechanisms encouraging this process.	☐	☐	☐	☐	☐	☐

PART-A **Evaluation of my company's Absorptive Capacity**	**No idea**	**1** Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
12 My company implements systems engineering approach in compliance with international standards and generated project documents are easily accessible by project personnel.	☐	☐	☐	☐	☐	☐
13 My company implements procedures and processes efficiently and such documents are improved continuously as well as these documents are easily accessible by project personnel.	☐	☐	☐	☐	☐	☐
14 My company provides well-organized face to face communication platforms through formal and informal meetings for the purpose of orientation for new comers, internal trainings, conveying "lessons learned", evaluation of relations between departments, etc.	☐	☐	☐	☐	☐	☐
In general, there is an efficient and fruitful knowledge flow within my company.	☐	☐	☐	☐	☐	☐
15 My company actively takes part in events that paves the way for interactions with state organizations, universities, research centers and rivals such as national technology platforms, project planning, feasibility studies and proposal preparation activities in a continuous manner.	☐	☐	☐	☐	☐	☐

PART-A Evaluation of my company's Absorptive Capacity	**No idea**	**1** Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
16 My company has solid interactions with numerous national universities in aerospace fields through; performing common projects, knowledge & technology transfer offices, researchers training programs, lectures provided by company experts in universities, etc.	☐	☐	☐	☐	☐	☐
17 My company has an organizational structure dedicated to training, which efficiently plans training programs based on the requirements of different departments and in a way that meets with the strategic goals of the company.	☐	☐	☐	☐	☐	☐
18 My company has a well-organized purchase department which has an access to a broad network and continuously improves national sub-contractors through well-defined qualification procedures and constant monitoring as well as through special programs like training, providing technical support or infrastructure.	☐	☐	☐	☐	☐	☐
19 My company effectively follows the developments in leading countries and companies through attending international conferences, taking part in international technology development projects (like European Union Framework Programs), supporting employees who enroll in graduate programs abroad and hiring foreign consultants.	☐	☐	☐	☐	☐	☐
In general, my company uses external channels for efficient and fruitful knowledge flow.	☐	☐	☐	☐	☐	☐

Part B: You are kindly asked evaluate an "International Technology Transfer" (ITT) project that you have participated in.

- "Home" is used for the owner of the technology; transferor.
- "Host" is used for the customer; transferee.

Evaluation of an International Technology Project That You Have Participated Before

MAIN GOAL of the evaluated international technology transfer project was to achieve a capability at: (Please put (x) in the selected cell, you can select more than one option)

☐ COMPONENT/MATERIAL LEVEL

☐ SUB-SYSTEM LEVEL

☐ SYSTEM-LEVEL

MAIN GOAL of the evaluated international technology transfer project was to achieve a capability: (Please put (x) in the selected cell, you can select more than one option)

☐ TO ASSEMBLY AND INTEGRATE (select only if assembly and integration activities were performed during the project)

☐ TO TEST (select only if test activities were performed during the project)

☐ TO MANUFACTURE (select only if manufacturing activities were performed during the project)

☐ TO DESIGN (may be in form of feasibility, conceptual, preliminary, detailed design)

DID THE PROJECT COMPLETED?

☐ NO

☐ YES

PART-B **Evaluation of an International Technology Transfer That I Have Participated in**	**No idea / Not app. (NA)**	**1** Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
1 In our country there was a strong political will to achieve technological improvement in the area of research. The area of research was set as a technological priority area by the state.	☐	☐	☐	☐	☐	☐
2 In our country a technological roadmap was established targeting an incremental improvement in the area of research. The technological steps and relations between sub-technologies were predefined explicitly by the state and this enabled considering utilization of foreign technologies through international technology transfer projects to fill the specific technological gaps.	☐	☐	☐	☐	☐	☐
3 The scope and the intended outputs of the international technology transfer project were reasonable and well-matched with the vision of my company, and have long-term strategic benefits for state as well as for the company rather than short-term economical profits. (there exists a vision of my company related to relevant area of research)	☐	☐	☐	☐	☐	☐
4 Selected Home Company was the best choice among all alternative technology sources in terms of overall evaluation of technical capability and proposed level of technology transfer.	☐	☐	☐	☐	☐	☐
5 Selected Home Company is still actively performing similar tasks defined in the Technology Transfer Project and the technology is not practically obsolete.	☐	☐	☐	☐	☐	☐

PART-B **Evaluation of an International Technology Transfer That I Have Participated in**	**No idea / Not app. (NA)**	**1** Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
6 International Technology Transfer Project provided valuable benefits to Home Party therefore Home Party set a high value on the realization of the project.	☐	☐	☐	☐	☐	☐
7 Developed countries or big companies around the world didn't hinder or prevent the realization of the intended International Technology Transfer Project through political repression to both countries, applying sanctions, preventing supply of critical material/equipment, etc.	☐	☐	☐	☐	☐	☐
8 Before beginning the project; at the end of the contractual negotiations, mutually agreed and well-prepared descriptive project definition documents have been prepared as annexes to the Project's contract. These annexes clearly defined the project scope, schedule, responsibilities, deliverables and cost.	☐	☐	☐	☐	☐	☐
In general, preparations before initiating the ITT were sufficient.	☐	☐	☐	☐	☐	☐
9 During the "design phase" of the Project, my company's experts grasped the knowledge regarding the design requirements, output design documentation and TDP through well-organized reviews.	☐	☐	☐	☐	☐	☐

PART-B **Evaluation of an International Technology Transfer That I Have Participated in**	**No idea / Not app. (NA)**	**1** Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
10 During "equipment installation and commissioning phase" of the Project, my company's experts worked under the supervision of Home company's experts in our territory and related documentation is generated as a result of joint efforts. The produced documents are well-suited to my company's culture.	☐	☐	☐	☐	☐	☐
11 During the "ground development tests phase" of the project, design and products are validated; related activities are carried out in my company under the supervision of foreign experts, results are evaluated in details and documented.	☐	☐	☐	☐	☐	☐
12 During the "manufacturing phase" of the Project, production process was optimized under the supervision of foreign experts. The produced documents were well-suited to my company's culture.	☐	☐	☐	☐	☐	☐
13 My company utilized mechanisms such as reviews, meetings, and questions/answers, therefore obtained detailed and comprehensive information from the Home Company throughout the Project.	☐	☐	☐	☐	☐	☐
14 Home Company implemented systems engineering approach in compliance with international standards and generated project documents accordingly. These documents satisfied the requirements of predefined reviews and enabled transferred knowledge to be completely adopted. For this purpose a rigid configuration and data management system has been implemented.	☐	☐	☐	☐	☐	☐

PART-B **Evaluation of an International Technology Transfer That I Have Participated in**	**No idea / Not app. (NA)**	**1** Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
15 Raw materials used in the Project were selected in a way that enabled the usage of a wide variety of alternatives; therefore my company was not dependent on limited sources of raw material.	☐	☐	☐	☐	☐	☐
16 Equipment provided by the Home Company was worthy in a way that it took the advantage of modern and up-to-date manufacturing technologies. Besides operational and maintenance costs were reasonable and relevant tasks could be performed independent of Home Party.	☐	☐	☐	☐	☐	☐
17 In-house softwares developed and provided by the Home Company were totally adopted by my company's experts through user manuals and trainings in a way that there were no black-boxes, undefined magic numbers, and indemonstrable empirical relations left within these tools. My company's experts mastered the capabilities of these tools thus future utilization beyond the ITT project became possible.	☐	☐	☐	☐	☐	☐
18 Training Program (theoretical and/or practical) that was provided by the Home Party was highly efficient in terms of; planning, quality & scope of training documentation, sufficiency of instructors (and translators), selected training tools and effective monitoring of the participants.	☐	☐	☐	☐	☐	☐

PART-B **Evaluation of an International Technology Transfer That I Have Participated in**	**No idea / Not app. (NA)**	**1** Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
19 Translation of the technical documents was made by experienced specialists and a common terminology has been used. Translated documents were proof checked in order to reduce the level information loss caused by translation to minimum. During the face-to-face meetings adequate numbers of capable translators have been assigned.	☐	☐	☐	☐	☐	☐
<u>In general, evaluated ITT was successfully conducted.</u>	☐	☐	☐	☐	☐	☐
20 Home Company fulfilled the requirements of the contract in terms of scope and the tasks defined in the Statement of Work as expected. By the successful completion of the project the intended technological gap previously defined in the technological roadmap was bridged.	☐	☐	☐	☐	☐	☐
21 By the help of the Project, my company reached a favorable level of technological capability; external dependence in terms of items in the Product Breakdown Structure, raw material and equipment was reduced to minimum.	☐	☐	☐	☐	☐	☐

PART-B **Evaluation of an International Technology Transfer That I Have Participated in**	**No idea / Not app. (NA)**	**1** Strongly disagree	**2** Disagree	**3** Neutral	**4** Agree	**5** Strongly agree
22 My company's experts repeated design activities under the supervision of foreign experts and obtained the same results as found during "design phase". For this purpose, design and analysis tools provided by Home Company or indigenously developed tools were used and consequently obtained design capability was verified and validated.	☐	☐	☐	☐	☐	☐
23 Employees, who were participated in the ITT, have been working in the similar tasks that they have gained experience even the ITT is over.	☐	☐	☐	☐	☐	☐

APPENDIX C
SUMMARY OF VARIABLES

Variable	*Definition*	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
ABS_KP_1	Setting academic goals for universities	74	3.689	0.720	2.000	5.000
ABS_KP_2	Hiring graduates of the top universities	74	4.108	0.587	3.000	5.000
ABS_KP_3	Access to world literature	74	3.797	0.596	3.000	5.000
ABS_KP_4	Culture of utilizing patent databases	74	3.432	0.684	2.000	5.000
ABS_KP_5	Firm level strategic plan and technology roadmap	74	3.757	0.592	2.000	5.000
ABS_KP_6	Intra-firm technology development projects	74	3.878	0.739	2.000	5.000
ABS_KP_7	Development of indigenous design and analysis tools	74	4.014	0.749	2.000	5.000
ABS_KP_8	Fringe benefits	74	3.257	0.908	1.000	5.000
ABS_KP_9	Emotional capability	74	3.135	0.689	2.000	4.000
ABS_KP_AVER	General Evaluation of intrafirm knowledge production	74	3.689	0.547	2.000	5.000
ABS_KF_1	Coordinating intra-firm knowledge creation activities	74	2.581	0.740	1.000	4.000
ABS_KF_2	Culture of codification within the company	74	3.703	0.716	2.000	5.000
ABS_KF_3	Culture of implementing systems engineering approach within the company	74	3.743	0.598	3.000	5.000
ABS_KF_4	Utilizing codified procedures and processes within the company	74	3.743	0.525	3.000	5.000
ABS_KF_5	Face to face intra-firm communication	74	3.122	0.793	2.000	4.000
ABS_KF_AVER	General Evaluation of intrafirm knowledge flow	74	3.446	0.622	2.000	4.000
ABS_SIS_1	Interactions with national players	74	4.014	0.652	2.000	5.000
ABS_SIS_2	Solid interactions with universities	66	4.015	0.668	3.000	5.000
ABS_SIS_3	Well-organized training to reach external knowledge	74	2.932	1.077	1.000	5.000
ABS_SIS_4	Improving capabilities of sub-contractors	74	2.581	0.979	1.000	5.000
ABS_SIS_5	Interactions with players outside national borders	65	3.369	1.024	1.000	5.000
ABS_SIS_AVER	General Evaluation of external knowledge flow	74	3.649	0.671	3.000	5.000
ITT_PREP_1	Strong political will	74	3.581	0.907	1.000	5.000
ITT_PREP_2	ITT fills a gap in the technology roadmap	72	3.389	0.972	2.000	5.000

Variable	*Definition*	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
ITT_PREP_3	Significant strategic benefits of the ITT	74	3.946	0.700	2.000	5.000
ITT_PREP_4	Selection Process of Home Company	74	4.014	0.836	2.000	5.000
ITT_PREP_5	Transferred technology is not practically obsolete	74	4.041	0.913	1.000	5.000
ITT_PREP_6	Motivation of the Home Party	74	3.743	0.684	2.000	5.000
ITT_PREP_7	Response of developed countries and big companies	74	3.243	1.156	1.000	5.000
ITT_PREP_8	Well-prepared contractual documents	74	3.716	0.958	1.000	5.000
ITT_PREP_AVER	General Evaluation of ITT preperations	74	3.662	0.799	2.000	5.000
ITT_CON_1	Benefits of “design phase”	43	3.488	1.009	2.000	5.000
ITT_CON_2	Benefits of “equipment installation and commissioning phase”	57	3.895	0.673	3.000	5.000
ITT_CON_3	Benefits of “ground development tests phase”	37	3.486	1.044	1.000	5.000
ITT_CON_4	Benefits of “manufacturing phase”	59	3.797	0.886	2.000	5.000
ITT_CON_5	Mechanisms for effective absorption	74	3.838	0.828	1.000	5.000
ITT_CON_6	Implementing systems engineering approach by Home Company	74	3.405	1.146	1.000	5.000
ITT_CON_7	Various sources for raw materials	50	2.420	1.180	1.000	5.000
ITT_CON_8	Benefits of the “equipments” provided	57	3.544	0.657	2.000	5.000
ITT_CON_9	Benefits of the “in-house softwares” provided	47	3.128	0.679	2.000	4.000
ITT_CON_10	Benefits of the “training” provided	70	3.586	1.136	1.000	5.000
ITT_CON_11	Managing the language constraints	57	3.456	1.181	1.000	5.000
ITT_CON_AVER	General Evaluation of the way of conducting ITT	74	3.608	0.873	1.000	5.000
ITT_PER_1	Fulfilling contractual requirements	74	3.770	0.803	1.000	5.000
ITT_PER_2	Reduced external dependency	70	3.771	0.837	1.000	5.000
ITT_PER_3	Obtained design capability is verified and validated	35	3.143	1.033	1.000	5.000
ITT_PER_4	Preventing “brain drain”	74	3.500	0.925	2.000	5.000

APPENDIX D
DETERMINATION OF SOPHISTICATION LEVEL OF ITT PROJECT

The types of capabilities achieved through ITT projects in terms of "Functional Capability" and "Level of Product"

Functional Capability	To design	FC1
	To manufacture	FC2
	To test	FC3
	To assembly and integrate	FC4
Level of Product	Component and/or material level	LP1
	Sub-system level	LP2
	System-level	LP3

- All types of Functional Capabilities (FCs) and Level of Products (LPs) has a sophistication value (SV) of 1; excluding FC1 and LP3 as these have sophistication values of 2.
- n(FC): is the number of FCs covered within the ITT project.
- n(LP): is the number of LPs covered within the ITT project.
- For the relatively sophisticated ITT projects that cover at least 2 FCs and 2 LPs; cond=1, for more simple projects cond=0.
- For any ITT project that covers different combinations of FCs and LPs, sophistication level (sophist_level) is calculated by the below mentioned formula;

$$sophist\_level(Project) = \sum_{i=1}^{n(FC)} SV(FC_i) + \sum_{i=1}^{n(LP)} SV(LP_i) + n(LP) + Cond - 2$$

<u>Example-1;</u>
Assume an ITT Project which involves design (FC1) and testing (FC3) of a sub-system level product (LP2).
Then according to abovementioned method;
n(FC)= 2, n(LP)=1, cond=0, SV(FC1)=2, SV(FC3)=1, SV(LP2)=1

$$sophist\_level(Project) = 3$$

Example-2;

Assume an ITT Project which involves manufacturing (FC2) and testing (FC3) of a sub-system (LP2) and system (LP3) level products.

According to abovementioned method;
n(FC)= 2, n(LP)=2, cond=1, SV(FC2)=1, SV(FC3)=1, SV(LP2)=1, SV(LP3)=2

$$sophist\_level(Project) = 6$$

Types of capabilities achieved through ITT projects		**Sophistication Level of Technical Support Through ITT Project**
Functional Capability	**Level of Product**	
FC1, FC2, FC3	LP1, LP2, **LP3**	10
FC1, FC2, FC4	LP1, LP2, **LP3**	10
FC1, FC3, FC4	LP1, LP2, **LP3**	10
FC1, FC2, FC3, FC4	LP1, LP2, **LP3**	10
FC1, FC2	LP1, LP2, **LP3**	9
FC1, FC3	LP1, LP2, **LP3**	9
FC1, FC4	LP1, LP2, **LP3**	9
FC2, FC3, FC4	LP1, LP2, **LP3**	9
FC1, FC2, FC3, FC4	LP1, **LP3**	9
FC1, FC2, FC3, FC4	LP2, **LP3**	9
FC2, FC3	LP1, LP2, **LP3**	8
FC2, FC4	LP1, LP2, **LP3**	8
FC3, FC4	LP1, LP2, **LP3**	8
FC1, FC2, FC3	LP1, **LP3**	8
FC1, FC2, FC3	LP2, **LP3**	8
FC1, FC2, FC4	LP1, **LP3**	8
FC1, FC2, FC4	LP2, **LP3**	8
FC1, FC3, FC4	LP1, **LP3**	8
FC1, FC3, FC4	LP2, **LP3**	8
FC1, FC2, FC3, FC4	LP1, LP2	8
FC1	LP1, LP2, **LP3**	7
FC1, FC2	LP1, **LP3**	7
FC1, FC2	LP2, **LP3**	7
FC1, FC3	LP1, **LP3**	7
FC1, FC3	LP2, **LP3**	7
FC1, FC4	LP1, **LP3**	7
FC1, FC4	LP2, **LP3**	7
FC1, FC2, FC3	LP1, LP2	7
FC1, FC2, FC4	LP1, LP2	7

Types of capabilities achieved through ITT projects		Sophistication Level of Technical Support Through ITT Project
Functional Capability	**Level of Product**	
FC1, FC3, FC4	LP1, LP2	7
FC2, FC3, FC4	LP1, **LP3**	7
FC2, FC3, FC4	LP2, **LP3**	7
FC2	LP1, LP2, **LP3**	6
FC3	LP1, LP2, **LP3**	6
FC4	LP1, LP2, **LP3**	6
FC1, FC2	LP1, LP2	6
FC1, FC3	LP1, LP2	6
FC1, FC4	LP1, LP2	6
FC2, FC3	LP1, **LP3**	6
FC2, FC3	LP2, **LP3**	6
FC2, FC4	LP1, **LP3**	6
FC2, FC4	LP2, **LP3**	6
FC3, FC4	LP1, **LP3**	6
FC3, FC4	LP2, **LP3**	6
FC2, FC3, FC4	LP1, LP2	6
FC1, FC2, FC3, FC4	**LP3**	6
FC1	LP1, **LP3**	5
FC1	LP2, **LP3**	5
FC2, FC3	LP1, LP2	5
FC2, FC4	LP1, LP2	5
FC3, FC4	LP1, LP2	5
FC1, FC2, FC3	**LP3**	5
FC1, FC2, FC4	**LP3**	5
FC1, FC3, FC4	**LP3**	5
FC1, FC2, FC3, FC4	LP1	5
FC1, FC2, FC3, FC4	LP2	5
FC1	LP1, LP2	4
FC2	LP1, **LP3**	4
FC2	LP2, **LP3**	4
FC3	LP1, **LP3**	4
FC3	LP2, **LP3**	4
FC4	LP1, **LP3**	4
FC4	LP2, **LP3**	4
FC1, FC2	**LP3**	4
FC1, FC3	**LP3**	4
FC1, FC4	**LP3**	4
FC1, FC2, FC3	LP1	4
FC1, FC2, FC3	LP2	4

Types of capabilities achieved through ITT projects		Sophistication Level of Technical Support Through ITT Project
Functional Capability	**Level of Product**	
FC1, FC2, FC4	LP1	4
FC1, FC2, FC4	LP2	4
FC1, FC3, FC4	LP1	4
FC1, FC3, FC4	LP2	4
FC2, FC3, FC4	**LP3**	4
FC1	**LP3**	3
FC2	LP1, LP2	3
FC3	LP1, LP2	3
FC4	LP1, LP2	3
FC1, FC2	LP1	3
FC1, FC2	LP2	3
FC1, FC3	LP1	3
FC1, FC3	LP2	3
FC1, FC4	LP1	3
FC1, FC4	LP2	3
FC2, FC3	**LP3**	3
FC2, FC4	**LP3**	3
FC3, FC4	**LP3**	3
FC2, FC3, FC4	LP1	3
FC2, FC3, FC4	LP2	3
FC1	LP1	2
FC1	LP2	2
FC2	**LP3**	2
FC3	**LP3**	2
FC4	**LP3**	2
FC2, FC3	LP1	2
FC2, FC3	LP2	2
FC2, FC4	LP1	2
FC2, FC4	LP2	2
FC3, FC4	LP1	2
FC3, FC4	LP2	2
FC2	LP1	1
FC2	LP2	1
FC3	LP1	1
FC3	LP2	1
FC4	LP1	1
FC4	LP2	1