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

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

BAŞAR SEÇKİN

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
THE DEPARTMENT OF SCIENCE AND TECHNOLOGY POLICY STUDIES

December 2015

Approval of the Graduate School of Social Sciences

Prof. Dr. Meliha Altunışık
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy.

Prof. Dr. M. Teoman Pamukçu
Head of Department

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

Prof. Dr. İrem Dikmen Toker
Co-Supervisor

Prof. Dr. Erkan Erdil
Supervisor

Examining Committee Members

Prof. Dr. M. Teoman Pamukçu (METU, STPS) ____________________

Prof. Dr. Erkan Erdil (METU, ECON) ____________________

Prof. Dr. Nafiz Alemdaroğlu (ATILIM UNI., SHYO) ____________________

Assist. Prof. Dr. Semih Akçomak (METU, STPS) ____________________

Assist. Prof. Dr. Umut Y. Çetinkaya (BOU, IE) ____________________

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : Başar Seçkin

Signature :

ABSTRACT

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

Seçkin, Başar
Ph.D., Science and Technology Policy Studies
Supervisor : Prof. Dr. Erkan Erdil
Co-Supervisor : Prof. Dr. İrem Dikmen Toker

December 2015, 258 pages

This dissertation 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.

Thesis 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. Thesis introduced a metric to quantify the sophistication level of ITT project considering the technical support provided by the transferor party.

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.

ÖZ

FİRMA SEVİYESİ ÖZÜMSEME KAPASİTESİ VE ULUSLARARASI TEKNOLOJİ TRANSFERİNİN BAŞARISI; TÜRKİYE HAVACILIK VE UZAY SANAYİ ÖRNEĞİ

Seçkin, Başar
Doktora, Bilim ve Teknoloji Politikası Çalışmaları
Tez Yöneticisi : Prof. Dr. Erkan Erdil
Ortak Tez Yöneticisi : Prof. Dr. İrem Dikmen Toker

Aralık 2015, 258 sayfa

Bu tez çalışmasında firma seviyesi özümseme kapasitesi (ÖK) ve uluslararası teknoloji transferinin (UTT) başarısı arasındaki ilişkinin incelenmesi amaçlanmıştır. Ayrıca UTT'nin başarısını etkileyen diğer etkenler de belirlenmiştir. Araştırmada teknolojiyi alan ülke açısından ve gelişmekte olan ülke perspektifinden değerlendirme yapılmış ve Türkiye'deki havacılık ve uzay sanayisine odaklanılmıştır.

Bu tez "firma seviyesi ÖK'yı neler oluşturur" sorusuna bütünsel bir yaklaşım ile cevap aramaktadır. Bu kapsamda ÖK oluşumunu etkileyen değişkenler 3 grupta toplanmıştır; "Bilgi Üretimi", "Firma İçi Bilgi Akışı", "Sektörel İnovasyon Sistemi (SİS) içi Bilgi Akışı". Çalışma, firma seviyesi yeteneklere odaklansa da değişkenler SİS perspektifinden belirlenmiştir.

Etkenleri tespit edebilmek ve ölçebilmek amacıyla bir soru seti oluşturulmuş, bu soru seti kullanılarak sanayiden uzmanların daha önce görev aldıkları UTT projelerini ve ilaveten firmalarının ÖK'sını değerlendirmeleri sağlanmıştır. Çalışmada, literatüre katkı sağlayacak şekilde, teknolojiyi veren tarafın katkısı temelinde UTT projesinin

karmaşıklık seviyesini ölçmeyi sağlayacak bir metrik oluşturulmuş, bunun için "Fonksiyonel Yetenek" ve "Ürün Seviyesi" tanımlanmıştır.

Ekonometrik analizler ile elde edilen sonuçlar, açıklayıcı değişkenler ve UTT'nin başarısı arasında doğrudan bir ilişki göstermektedir. Buna göre, gelecekte gerçekleştirilecek UTT projelerinin başarısının öngörülmesinin, firma seviyesi ÖK'nın belirlenmesi ile mümkün olabileceği değerlendirilmektedir.

Tanımlanan değişkenler ve soru seti UTT projelerinin planlanması aşamasında faydalı bir araç olarak kullanılabilir. Gelişmekte olan ülkelerde çeşitli yüksek teknoloji alanlarına uygulanabilir ve UTT projeleri öncesinde politika yapıcılara değerli bilgiler sağlayabilir.

Anahtar Kelimeler: Uluslararası teknoloji transferi, firma seviyesi özümseme kapasitesi, teknoloji değerlendirme, teknoloji geliştirme planları, havacılık ve uzay sanayi.

To my family

ACKNOWLEDGMENTS

I would like to express my sincerest thanks to my thesis supervisor Prof. Dr. Erkan Erdil for his continuous guidance. I would also like to thank Prof. Dr. M. Teoman Pamukçu for introducing me to research methods. In particular, I am grateful to Assist. Prof. Dr. Semih Akçomak for his precious advices regarding the improvement of econometric analysis.

I would like to express my sincere gratitude to my co-advisor Prof. Dr. İrem Dikmen Toker for the improvement of my research idea and helping me to formulate the structure of the thesis.

I am also grateful to Prof. Dr. Ahmet Ş. Üçer and Prof. Dr. Nafiz Alemdaroğlu. I am so lucky that I have been a student of such esteemed researchers.

I would like to thank my colleagues in my company who contributed to this thesis directly or indirectly. I am proud of being part of this team.

I would like to thank my wife for her endless support, encouragement and love. I would like to thank my beloved mother for her unconditional love and lifelong motivation. I would like to thank my daughter Doğa, *a minha pequenina*, for her presence in my life. Without their precious support, it would not be possible to conduct this thesis.

For the rest who are not specifically mentioned here, "*thank you for the inspiration, thank you for the smiles.*"

Ankara, 9th December 2015
Başar Seçkin

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FIGURES

LIST OF ABBREVIATIONS

AC	Absorptive Capacity
COTS	Commercial off-the-shelf
ECSS	European Cooperation for Space Standardization
FC	Functional Capability
ICT	Information and Communications Technology
IS	Import Substitution
ITT	International Technology Transfer
LP	Level of Product
NIS	National Innovation System
OEM	Original Equipment Manufacturer
OLS	Ordinary Least-Squares
R&D	Research and Development
RIS	Regional Innovation System
SIS	Sectoral Innovation System
SSM	Undersecretariat for Defense Industries
SCST	Supreme Council of Science and Technology
TC	Technological Change
TÜBİTAK	The Scientific and Technological Research Council of Turkey

CHAPTER 1

INTRODUCTION

1.1 AIM OF THE THESIS

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 (see Section 2.2). Therefore, this dissertation is focused on this aforementioned portion of the aerospace industry.

Another major topic of this thesis 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 dissertation 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 thesis 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?

1.2 THE METHODOLOGY AND THE ORGANIZATION OF THE DISSERTATION

The major aim of this thesis is to investigate the relation between firm level absorptive capacity and the success of international technology transfer in aerospace industry. It is also aimed to figure out the factors affecting the success of ITT projects other than firm level absorptive capacity. This section gives the methodology implemented in the thesis in the course of searching for the answers to the research questions.

The brief sketch of the implemented methodology is given in Figure 1 and the explanations are given 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.

Review of the relevant literature is presented in Chapter 3 of this dissertation.

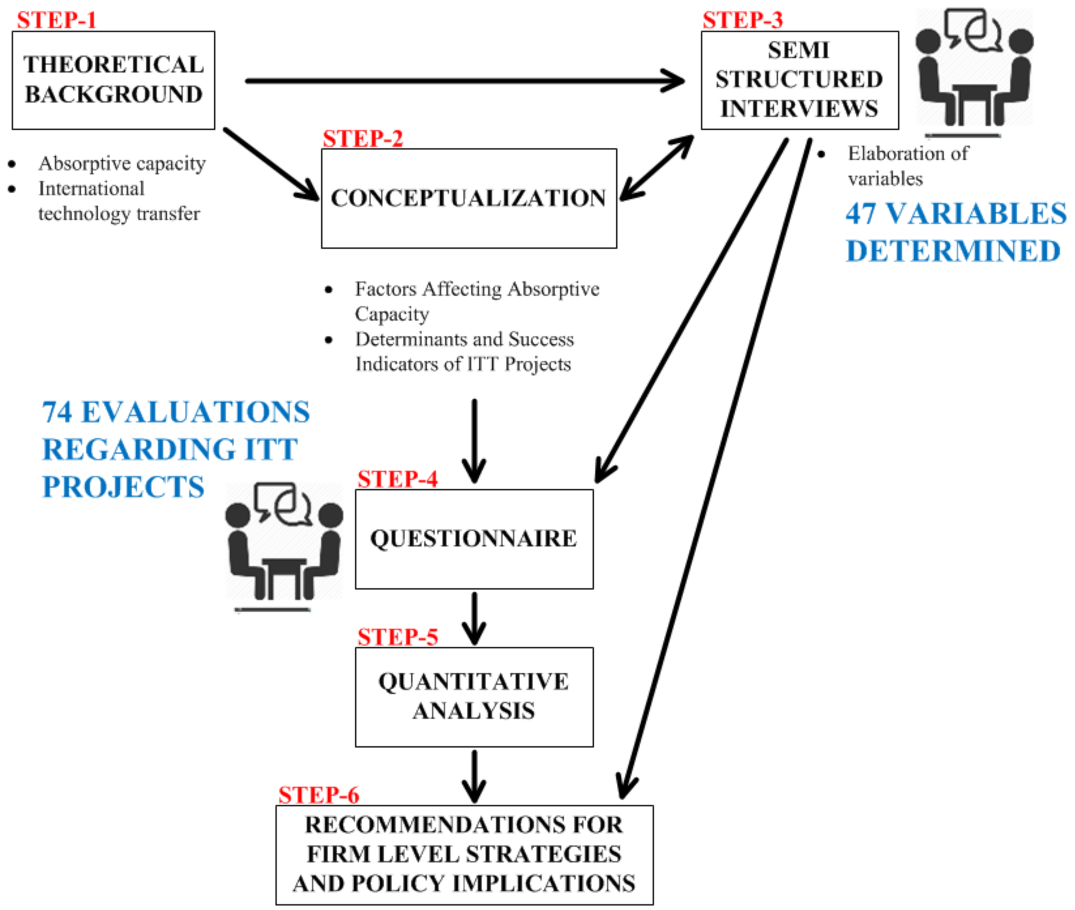


Figure 1 The brief sketch of the implemented methodology

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". The explanations for the generated concept and the relation with the literature are given in Section 3.3.

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 as given in Appendix A 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. 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. Moreover, suggestions for improving the defined variable through promising firm level strategies or policy measures were also discussed.

Information about the profile of experts who had contributed to research while determining the variables through semi-structured interviews is provided in Section 3.3 of the dissertation.

After the completion of Step-3, 47 variables are determined, elaborated and categorized under the conceptualized framework. Detailed discussions on these variables are given in Chapter 4. Consequently, conceptualization has been improved by means of defining subgroups under predefined titles as given below.

<u>Factors Affecting Absorptive Capacity;</u>

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

<u>Determinants and Success Indicators of ITT Projects;</u>

- 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 as given in Chapter 4 just after the explanations regarding the associated variables. Afterwards, these questions are gathered in a form of questionnaire given in 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 as introduced in Section 4.2.2 and Section 5.1.2. 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.

Information about the profile of experts who had contributed to research by filling in the Questionnaire is provided in Section 5.1.

At the end of Step-4, a total number of 74 evaluations regarding ITT projects were obtained. Detailed information about the variables that were evaluated through the questionnaire is provided in Section 5.1.

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 method of generating these representing variables is provided in Section 5.2. The explanatory variables and the dependent variable used in the regression are given in Table 1.

The information regarding the analysis and the obtained results are provided in Section 5.2.

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):
The conclusions of the analysis are discussed in Chapter 6. The results designate that there exists a direct relation between the explanatory variables (Factors Affecting Absorptive Capacity, Determinants of Success for ITT Project) and the dependent variable (the Success of International Technology Transfer). On the other hand, surprisingly, it is found out that some variables are not significantly related to the success of ITT as it would be expected according to the existing literature.

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. These evaluations are given in Chapter 6.

1.3 SIGNIFICANCE OF THE RESEARCH

In the literature there are many studies that have tried to explain factors affecting the success of an ITT project. Some researchers have focused on the determinants such as R&D activity, training (Hakam and Chang, 1988), the type of transferred technology and the transfer channels (Keller and Chinta, 1990), culture (Gibson and Smilor, 1991) and the existing technological capability (Kedia and Bhagat, 1988).

While most studies concentrate on the organizational level mechanisms related to knowledge (Cohen and Levinthal, 1990; Lane and Lubatkin, 1998) there exist conceptualization attempts related to firm level absorptive capacity like the concept proposed by Zahra and George (2002), in which absorptive capacity is defined through conceptualizing “potential absorptive capacity” and “realized absorptive capacity”. Additionally, existing literature contains methods, which intend to measure absorptive capacity, and some of which are applied in different industries, like the one proposed by Jansen et al. (2005). However, less attention is paid to the relation of firm level AC and the success of ITT project. That might be because the topic is more important for developing countries than the developed countries; and unlike other areas on science and technology management, this area is rarely studied.

This dissertation generates some significant contributions to the existing literature on firm level absorptive capacity and the performance of ITT project. One of the major contributions of the thesis is the extracted determinants and indicators through discussions with experts from aerospace industry who have participated in broad range of ITT projects (Step-3 of the research). These variables are distilled in such a way that, an important portion is uniquely related to aerospace industry. The existing concepts on absorptive capacity like the one proposed by Zahra and George (2002) and Jansen et al. (2005) are improved in this study by introducing determinants specific to aerospace industry. Moreover, the reviewed literature on 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). On the contrary, this thesis research stands at a position to answer the question of "what forms AC". This approach is explained in Section 3.3.

Although the study is focused on firm level capabilities, the variables are extracted and evaluated from the point of view of sectoral innovation system, which is also consistent with the evolutionary approach. The dynamics of sectoral innovation system (SIS) presented by Bergek et al. (2005) covers structural components and functional patterns as well as the methodology to understand the character of a SIS. Moreover, it is stated that in order to comment on the performance of functionality of the SIS, it is important to understand the inducing or blocking mechanisms. This thesis contributes to the literature based on the approach introduced by Bergek et al. (2005) in different manners. First, the thesis presents a variety of possible knowledge production and knowledge flow mechanisms specific to high-technology industries. In addition, actual status of determinants can be used to forecast the future success of ITT projects and therefore this may enhance the outputs of analysis, which are based on Bergek et al. (2005) approach.

There is no such a comprehensive study in the literature that examines this topic from the transferee country's point of view. 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. In addition, the achievements involve the essence of systems engineering approach and project management principals, which are essentially employed in aerospace industry.

In this research a new metric to quantify the "Sophistication Level of ITT Project" is introduced as a contribution to the existing literature (described in Section 4.2.2 and Section 5.1.2). 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 thesis are categorized according to this new approach. Instead of US-originated technology readiness levels (TRL), this two dimensional technological maturity categorization is used in order to be more distinctive. TRL metric, as defined in Section 3.2.4, is especially designed to measure the maturity level throughout the technology development process, but when 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 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. The research findings indicate that there is an opportunity of making estimations for the future success of ITT 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. Moreover, 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.

CHAPTER 2

A BRIEF INTRODUCTION TO AEROSPACE INDUSTRY

2.1 AEROSPACE INDUSTRY AT A GLANCE

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. Supply chain management is the vehicle of knowledge spillovers in this industry and in general this chain is international. Under the scope of supply chain management varying tasks are covered such as; issuing of technical specifications, concurrent engineering, strategic engineering alliances, quality control, product co-development, certification of suppliers, etc. Most prime contractors design products, then outsource to tenders among tier 2 suppliers across the world and send them their designs and requirements. These tier 2 producers make technical and commercial proposals to the main contractor, and the latter proceeds to a selection of partners/suppliers. In many cases, detailed engineering is left to the tier 2 producers, but often international collaboration and associated massive knowledge flows occur between tier 1, 2 and 3 firms, while local spillovers are less important. International knowledge spillovers mostly occur between tier 1 and 2 manufacturers, usually large corporations. Conversely, local knowledge spillovers, and aerospace clusters, are based on geographically close relationships between tier 2, 3 and 4 producers. The most important notion in clusters is "value chain", which is developed as a result of repeated interactions and it is important to keep in mind that supply chain is not sufficient.

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 differences between defense industry and civilian industry are discussed in Section 3.3.

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. The merits of innovation systems are discussed in Section 3.1.

In the recent years, leading countries, which maintain developed aerospace industry, face new types of problems regarding human resources as a significant portion of the workforce is approaching retirement. This has caused concern that valuable skills, acquired over the course of decades of experience, may be lost as older employees leave the workforce. Recruitment and training will be essential to ensuring continuity of skills and operational capabilities. According to “The Space Report 2012” issued by Space Foundation, each year more than 1.5 million people worldwide receive bachelor’s-equivalent degrees in aerospace relevant disciplines. This base of newly minted science, technology, engineering, and mathematics (STEM) graduates provides the labor pool to support future aerospace activities. Since veteran aerospace workers begin to retire around the world, the training of new employees in critical STEM fields has become a focus for governments and industry leaders. China is the leading producer of STEM bachelor's equivalent university graduates, doubling the number of graduating students between 2002 and 2006.[1]

2.2 AEROSPACE INDUSTRY IN TURKEY

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.

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

---

[1] The Space Report 2012, Space Foundation Washington, DC, ISBN-13: 978-0-9789993-5-3. This report is introduced as "an authoritative guide to global space activity".

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

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 dissertation is focused on this portion of aerospace industry.

2.2.1 Main Players in the Public Sector

As introduced above, 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.

SSM, which is responsible for setting and implementing the defense policies, is the main acquisition body for defense system needs and committed to make Turkey

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

superior in defense technologies. SSM has a separate legal entity, as well as its own extra-budgetary financial resources to perform the following functions[4]:

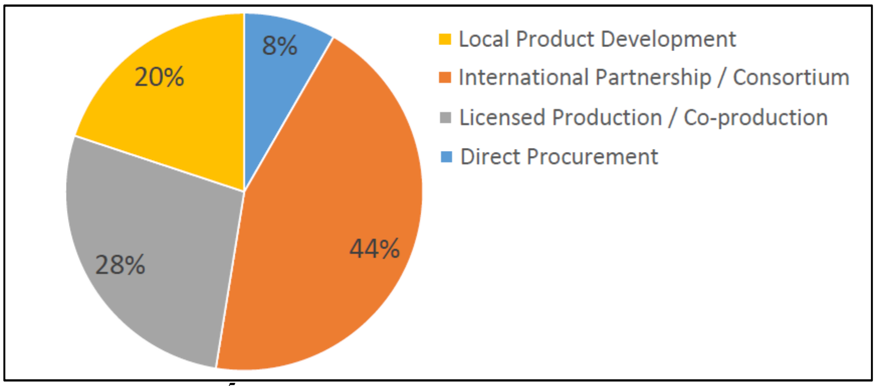
- To carry out the decisions taken by the Defense Industry Executive Committee which is chaired by prime minister,
- To reorganize Turkish industry in line with the prerequisites of the defense industry,
- To plan the production of modern arms and equipment at private and public sector entities,
- To conduct research and development of modern arms and equipment and to have their prototypes manufactured,
- To coordinate export and offset trade issues relating to defense industry products.

SSM performs these functions through different tools such as; Major Systems Acquisition, R&D and Technology Management, Industry Policy Making, Industrial Participation/Offset, Localization, Credits and Investment Financing, Clustering Activities, International Industrial Cooperation, as well as Quality, Test and Certification. SSM implements a prioritization approach for procurement models as follows;

1. Local development; involves indigenous design and development of priority systems and intends the enrichment of the product portfolio of industry and international market share.
2. International consortium participation in joint development programs; when domestic development is not considered cost-effective.
3. Co-development/co-production, active participation of domestic industry, production under license, joint production - joint-marketing; this model is intended to provide opportunities for local industries.
4. Direct procurement; only if above options are not feasible.

[4] http://www.ssm.gov.tr/home/institutional/Sayfalar/law3238.aspx accessed on February 28, 2015

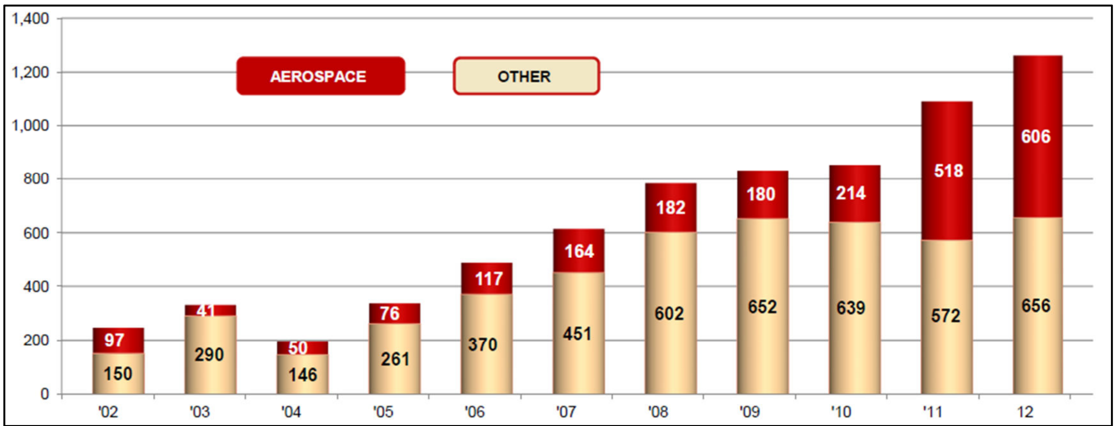
Distribution of SSM procurement models is given in Figure 2. Although the first priority is the procurement through local development, in actual case the most realized model is international consortium participation in joint development programs. Nevertheless, the least proportion of direct procurement model is in compliance with SSM's procurement strategy.



Source: SSM (2014)[5]

Figure 2 SSM procurement models distribution

In Figure 3, defense and aerospace export in Turkey is provided based on the evaluations by SSM. Within the increasing trend in overall defense exports in Turkey, the proportion of aerospace industry is also significantly increased in the recent years.



Source: SSM (2014)[5]

Figure 3 Defense and aerospace export in Turkey (Million USD)

[5] Turkish Defense & Aerospace Industry and Acquisition System, SSM, January 2014

Transport, Maritime Affairs and Communications Research Center is another important player related to the aerospace industry in the public sector. This center is under the Ministry of Transport, Maritime Affairs and Communication and has been founded by The Government Decree-Law no. 655 on "Organization and Duties of the Ministry of Transport, Maritime Affairs and Communications" published in the Official Gazette of November 1, 2011 and begun active duty in 2014. The Research Center is tasked with carrying out the activities of assessment, funding, monitoring and accomplishing of the projects related to research, development and education activities aiming domestic design and production in the fields of aerospace and electronic communications. In addition, the efforts for the establishment of Turkey's Space Agency under the auspices of the Ministry of Transportation, Maritime Affairs and Communications are continuing and Turkey Space Agency is planned to be activated in the year 2016. [6]

2.2.2 Turkish Companies in Aerospace Industry

According to a recent survey study, 46 Turkish aerospace companies that have participated in European Union Framework Program-7 (EU FP7) have been investigated. In this analysis, companies were categorized according to their response to questions, which aim to figure out below mentioned capabilities[7];

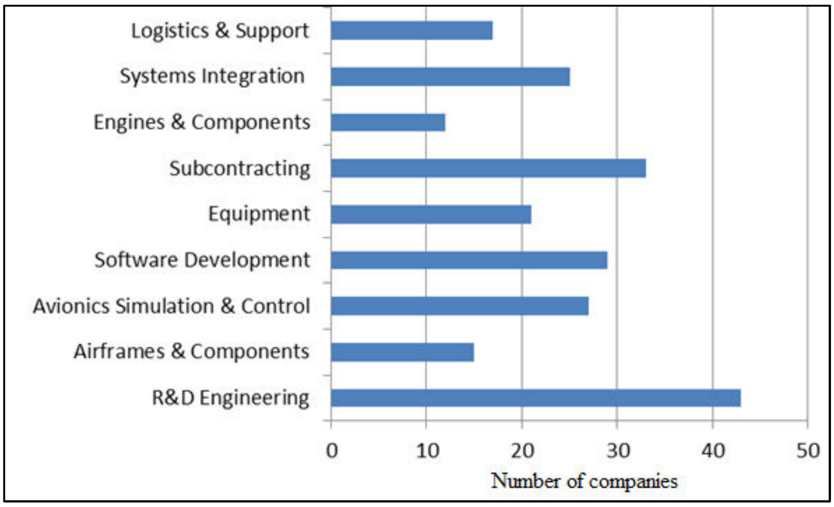
- R&D Engineering: Companies having indigenous R&D capability in terms of infrastructure and manpower.
- Airframes & Components: Companies having fixed and/or rotary wing aerial platform /component/detail part design and manufacturing capability.
- Avionics Simulation & Control: Companies having avionics, simulation, command and control system and/or sub-system design and manufacturing capability.

---

[6] http://gait2015.org/slide/GAIT%20Panel%20C2%20Mehmet%20Ali%20Deg%C3%8C%C2%86er_eng.ppt accessed on November, 2015

[7] http://www.cleansky.eu/sites/default/files/documents/calls/turkishaerospacecapabilitymatrix.pdf accessed on February 28, 2015

- Software Development: Companies having software development capability.
- Equipment: Companies manufacturing onboard equipment.
- Subcontracting: Companies providing services for special processes to main system suppliers.
- Engines & Components: Companies having engine component/detail parts design and manufacturing capability.
- Systems Integration: Companies having system integration capability.
- Logistics & Support: Companies providing ground support services.



Source: Cleansky (2015)[7]

Figure 4 Turkish aerospace companies capability matrix

According to the results of this survey given in Figure 4, the weakest capabilities among the Turkish aerospace companies are related to detail design & manufacturing. Moreover, companies did not react discreetly by declaring a huge capability in R&D, which probably is not the actual case. Even if the companies have the human capital, access to external knowledge and company vision, much more is needed for higher level achievements in technological readiness. For the qualification of newly developed technologies, environmental demonstration tests have to be conducted, which require expensive and sophisticated manufacturing and test infrastructure. Therefore, while evaluating the affirmative responses of Turkish aerospace companies that indicate 93% of the companies has the R&D capability, the goals set for R&D efforts in terms of technology readiness level, which is introduced in Section 3.2.4, have to be considered to evaluate the real capacity of the industry.

2.2.3 R&D Strategies of SSM and Funding Opportunities

At the 6th meeting of the Supreme Council of Science and Technology (SCST) held on December 2000, Turkey set the target of increasing the share of R&D in GDP from 0.67% to 2% by 2010. It had also been decided to actively participate in European Union 6th Framework Projects - FP6 (2002-2006) and, therefore, in European Research Area (ERA). Upon the decisions made at the 7th meeting of the SCST held on December 2001, the document entitled “Vision 2023, Science and Technology Strategies” has been formulated with the aim of forming the scientific and technological vision of Turkey. This strategic document has the goals of increasing Turkey’s production power and the net added value relying on its brainpower by enhancing competence in science, technology and innovation. In line with these developments, new policy measures have been implemented by the Turkish government. The most recent strategy document is “National Science, Technology and Innovation Strategy 2011-2016”, which was approved during the 22nd meeting of the SCST.[8]

Another example for the recent declarations of the government policies has emerged in the form of "2009-2016 Defense Industry Sectoral Strategy Document"[9], which was published by SSM in order to lead the defense industry. This document sets out particular targets in such a way that domestic development and R&D are especially highlighted as the most important goals in that document.

In line with the abovementioned targets, SSM has been supporting technology intensive R&D activities in priority areas, compatible with the needs and objectives of main system projects that involve collaboration of the industry, universities and research organizations. Scope of the R&D projects, which are treated as a parallel process that supports the procurement process including domestic development,

---

[8] Ulusal Bilim, Teknoloji ve Yenilik Stratejisi (UBTYS) 2011-2016, TÜBİTAK, 2010

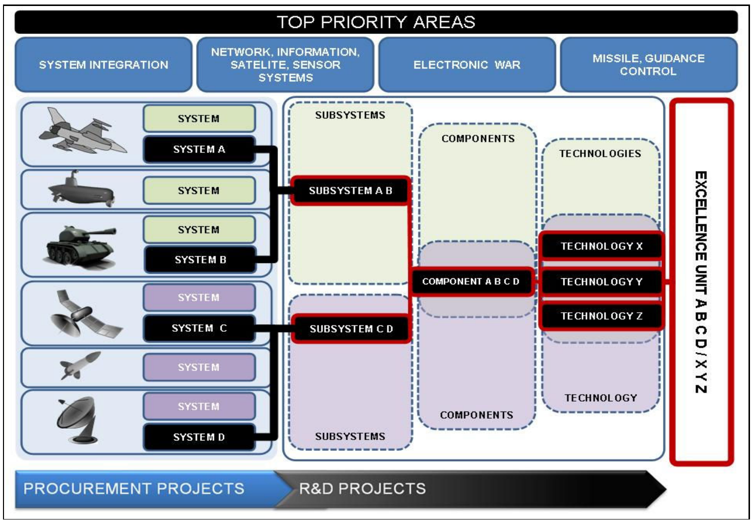
[9] "2009-2016 Defense Industry Sectoral Strategy Document" of Undersecretariat for Defence Industries, April 2009

varies from basic research and applied research to experimental development. R&D projects can be executed in advance of or concurrently with the main system projects, and aim to minimize external dependence in the future. According to SSM, significant technological achievements in R&D studies conducted by SSM so far have become the building blocks of the main system projects today[10]. However, this statement needs to be questioned attentively and the thesis contains discussions on this issue.

The R&D roadmap developed by SSM, illustrates the contribution of technology in the acquisition process. In this roadmap, R&D projects and procurement projects are handled as two separate processes where R&D projects are supposed to assist all procurement projects, including local development. In other words, as shown in Figure 5, R&D is not seen as a procurement process in itself. Moreover, in general, R&D is a desired and esteemed portion of system-level development 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 within the R&D becomes to be a contractual obligation to be fulfilled within the defined period of project, and it is not possible to innovate under performance obligations.

In Turkey, there are some other funding mechanisms for R&D programs that aerospace industry can make use of. The Scientific and Technological Research Council of Turkey (TÜBİTAK) Support Program for Research Projects of Public Institutions are designed to solve public institutions problems while contributing to capacity improvement of Turkish industry in R&D. Technology Development Foundation of Turkey and Small and Medium Enterprises Development Organization also provide funds for R&D. Besides there are some recent measures to encourage companies to conduct R&D efforts like the "*The Law Concerning the Promotion of Research and Development Activities - Law no:5746*", which provides some financial privileges to companies that perform R&D activities.

[10] http://www.ssm.gov.tr/home/tdi/radsup/Sayfalar/RDSupport.aspx accessed on February 02, 2015



Source: SSM[10]

Figure 5 SSM's R&D approach

Turkey was the second fastest growing economy in the first and third quarters of 2011, after China. Accordingly, there is a strong potential for growth in the aerospace sector in the long run and Turkey's strategic location as a hub offers access to other countries' markets in the region. In this manner, Turkey is a country proposing important occasions for foreign investors with its geographical position as a gateway between Europe, Central Asia and Middle East.

On the other hand, in Turkey *offsets* are compulsory for all defense procurements exceeding US$10 million, and foreign investors are expected to invest 50% of the contract value into the country's defense sector. This additional off-set agreement obliges the foreign investors to fulfill the requirements within a period to a maximum of a further two years after the termination of the procurement program. TUSAS Engine Industries, Inc. (TEI) and FNSS were established by foreign OEMs through joint ventures with domestic firms in order to fulfill offset obligations. This provided an access to external knowledge to be utilized by domestic companies. One of the most recent developments for these collaborations was in 2010, between Raytheon (USA) and Turkish military electronics manufacturer Aselsan. [11]

[11] http://www.aselsan.com.tr/en-us/InvestorRelations/Documents/Annual%20Reports/2010_ENG.pdf accessed on October 02, 2015

CHAPTER 3

THEORETICAL BACKGROUND AND CONCEPTUALIZATION

3.1 ABSORPTIVE CAPACITY AS A TOOL FOR DEVELOPMENT

3.1.1 Brief Description of Knowledge

In order to study knowledge economies, a conceptual understanding of knowledge is required to be used in economics and it is necessary to depict the "term of technology". According to the developed body of literature on knowledge economy, there seems to be a common understanding of "term of technology" has been obtained such that; technology is the making, usage, and knowledge of human designed tools for achieving a particular goal. Obtaining such tools entails knowledge, procedures and artifacts. Additionally, technology paradigm is defined as; problems, needs and technical requirements to be addressed and the encompassed scientific and technical principals to meet relevant tasks. In the same technology paradigm, design concepts are said to be similar and manufactured products are also similar (Dosi and Nelson, 2010). As the technology paradigm changes, the economic value of knowledge related to old paradigm may decrease. Furthermore, "technological trajectories" have been accepted to be the progressive improvement of the design concept while radical innovations are linked to paradigm changes.

According to neoclassical school, "technological knowledge" is characterized as non-rivalrous and non-excludible (pure public good), therefore, such goods may be consumed by multiple people without diminishing their utility to each user.

Additionally, it is assumed that there are similarities between "information" and technological knowledge; both are non-rivalrous, indivisible and infinitely reproducible. Within neoclassical approach, capital is something tangible to early economists and technological change is explained using the relation between capital and labor without giving importance to the recipes, routines and artifacts. Technological knowledge is accepted as information. The neoclassical theory is based on a representative firm, which has perfect market functioning and always maximizes its profits (Solow, 1957).

In contrast to the neoclassical theory, "Evolutionary Economics" (Schumpeterians) and the "Modern Growth Theory" (Romer, 1986) have modeled endogenous forms of learning, "creative destruction" processes, externalities, increasing returns to scale and imperfect competition. Rather than starting from the representative firm, the focused notions of this theory are disequilibrium, imperfect information, bounded rationality and evolutionary sequences.

Dosi and Nelson (2010) represented "technological advance" as an evolutionary process. It has been depicted as a "competition" by some researchers and accordingly there are winners and losers of this competition. Abilities to innovate and imitate are drivers of industrial evolution and these are the major determinants for the winner. The assumptions of Mainstream Economics have been criticized by Evolutionary Economics. The main shortcomings of Mainstream Economics have been stated as follows;

- Every agent cannot be identical and does not have the super calculating (or rationalizing) capability.
- It is not possible for every agent to interact with others without any limitations. In practice there exists a more heterogeneous structure. The assumption of "everybody knows what everybody else is" is not valid.
- From the perspective of networks, the main shortcoming of Mainstream Economics is the lack of importance given to relations and interactions, in other words lack of social context.

Neoclassical model only deals with codified knowledge where wisdom does not affected by knowledge. However, from the perspective of the Evolutionary School, knowledge has a long-term effect on wisdom. Ancori et al. (2000) argued that knowledge formation requires continuous feedback loops between data, knowledge and wisdom and they emphasized the importance of cognitive capacity. Knowledge is closely dependent on the cognitive abilities of the actors.

According to Katz (1999), technological behavior is determined by the co-evolution of micro, meso and macroeconomic forces (micro level: related to the learning strategy of each individual firm, meso level: competitive and technological regime in each particular industry, macro level: refers to regulatory systems, institutions and public policies applied in the fields of science and technology). Additionally, sustainable economic growth cannot simply be explained by increases in physical capital, natural resources or population and besides these factors do not guarantee long-term economic growth. Long-term sustainable growth depends on science, technology, innovation and knowledge accumulation (investment in education, lifelong education, accumulated scientific knowledge, etc.).

Polanyi's famous aphorism, “we know more than we tell” has long been used as a traditional description for tacitness. Tacit knowledge is the component that helps us transform information into knowledge and generally consists of habits and culture that we may not recognize in ourselves. Dosi and Nelson (2010) highlighted the differences between information and technological knowledge concluding that replication of technological knowledge has cost because of “tacit” nature of knowledge. Dolfsma (2008) also supports this vision and states that information needs interpretation. The sharing of tacit knowledge is non-verbal and generally has cultural dimensions.

Explicit knowledge refers to knowledge that is codified. Know-that is the conscious knowledge and can be articulated. On the other hand, tacitness refers to knowing-how and involves conscious and unconscious knowledge covering more than know-that. Tacit knowledge refers to knowledge that is deeply rooted in the human mind and is hard to codify. In other words, tacit knowledge is based on experience: people acquire it through observation, imitation and practice.

There is a general tendency to label tacit knowledge as “local” and codified knowledge as “global”. Codified knowledge may travel the world with gradually less friction. This physical metaphor may remind us about another physical phenomenon of “losses”. Assume a static object at a high altitude, in other words with high potential energy. If one wants to accelerate this object just by converting its potential energy to kinetic energy, theoretically, there is an expected maximum velocity that the object may reach. However, the concept of frictional or other types of losses prevents to reach this theoretical maximum. When we apply this to knowledge transfer, frictional losses or other types of losses prevents hundred percent success even when the knowledge attempted to be transferred is considered to be highly codified. Besides, there are usually considerable costs associated with identifying, assessing, assimilating and applying codified knowledge.

Balconi et al. (2007) defined information as; “the knowledge reduced to messages that can be transmitted”. In another research, Ancori et al. (2000) tried to distinguish the notion of knowledge from the notion of information and for this purpose they introduced the modes of conversion of knowledge. Knowledge must be put in a form that allows it to be exchanged in order to be treated as an economic good. The way of providing this is to transform knowledge into information through codification. However, whole knowledge is not reducible to information and production of codified knowledge would come with the production of new forms of tacit knowledge, which means that codified knowledge requires some tacit knowledge to be useful. The acquisition of tacit knowledge is a highly cognitive process. Moreover, codification may be very difficult and expensive for complex cases.

The development of new knowledge has been stated as a result of cooperation between individuals. Development process follows technological trajectories and involves tacit dimensions requiring coding and decoding, wherein, tacit knowledge can be depicted as the knowledge which is not expressed, and/or not expressible and/or not transmittable. Tacit knowledge is hard to encode and communicate. Some authors use the words “liquid and leaky” to define tacit knowledge, where explicit knowledge is represented as “solid and sticky”.

Balconi et al. (2007) categorized knowledge in three major groups;

- Knowledge as competence; ability to perform certain types of activities
- Knowledge as acquaintance; related to previous experiences
- Propositional knowledge; recognition of information to be correct.

According to the above categorization, Balconi et al. (2007) announced that codification is transforming competence into propositional knowledge. However, they highlighted the need to satisfy the isomorphia of meaning in order to obtain perfect codification. Because of its inter-subjectivity codification is not hundred percent possible in practice. Therefore, according to Balconi et al. (2007) tacit knowledge is exchanged face-to-face more effectively than at distance.

Morone and Taylor (2010) also proposed that, as tacit knowledge is hard to encode and communicate and the acquisition of tacit knowledge is a highly cognitive process, methods involving direct interaction, as in the case of networking that includes face-to-face interaction and practical experiences are more suitable for the transfer of tacit knowledge. Furthermore, machines are produced using knowledge and knowledge within machines can be named as “embodied knowledge”. Acquiring machines, with embodied (or embedded) knowledge, instead of acquiring tacit knowledge may lead to faster pace.

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. Socialization of knowledge provides a substitute to individual knowledge.

Embedded knowledge cannot move easily across organizational boundaries. When there are more than one individual in the process of learning; then there is a need for common classification, common language, collective learning and sometimes shared vision. Organizational context in which agents interact and communicate is the key for common knowledge (Ancori et al., 2000).

Foray (2004) took a further step from the difficulties in codification and argued that codification mutilates knowledge creating gaps as in the example case of the relation between long-plays and digital music CDs. Developments in ICT helps closing the so-called gaps. However, this time there is another extreme such that if there is enormous knowledge codification this may harm the creativity and may lead to lock-in in the long-term. Additionally, as excess codification impedes the flexible problem solving mechanisms of the organizations this may not help in situations with big variety of problems.

Simon (1999) stated that economics is concerned with the costs of acquiring knowledge (discovery or transfer), the costs of storing it, the costs of retrieving it (when it becomes relevant), and the opportunity costs of focusing to a piece of knowledge at the sacrifice of ignoring others. According to Simon (1999), knowledge acquisition depends on the speed and costs of creating new knowledge, and on the rate at which knowledge can be transferred. Therefore, lowering the costs of transferring knowledge is a very high priority activity.

3.1.2 Innovation and Innovation Systems

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 intra-firm relations. Innovation involves the use of existing knowledge, as well as the ability to generate and acquire new knowledge. According to OECD (2001), innovation is categorized in four groups; product innovation, process innovation, organizational innovation and marketing innovation.

When compared with innovation, “basic research” is “curiosity oriented” where the goals are totally different than of innovation. The expected results of basic research are generally public goods open to public usage. That is why in general firms with their profit-oriented nature, do not find an economically beneficial position to perform such an activity by themselves. Such activities are mainly performed by universities or non-profit research agencies. This situation can be named as a “market failure” such that basic research cannot be a responsibility of industry. But today especially big companies may conduct such activities with a strategy aiming that exterior-firm factors would be profitable in return in the long run. Besides, patents are given to inventions, not to innovations.

Future is more predictable according to neoclassic approach. However, according to Evolutionary approach, innovation is uncertain in terms of technological and economic success. Technical success of a technology does not guarantee the economic success. Until 1990s, the process of innovation is not studied in details and researchers only gave importance to the outcomes like export performance, performance in stock exchange, competitiveness, etc.

In the “black box model”, which emerged in late 1940s, technological knowledge was taken as a “public good”. Technology-push innovation model can be dated to the period between 1950 to mid-1960s and it was affected by the development process of Manhattan Project. In this model end user had no effect on the innovation process in contrast to learning by using. There were even no horizontal intra-firm interactions. The basic research had been treated as the most important stage. In the “market-pull model”, which was dated to mid-1960s to early 1970s, the market was the main source of innovation. Investments were made in order to rationalize the capabilities rather than to have new products.

In the “interactive-models” of innovation, which possibly emerged in late 1970s, design stage was the most important stage which initiates innovation (Kline and Rosenberg, 1986). This model introduced innovation, which was no longer sequential. The importance of feedbacks was understood in such a way that feedbacks serve to evaluate firm performance, firm competitive strength and to define further steps. In this model innovation was taken as a learning process. However, in the center of innovation there existed “design” rather than research on the contrary to the case defined in linear model where research was the initiating stage. Moreover, the importance of the interaction between research and the process of innovation was underlined with a statement that innovation was not merely applied science. According to this model, no matter how sophisticated R&D process is implemented and how qualified are the utilized labor, software and hardware, it is not possible to achieve the perfect product at the first iteration and feedbacks are very important in that manner.

Today, it is obvious that firms cannot innovate by themselves and interactions are required like cooperation, mutual dependency etc. Besides, in addition to inter-firm relations, intra-firm relations are also very important, such as relations between engineering, manufacturing and sales departments of the same company. These relations increase the possibility of successful innovation. Alternatively, institutions form the boundaries and ways of interactions and can be seen as (written or not) regulations between interacting parties. According to Shariff (2006), “*National Innovation System (NIS) is the set of institutions that (jointly and individually) contribute to the development and diffusion of new technologies”*. Using those institutions, governments can implement policies to influence the innovation process. A national system of innovation may be defined as; that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process (Metcalfe, 1997).

According to Kline and Rosenberg (1986); NIS are defined as "*organizations that promote the creation and dissemination of knowledge as the main sources of innovation*". However, it is difficult to plan the schedule of process of innovation. It is an evolutionary process that innovation systems may change in time in an unpredictable way with their own dynamics. In case of knowing all the determinants of innovation, it is not possible to establish and control the innovation system. In the NIS; the important relations between activities and components are relations between organizations-activities, institutions-activities, interactions among organizations and relations between organizations and institutions. Countries may have different NIS regarding their type of funding private R&D, competence provision, management, incentives to entrepreneurs, etc.

National innovation systems are becoming internationalized, even if the institutions that support them remain country-specific. However, know-how that gives firms competitive advantage is less internationalized and even very large corporations perform most of their R&D at home. In other words, competitiveness of firms depends on national systems of innovation and national systems of innovation depend on government policy (e.g. competition, macroeconomics, the behavior of national institutions, agencies funding basic research, banks and stock markets, systems of corporate governance)

Correspondingly, Carlsson (2006) stated that companies' innovative activities are influenced by their national system of innovation in terms of;

- the quality of basic research,
- workforce skills,
- systems of corporate governance, the degree of competitive rivalry,
- local inducement mechanisms (abundant raw materials, the price of labor and energy, and persistent patterns of private investment of public procurement).

While institutions are important for the formation and functioning of particular innovation systems, they may also slow down internationalization of innovation systems because of the differences in terms of intellectual property rights, education system, funding of basic research, financial institutions, fiscal, monetary and trade policies, laws, etc. The internationalization of innovation occurs at a slower pace than the internationalization of production.

R&D-intensive industries such as aerospace, biotechnology, software and computers tend to be highly concentrated spatially. Because of the tacit nature of knowledge, knowledge spillovers are mostly local (not national or not international) and this leads to the formation of clusters. According to Carlsson (2006), industry clusters and regional innovation systems are vehicles for internationalization of technology.

Starting from 1990s, notion of "globalization" emerged as a cliché of capitalist system, which can be defined briefly as the connection of regions through global production pipelines. Globalization and regionalization are complementary concepts. When we consider region as an economic environment, notion of "cluster" can be used to define region and it can be stated that "clusters are dense network between economic agents". There might be governing agents such as universities, research centers, financial institutions or big companies. Nowadays, the development and upgrading of "clusters" is an important agenda for governments, companies, and other institutions.

Industrial agglomerations are stated as "clusters" by Porter (1998). "*Geographically extensive areas throughout nations and even beyond their borders.*"(Porter, 1998). The idea behind this statement of agglomeration refers to geographical groupings of intra-sectoral firms. As the SMEs tend to shift to a "flexible" structure in terms of production or labor, sectors that the cluster members involve in may differentiate in time. However, the cluster is expected to remain within the shared "value chain", which is the most important notion in clusters. Moreover, it is important to keep in mind that the supply chain is not sufficient to develop clusters and value chain can be improved as a result of repeated interactions.

In order to convince the people that clusters are not necessarily a success story in all cases it is important to highlight the fact that "clusters cannot be established" or in other words "they are or not." Therefore policies aiming to building up clusters are totally misleading approaches with waste of time. However, it is possible to develop sources of prosperity. Clusters can be seemed as a part of innovation system. It is not possible to build up a cluster but it is possible to edit innovation system and manage clusters.

When the relations become formalized through contracts or similar documents, it becomes possible to manage knowledge flow and consequently leads to the formation of networks. At that point it is possible to state that clusters cannot be created, however networks within clusters can be.

Cluster's performance depends on the harmonized supply chain and directly linked to absorptive capacity of the suppliers. Regarding the varying absorptive capacity of companies, even the knowledge flows expected to be symmetrically spread among the companies within a cluster, some companies can achieve competitive advantages that others could not obtain. Firm's absorptive capacity not only depends on its individual employees and managers but it also depends on the number and extent of its pipelines. Clusters provide the suitable environment for successful spillover, which is an externality of knowledge transfer from external sources received via pipelines. Bathelt et al. (2002) introduced the concept of pipelines to define knowledge creation across clusters and referred to channel used in distant interactions. Decisive, non-incremental knowledge flows are often generated through 'network pipelines'. Global pipelines also help to strengthen local interactions between cluster actors. Establishing pipelines requires considerable time and efforts. They are not created automatically and do not continue to exist without regular communication and interaction.

OECD (2011) focuses on the role of regional actors in the act of supporting innovation. Regional innovation policy is depicted as an instrument of regional growth. Furthermore, "context specificity" is a notion of lacking knowledge creation due to insufficient absorptive capacity, path dependency and lock-in. Although in general regional innovation systems are stated to be context-specific, it is important to keep in mind that RIS model emphasizes the importance of being articulated to global chains without pure isolation. Also ability of learning is the key point for success.

The “path dependency” thesis states that institutional transformation is affected only slightly by foreign institutions, and learning can take place only within the framework of existing institutions. “Path dependency” explains the difference between the theoretical assumption of efficient institutional development and the durability of inefficient institutions. (example; QWERTY keyboard; it has a suboptimal design but by the help of positive network externalities, in other words high number of users, this approach found the chance to be durable.) Similar mechanisms are valid for institutions as well. Institutions require high start-up costs, learning costs and coordination costs that arise for the adaptation of formal and informal rules. Transformation of institutions is limited by the path (legacy of the past), as in the example of QWERTY, it may be rational to hold on to a suboptimal institution. Actors leave the path only when efficiency losses are greater than the costs for creating a new, more efficient institution. (Scherrer, 2005) However, efficiency cannot be determined objectively for institutions.

In a specific sector, being path dependent is mainly linked to the regression of this sector most of the time. Furthermore, path dependency indicates the existence of heritage and existing knowledge on a specific issue. According to Scherrer (2005) the simultaneous existence and the pattern of interaction of a series of institutions (old and newly transferred) is vital for success.

In the case of Turkey, national agencies are more effective in the management of regions (like TUBİTAK, KOSGEB). This is a result of path dependent history related to the experiences gained. Although development agencies play an important role in decentralization, national agents are still dominant in Turkey. If an industry is considered to be an important industry by the government, decision makers feel the pressure to make interventions. Historical experience is very effective in the decentralization process.

As introduced by Granovetter (1983), the economic sociology term "embeddedness" is the idea that economic relations between individuals or firms are embedded in actual social networks and do not exist in an abstract idealized market. The term embeddedness involves effects of social relationships, like trust and cohesion, on economic outcomes. It is stated that there is an inertial tendency to repeat transactions over time. Besides there exists an important knowledge flow between friends and close associates. Recent economic approaches have been giving much importance to over-embeddedness and related issues like strong ties, weak ties, filling a structural hole, social capital, network density, individual performance, etc. However, it is difficult to gather "new" knowledge from the ones very close. Distant connections may be more important considering the "new" type of knowledge.

"Learning process" establishes and shapes an "economic region". However, repeated interactions, which can be stated as obstacles to new knowledge generation, lead to "lock-in". In other words, having interactions with only the same partners for a long time prevent creation of new knowledge. Such relations may target profit maximization, but on the other hand strong relations may shift to "over embeddedness". When considering a sector like aerospace, such repeated interactions can also occur at international level. In order to prevent possible harmful effects of repeated relations, parties need to search for new knowledge continuously.

There are some other approaches to define the systems of innovation like Sectoral Innovation Systems, which is considered to be more suitable to discuss under developing country perspective. According to Malerba and Mani (2009); "*a sector is a set of activities that are unified by some linked product groups for a given or emerging demand and that share some common knowledge.*" In line with this explanation Sectoral Innovation System (SIS) consists of;

- the regimes of knowledge and technologies,
- demand conditions,
- actors and networks and the coordination among them,
- the surrounding institutions, including IPRs, laws and culture.

SIS is a notion based on Italian tradition. In this approach there is "developing country perspective", which is also suitable for Turkey. On the other hand, neoclassical school or industrial economics are concepts emerged in developed countries and such concepts can be more difficult to adapt to developing countries.

Sectoral knowledge base naturally covers the concepts of "accumulated knowledge" and "path dependency", which are not introduced in neoclassical school. Furthermore, relations between universities and companies (and other similar relations), which can be named as "non-market interactions", are also embraced by SIS. Inter-agent relations involving trust, beliefs and behaviors or the shaping of interactions via institutions are major differences of SIS compared to neoclassical approach. Notion of "cognitive lag" clearly defines the natural differences in perception of industry and universities, which is important to figure in SIS.

In regional innovation system or national innovation system, it is also possible to analyze sectors, but differently in SIS, the starting point is the sector, and therefore the methods of analysis are expected to be different than RIS and NIS. Sectoral data is more important in SIS than national or regional scope. However, the basics of all systemic approaches are similar.

Bergek et al. (2005) defined the dynamics of sectoral innovation system (SIS) covering structural components and functional patterns as well as the methodology to understand the character of a SIS. The methodology is introduced step by step through easily understandable definitions; starting from defining the focus of attention while defining SIS; identifying the structural components of the SIS; defining the functions within the SIS; assessing how well the functions are fulfilled; identifying features in the structure inducing or blocking development; specifying key policy measures; evaluating the expected impact of different policy instruments; and improving the whole process through feedbacks. It is a common misleading approach in developing countries to rely on same type of incentives (funding in most

cases) for every problem. After recognizing the relations between sectoral agents, some other more effective types of incentives might be suggested.
Maturation of an innovation system takes a long time. This long period of time forces decision makers to forecast about the possible future environments. The major problem is the high level of uncertainty. It may be understandable to tend to define measures as imitations of successful implications emerged in other sectors and/or regions. However, one has to keep in mind that "one size does not fits all" and new (sector-specific) approaches might be probably required to fulfill the future goals of developing SIS. On the other hand, the terminology of "optimization", which is broadly used in natural sciences, is not applicable to the policy problem; it is not feasible to specify all possible outcomes.

The main actors in a SIS are similar to the actors in NIS and RIS; firms along the whole value chain, universities and research institutes, public bodies, influential interest organizations (e.g. industry associations and noncommercial organizations), venture capitalists, organizations deciding on standards, etc. It is important to understand if there exists a relation between actors and the focused sector or technology through analyzing industry associations, exhibitions, company directories and catalogues; patents; bibliometric analysis and through interviews with experts.

In order to describe the "functional pattern" of the SIS it is necessary to formulate policy goals and policy problems in functional terms. Knowledge development and diffusion are stated as an important function and type (scientific, technological, production, logistics, application specific, etc.) and source of knowledge development (R&D, learning from new applications, imitation, import, etc.) are important within this function. "Influence on the direction of search" is another important function such that, sufficient incentives and pressure on firms are important. This can be understood like that; expectations and belief in growth potential may not be envisioned by companies and proper level of forcing by state is required. Especially for "critical technologies" related to aerospace and defense industry, successful involvement of state is crucial. Other important functions are mentioned as entrepreneurship, market formation, legitimation, resource mobilization and development of externalities.

Bergek et al. (2005) introduced "unaligned institutions" as a blocking mechanism, which leads to poor market formation and duplications, waste of resources and target contamination. Policy issues shall be specified aiming an improvement in the targeted functional patterns by strengthening inducement mechanisms and removing blocking mechanisms. Bergek et al. (2005) used a modernist approach in a way that it relies on the rationality of neoclassic theory but attached no importance to tacit type of knowledge. They did not also focus on the issues regarding forecasting and decision making, which are the most challenging issues in setting up a policy. A good method to estimate possible future impacts of a measure might involve blending of real cases and real impacts with dynamics of the focused sector aiming some sort of a probability analysis. Although, Bergek et al. (2005) mentioned that optimization does not work for policy issues, paraphrase by Lord Kelvin "*if you can measure it you can improve it*" is also suitable for policy issues.

The most important weakness of SIS approach is that; it does not give importance on "labor market". It behaves to labor as an objective component. Labor market depends on wage rates, conditions of employment, level of competition, job location and additionally willingness of the employees. Education and even cultural aspects affect the willingness and readiness of the employees. In Turkey, for example, mobility is not encouraged, which is an indispensable element for diversity and continuous development, hence related policy mix would better involve measures to encourage diversity and mobility.

Vertesy and Szirmai (2010) analyzed the role of sectoral innovation systems in the emergence and catch-up of aerospace industries in latecomer economies. They stated that changes in the global competitive landscape and major political developments trigger crises in the aerospace industry, with which existing systems of innovation are unable to cope. According to their conclusions, the aerospace sector is characterized by a process of "interrupted innovation". According to this introduced terminology, competitive pressures and the cyclical nature of the industry not only require shifts in the direction of innovation and changes in the production system, but also periodical restructuring of the whole sectoral system of innovation. As infant aerospace industries develop and face increased competition, the underlying national-sectoral innovation system undergoes both gradual expansion and radical transitions. After periods of gradual expansion along a given trajectory, the innovation system undergoes interruptions, which radically affect the institutional framework.

New growth theory and evolutionary economics introduced the link between innovation, technological change and economic growth. A careful look at what lies “inside the black box” of technology and innovation revealed the crucial role of historical context and institutions. The development of national technological capabilities required for industrialization was found to depend on the interplay of incentives, capabilities and institutions. 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. (Vertesy and Szirmai, 2010)

3.1.3 Learning and Technological Capability Building

Knowledge involves cognition and it is generated through a cognitive process within which information is articulated with other information. This process can be labeled as “learning”. According to Dolfsma (2008), learning is an investment on human capital. However, as knowledge on a specific topic may not be measurable, as a result, return to investment may not be measurable. Learning in the sense of building and deepening capabilities to innovate is conscious, purposive and costly, rather than automatic and passive (Lall, 1992; Malerba, 1992).

Hey (2004) used metaphors to clarify the relation between data, information and knowledge. He reminded metaphors like data mining, raw data, information flow, information overload, information explosion or codification of knowledge. In this context, data can be defined as unprocessed information. It is discrete and can be mined or extracted. “Data” can be seen as manipulable object besides measurable and have no meaning. On the other hand, “information” is quantifiable, transferable, and measurable and it has shape. It can be processed, accessed, generated, stored, distributed, and duplicated and therefore, information can be seen as “data with meaning”. For the process of creating knowledge, the relationship between pieces of information is critical. In the information age (case of information explosion or flood) such relations are easily lost. Hey (2004) states that knowledge is generally personal and subjective. It is found within the heads and it is possible to possess knowledge, which is impossible with data. In other words, information is the flow, and knowledge is the stock.

According to Polanyi (1969), “knowledge is an activity which would better be described as a process of knowing”. Knowledge is a key component for individual and collective growth and a firm’s ability to innovate depends largely upon its ability to capture human intellectual capital effectively. In addition, firms can enrich their knowledge base: through the use of the internal resources (through R&D activities or learning by using or doing) or through the use of resources located externally (‘learning by interacting’). Supportively, according to Forbes and Wield (2003), the effort required to build technological capability can be separated into two categories:

- Learning by doing is a passive, automatic and costless by-product of production
- Learning by investment is more complex since it involves at least three categories (learning by analyzing, learning by explicit action, research and development)

Passive “doing-based” learning is insufficient for efficient capability building. In addition to “doing”, learning process shall include training, hiring foreign advisors, changing and adapting imported technology, monitoring the production performance, and searching new technological solutions. Besides, learning does not possibly occur in all firms.

Innovation, knowledge creation and learning are results of interactive processes, in which actors with varying type and depth of knowledge act to solve some technical, organizational, commercial or intellectual problems. Bathelt et al. (2002) state that knowledge is created, stored and utilized locally in a decisive manner and "decision making" is also a cognitive process based on the existing knowledge base.

For knowledge creation within firms; "visions, values, and memories in the form of artifacts, routines and experience" are keywords. It might be expected that there is an automatic educational process for new employees to catch-up. However, as the size of the firm increases and the borders between the specialties of departments within the firm become highly visible, this process cannot occur automatically and a natural diversity (or heterogeneity) within the firm emerges. When experts from different departments get together to develop a new idea to a situation, because various sources of tacit knowledge are articulated, the possibility of suggesting fruitful solutions are increased. However, the responsibility definitions of departments shall clearly be defined so that overlapping or destructive competition within firm can be avoided. The concept of "core technological capabilities" is used for the abilities that distinguish the firm and allow it to create a sustained competitive advantage based on the technology in a changing context. Tacit knowledge can be depicted as the base of the core capabilities/competencies of firms. According to Dutrénit (2004), literature on strategic management, based on the most innovative firms in the advanced countries, has focused on analyzing the core technological capability building. On the other hand, the relevant literature for latecomer companies has focused on analyzing the learning processes involved in the continuing building up of technological capacities to be able to carry out innovative activities. These can be summarized as; the ability to use technological knowledge efficiently to assimilate, use, adapt and change existent technologies; the ability to create new technologies and to develop new products and processes.

Technological capabilities include a technological aspect and an organizational aspect and within the organizational aspect the behavior of firms is very important in the process of building up technological capabilities. As Dutrénit (2004) has pointed out, lack of technological knowledge is rarely the cause of innovation failure in large firms. The main problems arise in organization. Companies which have accumulated knowledge and built the minimum essential knowledge base and, even more, are close to the international technological frontier in some areas, may have not yet built core capabilities. In addition to prior knowledge resources, firms to develop their organizational capabilities that enable them to apply current and newly acquired.

According to Foray (2004) "knowledge spillovers" can be defined as "*valuable knowledge generated somewhere that becomes accessible to external agents*". Morone and Taylor (2010) labels spillovers as unintended processes of knowledge diffusion. In order to study "knowledge spillovers", three properties of knowledge "as an economic good" are important;

- Uncontrollability; knowledge is a non-excludable good. It is difficult to make it exclusive or to control it privately. Knowledge leaks out in multiple ways; (informal networks, disassembling, etc.).
- Nonrivalry; knowledge is inexhaustible.
- Cumulativeness; in a way that generates new ideas and new goods.

For a firm, it is more difficult to control its knowledge than its machines so that conditions for leaks and spillovers arise. Information and knowledge continuously escape from the entities producing them. However, as we discussed before, knowledge is a combination of explicit and tacit knowledge. An organization or an individual cannot capture all the benefits resulting from its inventive activity leading to involuntary spillovers. Competition forces agents to increase their performance through imitation, adoption, and absorption of the new knowledge created elsewhere, which is depicted as "absorptive capacities" by Cohen and Levinthal (1990). Externalities become effective when agents develop and maintain absorptive capacities. Knowledge being spilled over is tacit in nature, and requires 'absorptive capacity' to be effectively utilized. Theories of AC are discussed in the next section.

The cost of using existing knowledge is zero, but there are costs for reproducing, transmitting, and acquiring it. Externalities are not "ready to use". Acquisition costs are intellectual investment needed for people to be capable of understanding and exploiting knowledge. Although acquisition costs remain very high for specialized knowledge, the increase in education and training investments may cause them to decline over time.

Direct contact and real meetings have an advantage in the field of knowledge exchange. In this manner, geography matters in explaining the importance of spillovers are unquestionable. However, Foray (2004) highlights the potential of ICT to reduce spatial and proximity constraints and states that ICT revolution causes knowledge reproduction and transmission costs to drop, also learning-related investments (training and education) leads to some decrease in acquisition costs. Additionally, the marginal cost of acquiring, reproducing, and transmitting knowledge constantly decreases and geographical constraints are mitigated. Therefore, Foray (2004) concludes that knowledge-based economy is an economy in which knowledge externalities are more powerful than ever.

According to Brynjolfsson and Hitt (2000), information technology is a "general purpose technology" and such technologies are economically beneficial for the reason that they help complementary innovations like telegraph, steam engine and electric motor. Brynjolfsson and Hitt (2000) stated that the returns of ICT investment may be higher than assumed if firms adopt computers as part of their system. Unmeasured and slowly changing organizational practices significantly affect the returns to information technology investment. Moreover, it is stated that ICT investments without organizational change can create productivity losses.

Within the context of this thesis, ICT is believed to be an important tool for facilitating access to external knowledge and may provide a common terminology for transferor and transferee parties in an ITT project through using commercial off-the-shelf design, analysis, test softwares as well as project management and systems engineering tools. These may help in conducting the ITT project smoothly even the parties does not use common language.

Mathews (2004) has seen “strategic management” as the key to success for latecomer firms and introduced linkage, resource leverage, and learning as resource-targeting strategies. Linkage is depicted as an initial step that generates opportunities for the latecomer. Resource leverage is defined as the means through which the latecomer is able to exploit the linkages established. This is a strategic framework of latecomers for breaking into advanced technological sectors. Finally, learning is presented as the outcome of repeated applications of linkage and leverage. Mathews (2004) stated that each round of leverage has to be accompanied by in-house deepening of technological competences for new product development, new production line installation and mass production. According to Mathews (2004) “absorptive capacity” is the ability of the firm to “absorb” the leveraged resources in terms of product and process technologies.

3.1.4 Theories of Absorptive Capacity

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.

There is a common understanding in the literature that AC can be denoted as a group of firm abilities to manage knowledge. However, there are wide variations in terms of definitions and the functionality of AC. Some studies highlighted the ability of a firm to use outside knowledge while defining AC, whereas others used AC as an indicator to understand a firm's openness to technological change.

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. At the time, the existing approach was that external knowledge is public good and there is little cost involved in identifying and assimilating it. However, 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 investments in R&D. Descriptions for absorptive capabilities of a company, based on Cohen and Levinthal (1990), are given as follows;

- Ability to value knowledge through past experience and investment
- Ability to assimilate;
  - based on knowledge characteristics
  - based on organizational or alliance characteristics
  - based on technological overlap
- Ability to apply;
  - based on technological opportunity (amount of external relevant knowledge)
  - based on appropriateness (ability to protect innovation)

In their theory of AC, Cohen and Levinthal (1990) emphasized the cognitive characteristics of learning by linking the dynamics of individual into organizational learning. According to them, prior related knowledge or problem solving experience makes individuals receptive to new knowledge in the respective domain:

> Prior knowledge enhances learning because memory-or the storage of knowledge-is developed by associative learning in which events are recorded into memory by establishing linkages with pre-existing concepts. (Cohen and Levinthal, 1990 p.129)

Cohen and Levinthal (1990) offered that firms follow the similar path to individuals in learning in a way that the prior knowledge that a firm accumulates defines the effectiveness of their later efforts to gain external knowledge. Moreover, firms have memories, which can be used for stocking knowledge, and consequently it is possible to state that the bigger the knowledge base of firms, the more probable that they will sense new external knowledge and absorb it.

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. Followers can only effectively absorb knowledge disseminated by external sources of knowledge, if they have developed their own capabilities. This requires individual and organizational learning.

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.

Acquisition; refers to a firm's capability to identify externally generated knowledge that is critical to its operations. Prior investments and prior knowledge are the major components of acquisition capability. The diversity in existing capabilities affects the quality and speed of acquisition. In other words, there is a need to have different areas of expertise initially within a firm to successfully import external technologies with high intensity.

Assimilation; can be denoted as the firm's routines allowing it to analyze, process and understand the information obtained from external sources. However, external knowledge is context specific and often prevents others from understanding or copying this knowledge (Szulanski, 1996). Ideas and new knowledge that fall beyond a firm's search area are overlooked because the firm cannot easily realize them. Moreover, understanding a new knowledge stimulates knowledge assimilation that allows firms to internalize externally generated knowledge. However, this is difficult when the complementary assets are not available to the follower firm.

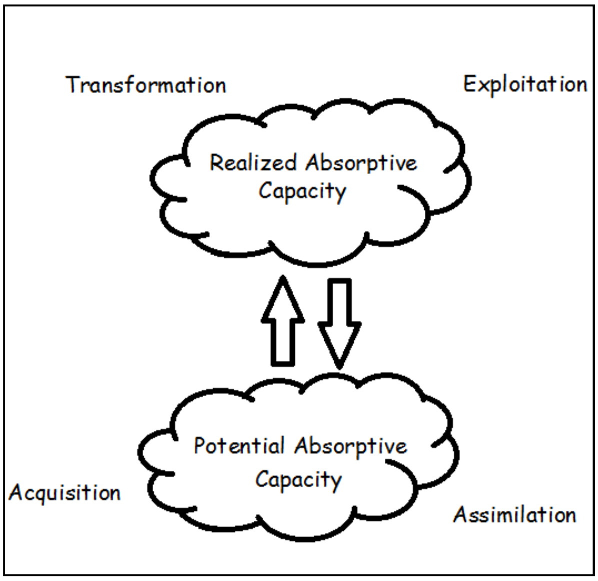
Transformation; can be depicted as a firm's capability to develop practices that enable to combine existing knowledge and the newly acquired knowledge. This might be possible through interpreting the knowledge in a different manner. This may lead to a change in the well-known and ordinary procedures within the organizational culture. Moreover, transformation may change the character of imported knowledge, as there might be different frames of reference in terms of practices as of the provider and the recipient bodies. Therefore, the ability of firms to combine two sets of information to arrive a new output represents the transformation capability.

Exploitation; can be depicted as the action to exploit knowledge and this capability is based on the procedures that allow firms to leverage existing competencies or to create new ones by utilizing acquired and transformed knowledge. An important feature of exploitation is that it requires retrieving knowledge that has already been internalized. Possibly, firms may be able to exploit knowledge coincidentally or unexpectedly without systematic procedures. Capability of exploitation is the ability of a firm to integrate knowledge into firm's processes leading to competitive advantages in a systematically or unintended way. However, the outcomes of systematic exploitation routines are the continuous creation of new knowledge, goods or new organizational forms (Spender, 1996).

Zahra and George (2002) introduced "potential" and "realized" absorptive capacities as schematized in Figure 6 and described as follows;

- “Potential absorptive capacity” comprises knowledge acquisition and assimilation capabilities,
- “Realized absorptive capacity” focuses on knowledge transformation and exploitation.

According to Zahra and George (2002), potential absorptive capacity makes the firm open to acquiring and assimilating external knowledge. It can also be assumed to provide firms with the strategic flexibility and the degrees of freedom to adapt and evolve in high-velocity environments. By doing so, potential capacity allows firms to sustain a competitive advantage even in a dynamic environment. However, this capability to value and acquire external knowledge does not guarantee the exploitation of this knowledge. Realized absorptive capacity, on the other hand, is related to transformation and exploitation capabilities. Realized AC reflects the firm's capacity to utilize the knowledge that has been absorbed previously.



Source: adapted from Zahra and George (2002)

Figure 6 Realized AC and Potential AC

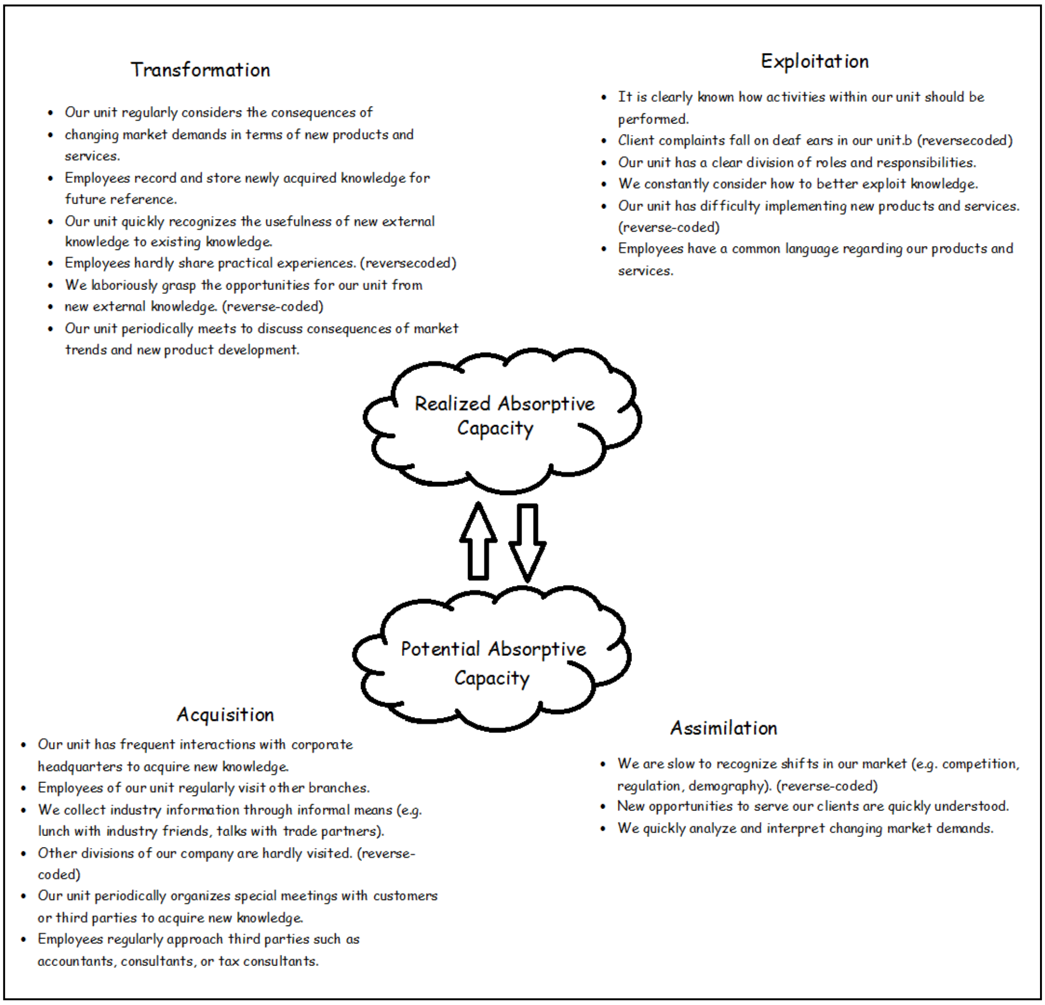
Realized AC and Potential AC have distinct but complementary functions. Both satisfy a necessary but insufficient condition to develop firm performance. Firms cannot exploit knowledge without first acquiring it. Likewise, firms can acquire knowledge but might not have the capability to exploit. Therefore, a high Potential AC does not necessarily imply enhanced performance. In order to explain why certain firms are more efficient than others in using AC, Zahra and George (2002) introduced an efficiency factor (η) as the ratio of Realized AC to Potential AC.

A firm can expose to external knowledge via acquisitions –purchasing the company itself- (Chaudhuri and Tabrizi, 1999); purchasing through licensing and contractual agreements; inter-organizational relationships, including R&D consortia, alliances, and joint ventures (Vermeulen and Barkema, 2001). As a result, firms may acquire external knowledge from different sources and the variety of these sources influences the acquisition and assimilation capabilities that create their Potential AC. However, exposure to diverse sources does not necessarily lead to Potential AC development. According to Zahra and George (2002);

> The greater a firm's exposure to diverse and complementary external sources of knowledge, the greater the opportunity is for the firm to develop its Potential AC. (Zahra and George, 2002 p.193).

Internal and external conditions may influence Potential AC and Realized AC in different ways. Therefore, different approaches are necessary to support and benefit from these two components of AC. Zahra and George (2002) stated that firms need to handle these four dimensions of absorptive capacity successfully to obtain better performance. Firms focusing on Potential AC (acquisition and assimilation of new external knowledge) are able to continually renovate their knowledge stock, but they may suffer from the costs of acquisition without gaining benefits from exploitation. Besides, Potential AC is a path-dependent feature and it is affected by firm's past experiences. Therefore, it is promising to state that, firms search for information in areas where they have had past successes (Christensen, 1997). On the contrary, firms focusing on Realized AC (transformation and exploitation) may achieve short-term profits through exploitation but may not be able to reply to environmental changes.

Jansen et al. (2005) conducted a research on AC by empirically validating the conceptual distinction between potential and realized AC introduced by Zahra and George (2002). They tried to examine links between specific organizational mechanisms and dimensions of AC. For this purpose they suggested specific organizational mechanisms, (1) coordination capabilities, (2) systems capabilities, and (3) socialization capabilities, and examined how they influence Potential and Realized AC. In order to examine coordination capabilities; they focused on cross-functional interfaces, participation in decision making and job rotation (the lateral transfer of employees between jobs). For the definition of systems capabilities; formalization (as the degree to which rules, procedures, instructions, and communications are written down) and routinization (as tasks that are executed by employees in an invariable and repetitious way) have been examined. And finally for social capabilities; they introduced the constituents as connectedness (in terms of dense and sparse networks) and socialization tactics (offering newcomers specific information to increase their commitment to past policies and procedures of the firm).



Source: adapted from Jansen et al. (2005) and Zahra and George (2002)

Figure 7 Questions to quantify Realized AC and Potential AC

Jansen et al. (2005) defined control variables such as unit size, branch size, unit's age, urban/rural unit location. Then they made a regression analysis for organizational mechanisms and both components of absorptive capacity. Questions to determine and quantify the realized absorptive capacity and potential absorptive capacity according to Jansen et al. (2005) and Zahra and George (2002) are schematized in Figure 7.

Some major results they obtained were as follows;

- Mechanisms associated with coordination capabilities had positive and significant effects on potential absorptive capacity.
- Participation in decision making was positively associated with acquisition, but not with assimilation.
- Participation in decision making had no significant, negative effect on realized absorptive capacity.
- Organizational mechanisms associated with coordination capabilities enhance a unit's potential absorptive capacity.

In a recent study by Omidvar (2013), it is stated that there exists two research streams that have developed since the introduction of AC, and these are classified as the "cognitive approach", and the "evolutionary/dynamic capability approach".

For "cognitive approach", two sub-streams are introduced to discuss in details. The first sub-stream considers AC as an "absolute concept" arguing that the ability to identify, assimilate, and apply new external knowledge depends on the level of the prior knowledge the firm irrespective of the characteristics of the senders and receivers of knowledge. According to this approach; R&D intensity and percentage of higher educated employees are assumed to be indicators for AC.

The second one argues that AC is a "relative concept" and depends on the features of the parties involved in the learning process. Lane and Lubatkin (1998) introduced the concept of relative AC as the ability to extract knowledge from a particular teacher firm. They assumed that relative AC is represented by the similarities between firms' knowledge bases, and organizational structures. They conducted a research in pharmaceutical–biotechnology sector and then proposed a conclusion such that;

> The relative absorptive capacity measures are also shown to have greater explanatory power than the established measure of absorptive capacity, R&D spending. (Lane and Lubatkin, 1998 p.461)

For "the evolutionary/dynamic capability approach", AC of the firms directs the evolutionary path that they take and the responses they give to environmental change (Van den Bosch et al., 1999). In this approach; AC of a firm advances through the interactions between the prior related knowledge and the knowledge environment. AC changes by utilizing the opportunities of knowledge acquisition in harmony with the development of knowledge environment. Introducing "knowledge environment" concept is an important departure from the approach of Cohen and Levinthal (1990) in which knowledge is "out there" and it is up to firms to extract and exploit it. Dynamic capability formulation of AC as proposed by Zahra and George (2002) can also be considered within "the evolutionary/dynamic capability approach". In their definition of AC, dynamic capability is assumed to be embedded in a firm's routines and processes, making it possible to analyze the stocks and flows of a firm's knowledge.

Knowledge cannot be assumed as a simple commodity and especially tacit knowledge is difficult to codify and transfer. Furthermore, knowledge transfer can occur through coding and decoding mechanisms. This statement directly increases the expectations from AC in a way that; knowledge can be transferred only if there exists a well-developed capability to successfully decontextualize, codify and absorb it (Szulanski, 1996). Besides, knowledge develops in the context of local communities and is hardly accessible to the people who do not hold any participation in those communities. In this view, participation assumed to be involving mutual recognition and through participation in the activities of teacher, student can access meaning of tacit knowledge. Therefore, participation plays a key role in developing absorptive capacity.

In the following section, literature related to international technology transfer is reviewed. Mechanisms of international technology transfer and the reasons for a nation (or a company) to take part in an ITT project are evaluated.

3.2 MERITS OF INTERNATIONAL TECHNOLOGY TRANSFER

3.2.1 Brief Discussion on Development Strategies

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.

According to the National Science Board (2002), at the beginning of 2000s, about 80% of world innovation activity was performed by only seven developed countries. The United States accounted for roughly 40% of world R&D expenditures, spending as much as the rest of the major advanced countries. Japan, the second largest R&D

investing country, is responsible for about 18% of world expenditure and the European Union for approximately 30%. In terms of GDP, in 2000 Japan invested about 3% in R&D, the United States about 2.7% and the European Union around 1.9%.

Technological Change (TC) in Industrialized Countries (ICs) consists mainly of cost-reducing improvements in production processes and the creation of new products. On the other hand, typical TC efforts in developing countries are determined by the need to use different raw materials, to scale down plant size, to diversify the product mix, to adapt the product design, to use simpler and lower capacity machinery and to stretch-out the capacity of existing equipment (Teitel, 1984). Industrial development is directly related to the developmental role of the government, the focus of enterprises on competition and the strategy of leading firms. For industrializing, systematic and well-coordinated government intervention to promote manufacturing investment is necessary. Moreover, state intervention had a significant role in twentieth-century for late industrialization than in earlier industrializations.

The more assets (both tangible and intangible) a country has, the easier it will be to industrialize. There is a tendency to state that, the only asset of late industrializers in manufacturing is low wages. However, low wages cannot be used for sustainable growth in the long-term. Labor-intensive industries getting industrialized lose their competitiveness to still lower-wage countries. For the identical production process, the more advanced economies may be more cost effective, because of better management skills and work force skills as well as the capability of increasing tacit knowledge. According to Hikino and Amsden (1994), for late-industrializing countries it is better to focus on mid-technology industries. However, in order to compete against more advanced economies with higher productivity and lower cost, latecomers must develop their own managerial and organizational skills, and also shorten their learning period. Making incremental improvements in the cost, quality, and performance of their processes and products are essential.

The transfer of technology from rich to poor countries is supposed to enable developing countries to leap-frog intermediate development stages. However, for most firms, growing value-added is determined by the policy environment. National environment is important for the development of science and technology. The national policy environment determines growth rate of value-added. According to Forbes and Wield (2003) growing up is more important than leap-frog, and the shop-floor is the first place to begin. Therefore, the goal of an appropriate policy has to drive firms to build technical capability.

Dominant industrial technology-in-development paradigms summarized by Forbes and Wield (2003) are as follows;

- Pre-1980 (Import-substitution, regulate technology imports, invest at home in science and technology, discourage direct foreign investment),
- Post-1990 (Export-orientation, free technology imports, less state investment in science and technology, encourage foreign direct investment, open up markets to free competition.)

Import Substitution (IS) industrialization strategy in developing countries is a development strategy whereby a government restricts or forbids the import of industrial material and subsidizes local material. IS industrialization simply means substituting local industrial production for those goods that a nation has imported. A series of measures can be used to support IS, including the use of relatively high import tariffs, quota restrictions on imports, offering financial incentives to those who invest in new production.

In export-orientation, on the other hand, state encourages foreign direct investment; but the richer countries have a strong motive to keep exporters of developing countries as reliable providers of lower value-added items. Export-orientation has several benefits such that competing with international best practice compels firms to provide value for money, and serving larger markets allows firms to operate at international scale.

According to Bernard and Ravenhill (1995) the world economy is characterized by alternating periods of free trade and protectionism. For the latecomers this can be taken as a chance to replicate the development experience of the leading countries. However, it is difficult and for some specific sectors almost impossible for developing countries to build up internationally competitive big enterprises from the perspective of national catch-up goal. Kim and Lee (2009) highlighted the differences between two different sectors in Korea, namely "consumer goods industry" and "capital goods industries".

> Only with a quality 30% higher for a 30% lower price can locally produced machine tools be chosen by user conglomerates. (Kim and Lee, 2009 p.269)

In most developing countries, user firms (or governments for defense and aerospace products) are seriously reluctant to use locally made machine tools. Absence of long-term market demand is an obstacle for the development of R&D capability in high-technology areas as relevant tacit knowledge is accumulated in the process of developing and producing through long-term interactions with the customer firms.

When the aerospace industry is considered, the IS approach alone has no chance to be applied because the local markets are not strong enough. Moreover, there always exist uncertainties such that local market may hesitate to use indigenous products when there are much more developed versions that can be imported.

Some sectors are depicted as "strategic sectors" as the involved technology may not be available externally because of political reasons. So-called sectors are commonly taken care of within the national innovation system. At that point it is possible to distinguish different approaches for strategic sectors (like aerospace industry) and general purpose sectors (like automotive industry) in a way that it is acceptable to implement import substitution approaches for such strategic sectors without considering the additional costs.

Government has an important role; policy support such as subsidies and wage promotion might be effective in high-technology industries. Limitations on imports may work to some degree if applied carefully. In Korean case, a specific enterprise is selected and financed. Establishment of a joint company with a foreign partner is also a verified measure. Policies after the year 2000 were focused on countering the negative effects of highly protective policies (Kim and Lee, 2009).

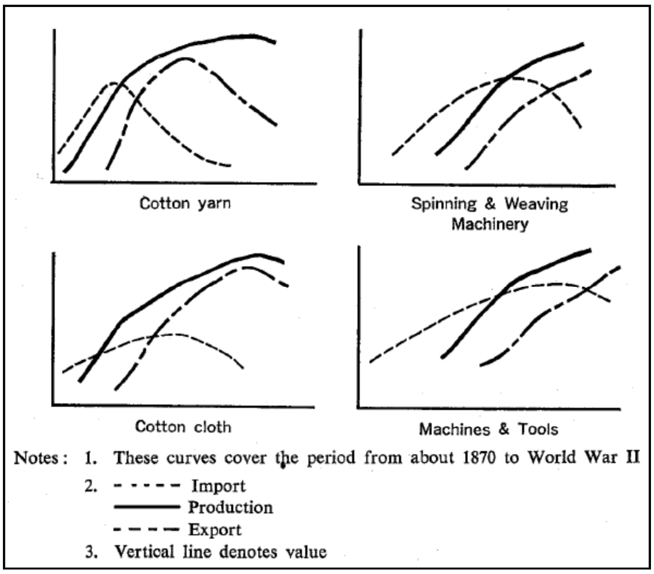
3.2.2 Development Opportunities for Latecomers through ITT Projects

International Technology Transfer (ITT) refers to the transfer of a technological capability from firms in one country to firms in another. Ramanathan (1999) defined the term "technology transfer" as the process of movement of technology from one entity to another and depicted technology transfer as successful if the receiving entity, the transferee, effectively utilizes the transferred technology and eventually assimilate it. Mansfield (1975) highlighted the importance of ITT in terms of economic growth and achievement of economic goals.

> One of the fundamental processes that influence the economic performance of nations and firms is technology transfer. Economists have long recognized that the transfer of technology is at the heart of the process of economic growth, and that the progress of both developed and developing countries depends on the extent and efficiency of such transfer. In recent years economists have also come to realize (or rediscover) the important effects of international technology transfer on the size and patterns of world trade. (Mansfield, 1975 p.373)

In order to study the merits of ITT, it is required to have an understanding of the reasons why nations choose to collaborate through ITT projects. ITT is an important tool for developing countries to be used as technology capability gap filler. Latecomers can find the opportunity to achieve technological capabilities in a faster pace when compared to endogenous efforts. There are mutual interactions between the economic growth of the developing countries and the economies of the advanced countries. The Wild-Geese-Flying Pattern; a historical theory in which heterogeneization and homogeneization of an advanced country's economy and a less-advanced country's economy is formulated was introduced by Akamatsu (1962). In other words, this pattern refers to a situation, where less advanced countries adopt the industries of more advanced countries along the road of development.

The wild-geese-flying pattern of industrial development denotes the development characteristics of a less-advanced country after having an international economic relationship with advanced countries. The pattern is schematized in Figure 8. So-called patterns are the time-series curves each denoting import, domestic production, and export of the manufactured goods in less-advanced countries. The most advanced industrialized countries import consumer goods from medium-advanced industrialized countries, resulting in an international division of labor through high-degree heterogeneization. The less-advanced "wild geese" are chasing those ahead of them, some gradually and others rapidly, following the course of industrial development in a wild-geese-flying pattern. Technological innovation heterogeneizes the economies of advanced countries with those of less-advanced countries.



Source: Akamatsu (1962)

Figure 8 Wild geese flying pattern

The industrial policy of a country has a great influence on the wild-geese-flying pattern, for example import restrictions cause a sharp decline in the import curve. According to Akamatsu (1962) the only way for less-advanced countries is to weaken their vertical dependency upon the advanced industrialized countries by pushing forward their own industrialization.

Korhonen (1994) criticized Akamatsu and stated that economic nationalism may be very beneficial for the follower country, if protective measures are used only in cases where the native industry is healthy and it needs time to achieve a scale large enough to compete with foreign manufacturers. However, if local industry fails to develop efficiently, economic nationalism may impoverish the economy.

As the level of technology in the follower country advances, it becomes possible to produce more sophisticated products. Since the weak always has fairly good chances of becoming stronger as homogenization of the world economy spreads through development, the grip of any dominating power is bound to loosen eventually. The follower country will always have at least two things in its favor:

- a comparative advantage based on cheaper wages,
- the clear goal of absorbing an existing and well-proven industrial culture.

The imported culture becomes an essential part of national self-understanding and of the international image of the country. The closer a follower country to the leading countries, the more it becomes similar to them in the main components of its culture. According to Korhonen (1994), the more a follower country becomes influenced by foreign culture during the early phases of communication, the more independent it will become in the later phases. He suggested that, the most successful strategy for a follower country is to have close communication with leading countries and to facilitate the import of appropriate pieces of their culture. This must be combined with carefully planned policies for trade and other forms of international communication. The situation of an advanced or relatively advanced country in respect to the followers is the reverse. In the long run, dominance does not work. The only solution is the continuous upgrading of existing products, as well as the introduction of new ones.

Vernon (1971) in his “Product Cycle Theory” focused on the behavior of individual firms. According to him product innovation occurs in high-income countries. The firm that originated the product often abandons its production as its oligopolistic advantages disappear. Vernon’s model highlights that there exists a “rational” pattern of industrial diffusion from Japan to the East Asian newly industrializing countries

(NICs), to ASEAN, and most recently to China. According to Vernon's product-cycle theory, the life cycle of each manufactured product goes through three stages:

- novelty (a new product)
- maturity (a mature product)
- standardization (a standardized product)

However, Product Cycle was misleading for several reasons;

- The theory makes assumptions about the maturation of products. Accordingly, technical change had been continuous and rapid as well as the product and process innovation continued at a rapid rate.
- Production for export in latecomers would be built on an experience of import-substituting manufacturing.
- In the last stage of product cycle, firms in the leading country are supposed to exit from the market, leaving domestic demand to be met by the exports of latecomers.

In harmony with the rapid pace of technological change, the products have become more complex and consequently it has become more difficult to apply reverse engineering. Moreover, mature industries should not be viewed in static terms. New technologies are needed not only to move into more sophisticated product lines but also to maintain established positions in core industries. Therefore, development models described above may not be appropriate to explain the technology development patterns in high-technology industries like aerospace industry. Increased technological complexity has produced greater barriers to entry in the form of higher start-up costs, steeper learning curves and increased specialization. Moreover, political reasons due to the possible military applications of relevant technologies may lead to reluctance to transfer technology.

Firms/countries can come from behind, learn from the best and then close the gap. For this purpose, innovation and the effective management of technology are compulsory. According to Forbes and Wield (2003), developing nations are not restricted to being simply offshore manufacturing and places of assembly for the business of the advanced nations. Samsung of Korea and the Indian pharmaceutical industry, are major examples for this situation. The technology-follower might begin by building process innovation capability on the ground/shop-floor with the aim of being as efficient as other producers, but must then move beyond competing on price to competing on product features (from process to product, from increasing efficiency of processes to higher value-added products). Forbes and Wield (2003) stated that catching up requires incremental innovation at a faster pace than in the leader. Incremental innovation is the primary source of long-run competitiveness in technology-followers.

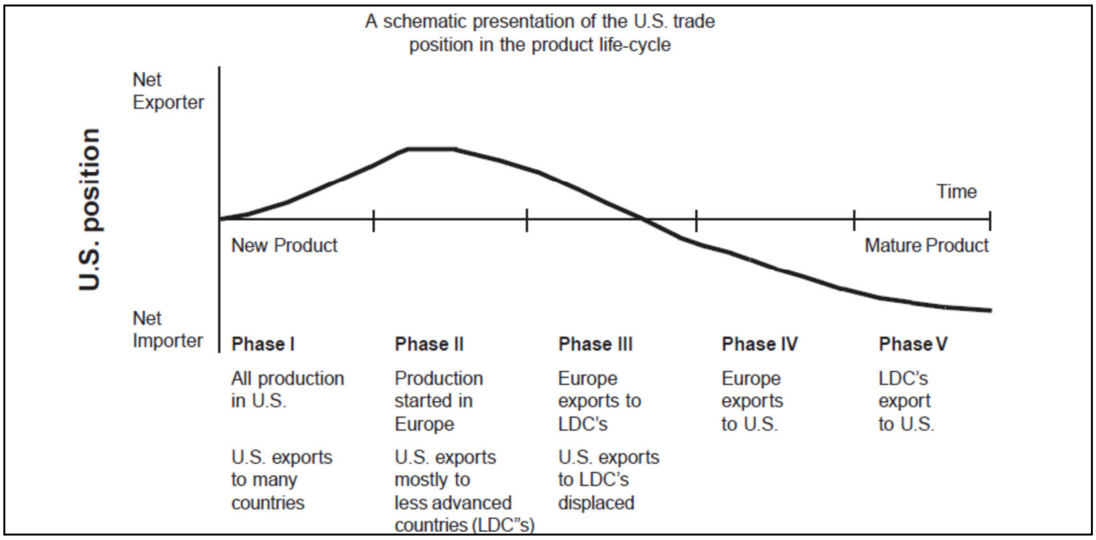
Introduction of new technologies may lead to a jump in productivity; nevertheless this does not reduce the importance of incremental technical change. According to research studies carried out since late 1970s, concepts of assimilation and adaptation of imported technology by local firms are introduced rather than the previously assumed high contrast “make or buy” concept. By the help of technical change, productivity increases and new products are introduced.

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. Technological opportunity presses for change so the countries improve themselves as they gain experience. Social capability depends also on openness to competition, the establishment and operation of new firms. He suggests that followers may forge ahead of leaders regarding the increase in social capability. The institutional and human capital components of social capability develop only slowly as education and organization respond to the requirements of technological opportunity. Besides, catch-up performance also depends on diffusion of knowledge, the mobility of resources and the rate of investment.

Perez (2001) defined the opportunities for development as a “moving target” and stated that “development opportunities” arise when the successive technological revolutions are deployed in the advanced countries. Most technologies tend to follow a similar trajectory regarding the rate of change from initial innovation to maturity. The advantages shift in favor of the less advanced countries when technologies approach maturity. Technologies tend to make more intensive use of labor in their initial phases, and when they approach maturity they use highly standardized, mechanized and automated processes. After the first innovations, the firms developing the technology acquire advantages through the experience accumulated in product, process and markets. This tends to keep the corresponding know-how in the hands of the producers, making it less accessible to followers.

The maturity phase of technologies according to Perez (2001) is schematized in Figure 9 and summarized as follows;

- Phase I: Production does not require much prior know-how or experienced managers, while the processes can be conducted by unskilled labor.
- Phase II: Mature technologies reach a point where they have only minimal potential for producing profits, and have no room left for improving productivity.
- Phase V: Maturity phase is the best starting point for industrialization; generating learning capacity, and establishing the basic infrastructure. However, catching-up supposes a dynamic development process, fuelled by local innovation and growing markets.



Source: Perez (2001), Wells (1972)

Figure 9 The geographic outspreading of technologies as they mature

Perez (2001) states that, for weaker players, Phase I is the most promising one as an entry point with higher potential of profits. R&D investment can be lower than that of the original innovator. Moreover, according to him, a strategy could be designed for accumulating technological and social capabilities through the use of mature technologies and then making use of that base for gaining access to new and dynamic technologies. Newcomers can redirect their efforts towards learning the new practices, whereas the established leaders have to "unlearn" much of the old paradigm and adopt the new one.

Gerschenkron (1962a) tried to clarify the prerequisites of industrialization. He stated that the existence of more advanced countries as sources of technical assistance, skilled labor and capital goods might be evaluated as prerequisites to industrial development.

The development of a backward country may tend to differ fundamentally from an advanced country regarding the speed of development, productive and organizational structures of the industry. The cheapness of labor in the latecomer aids the process of industrialization. On the other hand, industrial labor of a stable, reliable and disciplined group is scarce in a backward country. Nevertheless, together with the implication of incremental technology development strategies, international technology transfer emerges as a strong tool that utilizes the advantages of being backward.

Innovation is a collective process in which networks play a central role and firms are the main actors. Innovation is viewed as a dynamic collective learning process. Organizational learning is both a function of access to new knowledge, and the capabilities for utilizing and building on such knowledge. According to Özman (2009) "economics of technological change" is more related to the diffusion of knowledge and how networks shape technology adoption decisions. Knowledge society is the creation of conditions for all members of the society to have access to information. Modern firms have been restructuring their activities in order to use the advantage of networks. In today's paradigm, development of the capacity to take advantage of information and know-how for innovation is highly important. In terms of aerospace industry, this development approach is indispensable for backward companies to recognize and utilize the existing opportunities.

Firms form alliances with other firms because they are not self-sufficient, so they collaborate to reduce uncertainty and to access each other's resources especially in technologically intensive industries. The motives of the organizations for collaboration can be described by different means such as; necessity, potential of an organization to control another organization, reciprocity (horizontal linkages rather than vertical), efficiency, stability, legitimacy, to improve reputation and prestige. External collaboration is complementary to internal capabilities and networking enables firms to effectively explore new knowledge. ITT projects can be structured in a way that maximizes the advantages of networks from the perspective of both the transferee and the transferor of knowledge.

It can be suggested that, there are three main elements in the ITT projects; a home country, a host country, and the process of transaction. The home country (transferor) is where the technology originates and the host country (transferee) denotes the recipient. In this thesis, home and host prefixes are used with country, company and party.

A technology provider firm's decision, which is located in the home country, to transfer its technology through licensing, investing or by other means, involves an evaluation of the benefits and costs to the firm. In the past, some researchers claimed that ITT affects the home country's economy negatively in terms of overall benefits including employment and technological lead (Baranson 1978; Krugman 1979). However, following studies indicated that ITT benefits the home country both economically and technically (Mansfield and Romeo 1980; McCulloch and Yellen 1982).

Developing countries are eager to obtain high technologies through ITT with the aim of improving their technological infrastructure. According to Aharoni (1991), major expectations of the host countries' governments from an ITT project can be represented as follows:

- Contribution to the local technology,
- Job creation in the country,
- Foreign currency savings,
- Performance of the product,
- Localization of the technology,
- Investment increase of the home party,
- Minimum dependence on foreign companies (technical independence),
- Decreased control of the home party over the ITT process,
- Commitment to the relevant contracts.

3.2.3 Determinants for the Performance of ITT

Existing literature on ITT is mainly based on the transferor (home) party's point of view. However, less attention is paid to the effectiveness and performance of ITT considering the transferee (host) party concerns. This area is rarely studied probably because the topic is more important for developing countries than the developed countries.

Reddy and Zhao (1990) introduced the types of technology transfer as materials transfer, design transfer, capacity transfer (operational, duplicative and innovative capabilities); the levels of knowledge transferred through ITT projects as the market level, the production level, and the research and development level. According to Mansfield and Romeo (1980), supplier firms tend to transfer their newest technologies overseas through subsidiaries rather than licensing or joint ventures, but the latter channels become more important as the technology ages.

According to Mansfield (1975), the transfer of technology between the home country and the host country advances in three phases;

- Phase-1 : Material transfer
- Phase-2: Transfer of design documentation (transfer of design, blueprints, and the ability to manufacture the new product in the recipient country)
- Phase-3: Capacity transfer which occurs when the capacity to adopt the new item to local conditions is transferred.

Mansfield (1975) stated that the last phase of ITT is quite different and difficult from the earlier phases and costly to realize.

Pre-ITT term has been used for the period before signing the deal of ITT project (Ramanathan, 1999). 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. Transferor firm will have great negotiating power if it is capable of providing the host country firms with a technology that is not domestically available and an ITT channel that has more advantages than others. Moreover, Reddy and Zhao (1993) stated that the transferee company has a strong haggling position when;

- It has strong technological absorption capability,
- It can provide the home company with complementary technology,
- It has strong domestic marketing capability and reputation,
- It is a big user of product produced by supplier firm,
- It has a convenient geographic location or access,
- It has a strong position in the procurement of local raw material,
- It is not a direct competitor of the home company.

During the negotiations, parties have to mutually agree on complex issues such as copyrights, royalties, rentals on equipment, technical assistance, know-how, off-set, barter, management contracts, donations, unilateral transfers, loans, ITT modes and balance of payments. Weak contractual structures regarding these issues may lead to huge budget deficits during the execution phase of ITT.

"Execution" is the period that starts after signing the ITT contract. Öner and Kaygusuz (2007) assessed the success of the execution period of ITT from the perspective of the host country based on the degree of localization of technology or product. They highlighted the importance of the processes related to the transfer of hardware & software and the localization of the transferred knowledge considering the organizational structure.

The effectiveness of transfer activity is evaluated in several different ways in the literature. From the efficiency perspective, some researchers measured transfer effectiveness by calculating the cost of the transfer. Others analyzed the scope and level of internal vs. external efforts. Another way to measure efficiency of ITT is through the R&D sufficiency in the local facility. From the host country perspective, control on imported technology can be used as a measure such as; the capacity to use the technology without foreign assistance and having the capability to reproduce or even improve the imported technology. (Reddy and Zhao, 1990)

In order to make an assessment for the success of an ITT project, different indicators that represent the viewpoints of home country and host country are required.

According to Wilking (1974), ITT success can be obtained through having an effective business organization while overcoming the barriers listed below:

- Demand barriers; insufficient demand to national production.
- Capital barriers; local producers may not have or be able to obtain the capital to utilize the technology. (Especially, as aerospace projects are very big projects, a strong will and readiness in terms of capital are vital.)
- Technological barriers; local producers may not have the required skills to absorb the incremental technological know-how.
- National resource barriers; inappropriate natural resources for effective utilization of the obtained technology.
- Labor-cost barriers; low labor cost relative to other costs may discourage the application of a particular technology.
- Scale barriers; owner of the technology may have economies of scale that cheapen costs to values that national producers may not compete.
- Infrastructure barriers; there may not be sufficient supporting services or complementary techniques to permit diffusion.
- Language barriers; decelerates the process of technology absorption.

Öner and Kaygusuz (2007) depicts international technology transfer as a very complex process because the amount of investment, the infrastructures of the firms, the phases of product life cycle, the aims of the firms, the phases of technologies, the nature of contracts and behaviors of host country and home country are all different in each ITT process. Therefore, in such an environment it is a very complicated task to measure the success of ITT. Öner and Kaygusuz (2007) introduced a methodology in order to measure and analyze the success of ITT in defense joint ventures in Turkey from viewpoint of the host countries' governments and firms. They categorized success indicators under the groups namely; people, system, organization and knowledge. They provided a discussion on indicators such as localization of employees and managers, foreign training, localization of hardware and software, coordination in the organization, motivation and human based knowledge infrastructure. They also provided a case study for a defense-oriented joint venture, which is responsible for producing Armored Vehicle System for the Turkish Land

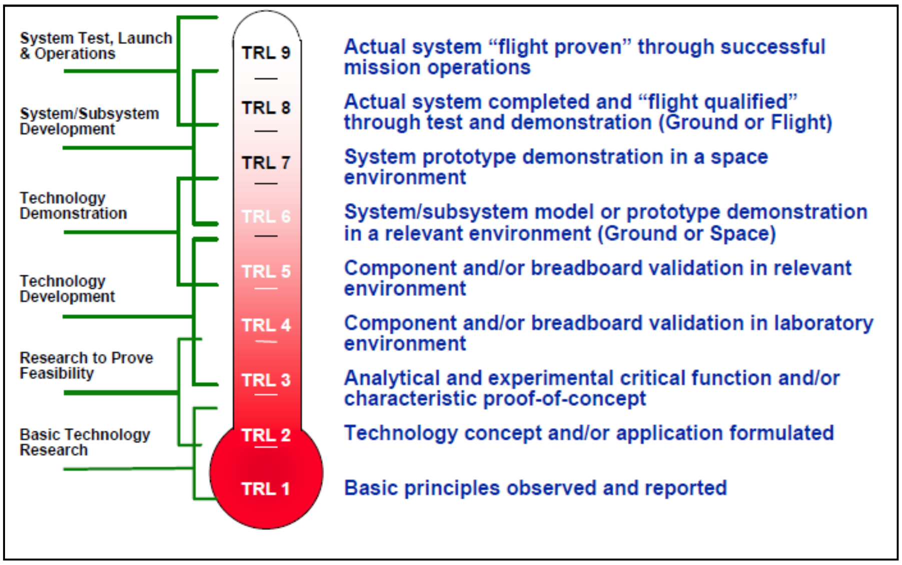
Forces. However, the introduced model focuses on the contract period and does not pay attention to firm level knowledge transfer or effects of sectoral innovation system.

3.2.4 The Concept of TRL and Technology Roadmap Planning

The aim of technology transfer is to reach a certain level of capability in the relevant field. The type of an ITT project can differ in terms of the final goal of intended technological capability. There can be a wide variety of expectations on the targeted level, such as; to obtain a system, sub-system or material level capability. Therefore, in order to discuss the nature of technology transfer, it is necessary to define the levels of capability in the relevant technological area. For this purpose, a well-known terminology, Technology Readiness Level (TRL) is referred within this dissertation and it is briefly introduced below.

The TRL terminology was initially conceived by NASA as a method for flight readiness assessment but has since been adopted by others including the US Department of Defense and European Space Agency. It is a metric used to assess the maturity of evolving technologies during its development. When a new technology is first invented or conceptualized, it is not suitable for immediate application. Instead, new technologies are usually subjected to experimentation, refinement and increasingly realistic testing. Once the technology is sufficiently proven, it can be incorporated into a system/sub-system. NASA representation of technology readiness levels is given in Figure 10.

According to the TRL approach, basic research is denoted with TRL 1 to TRL 3 grades. Starting from TRL 4 there is a need to perform laboratory level validation tests, which means there is a need for test infrastructure. The difference of TRL 5 is that, the sophistication level of performed tests is increased as the tests are supposed to be conducted in the relevant environmental conditions and starting from this grade the activities are denoted as “technology demonstration”. TRL 6 and TRL7 levels are achieved after successful ground or flight tests of sub-system and system-level prototypes in relevant environment. Attempts to achieve these levels of TRL grades require very complicated efforts, such that for some prototypes relevant efforts can be performed under huge project contracts. TRL 8 and TRL 9 grades are only obtained after successful system-level qualification.



Source: NASA[12]

Figure 10 NASA graphic showing Technology Readiness Levels

Similarly, European Space Agency (ESA) uses a very comparable approach to categorize the maturity level of a specific technology as given in Table 2.

Table 2 Technology Readiness Levels in the European Space Agency (ESA)

Technology Readiness Level	Description
TRL 1.	Basic principles observed and reported
TRL 2.	Technology concept and/or application formulated
TRL 3.	Analytical & experimental critical function and/or characteristic proof-of-concept
TRL 4.	Component and/or breadboard validation in laboratory environment
TRL 5.	Component and/or breadboard validation in relevant environment
TRL 6.	System/subsystem model or prototype demonstration in a relevant environment (ground or space)
TRL 7.	System prototype demonstration in a space environment
TRL 8.	Actual system completed and "Flight qualified" through test and demonstration (ground or space)
TRL 9.	Actual system "Flight proven" through successful mission operations

Source: ESA [13]

[12] http://science.ksc.nasa.gov/shuttle/nexgen/The_Primer.htm accessed on February 02, 2015

[13] http://sci.esa.int/sre-ft/37710-strategic-readiness-level/ accessed on February 02, 2015

It is believed that effective usage of TRLs can reduce the risks associated with investing in immature technologies. The lower the maturity or readiness of a related technology, the more time and money will likely be needed to mature that technology to higher levels.

In other words, a technology can be stated to have minimum technical risks before starting the engineering and manufacturing development stage when;

- a prototype of that technology has been developed that includes all of its critical components in approximately the same size and weight, and
- that prototype has been demonstrated to work in environmental conditions similar to that of the planned operational environment.

There are many challenges to overcome before an idea finds its way to practical use. This is acknowledged in the science and technology (S&T) investment of US Department of Defense (DoD) in Research, Development, Test, and Evaluation (RDT&E). RDT&E is funded according to the type of research and the technological maturity of the concept as categorized in Table 3.

Table 3 US Department of Defense (DoD) Research, Development, Test and Evaluation (RDT&E) categories

Basic Research
Applied Research (Exploratory Development)
Advanced Technology Development
Demonstration and Validation
Engineering and Manufacturing Development
RDT&E Management Support
Operational Systems Development

Source: Naval engineers[14]

[14]https://www.navalengineers.org/SiteCollectionDocuments/2008%20Proceedings%20Documents/UHSI%202008/1330-Wallace-AddressingHSIissuesearlyintheSTprocess-TRLs-UHSIS.pdf accessed on January 31, 2015

According to the US Federal Accounting Standards Advisory Board[15], research and development is composed of the first three items of Table 3;

- Basic research: Systematic study to gain knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind;
- Applied research: Systematic study to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met;
- Development: Systematic use of the knowledge and understanding gained from research for the production of useful materials, devices, systems, or methods, including the design and development of prototypes and processes.

Accordingly, the projects can be categorized as follows;

- Technology Development Projects (including "Basic Research", "Applied Research", "Advanced Technology Development")
- Product Development Projects (including "Advanced Component Development and Prototypes", "System Development and Demonstration", "Research, Development, Test & Evaluation Support", "Operational Systems Development")

In this thesis, while discussing the relation between absorptive capacity and the success of international technology transfer, the type of the conducted project will also be considered. For this purpose, thesis introduces a metric to quantify the "Sophistication Level of ITT Project" as described in Section 4.2.2 and Section 5.1.2.

A technology roadmap is a plan that matches technological goals, or targeted TRLs, with specific technology solutions to reach these goals. It is a plan that applies to a new product or process, or to an emerging technology. In general, technology roadmapping process is made of the following steps:

- Define system-level requirements and main assumptions,

---

[15] http://www.fasab.gov/pdffiles/sffas-8.pdf accessed on January 31, 2015

- Identify major technology areas,
- Determine and select the technology alternatives,
- Generate plans to develop, deploy and mature those technologies.

Technology roadmap can be a part of a strategic plan, which is supposed to indicate some critical non-technical issues such as vision, mission, searching for markets and intentions, political position, etc.

For a case of an aerospace system (or product) with specific requirements to be achieved in a certain time period, the most convenient way is to plan related sub-system development projects in a way that all such projects become correlated. This approach is expected to maintain continuity of scientific and technological development in the relevant area.

In the United States; the agency named as the Government Accountability Office (GAO) is the audit, evaluation, and investigative arm of the US Congress. It is a part of the legislative branch of the US government. GAO has been referred to as "the congressional watchdog" and "the taxpayers' best friend" for its frequent audits and investigative reports that have uncovered waste and inefficiency in government. After the closing of the Office of Technology Assessment (OTA) in 1995, Congress directed GAO to conduct a technology assessment (TA) pilot program. Since 2007, Congress has established a permanent Technology Assessment function within GAO. This new operational role expanded GAO's performance audits related to science & technology (S&T) issues, including effectiveness and efficiency of the US federal programs.

When the GAO receives a request to conduct a TA, it follows five phases: acceptance, planning, data gathering and analysis, product development and distribution of results. Phases one and two include selecting the topic and initiating the TA plan while the other ones are respectively: conducting TA, developing the report and ensuring its accuracy and integrity, and finally receiving feedback from

Congress and developing lessons learned to enhance the TA process. GAO mainly uses NASA TRL scale and DOD's TRL calculator to assess technological maturity.[16]

In Europe; there are organizations such as European Parliament/Science and Technology Options Assessment (STOA) and the European Parliamentary Technology Assessment (EPTA). The aim of STOA is given as "the assessment of scientific and technological policy options for the European Parliament"[17]. On the other hand, EPTA is a network of TA institutions specializing in advising parliamentary bodies in Europe.[18]

In Turkey, there are more than one state organization that carry out technology assessment and roadmapping for aerospace related technological areas. Undersecretariat for Defence Industries (*Savunma Sanayi Müsteşarlığı* – SSM) is one of them and has especially designated departments to focus on technology roadmapping activities. Technology Management and Technology Roadmapping approach of Undersecretariat for Defence Industries (including aerospace industries) is announced in a strategy document, namely "*Savunma Sanayii Müsteşarlığı, Teknoloji Yönetim Stratejisi 2011-2016"*. Funding mechanisms based on this strategy was presented in Section 2.2.

Although, it may be possible to obtain a certain level of technological capability through national channels with the help of indigenous abilities, for a developing country international technology transfer can be used as an alternative tool. By utilizing ITT projects, it might be possible to proceed with increased pace to the defined technological goal. However, usage of ITT 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. Technology assessment

---

[16] http://www.gao.gov/about accessed on January 31, 2015

[17] http://www.europarl.europa.eu/stoa/cms/home/about accessed on January 31, 2015

[18] http://www.eptanetwork.org accessed on January 31, 2015

methodology (or culture / firm level or national level) has to be considered as a determinant of success of international technology transfer.

3.3 CONCEPTUALIZING THE RELATIONS BETWEEN FIRM LEVEL, SIS LEVEL AND ITT PROJECT SPECIFIC DETERMINANTS

When compared to other high-technology industries, the aerospace industry has some highly distinctive features. As it was mentioned previously, aerospace industry requires advanced technological capabilities even at the earliest stages of the emergence of the industry; therefore even at the initial stages of technology development, newcomers need to comply with high international technological standards.

Catch-up theories, which were introduced in Section 3.2, are mainly based on a tradeoff effort between quantity and quality. It can be possible to find a huge market for a less reliable but cheaper consumer electronics product, however this is not possible for aerospace products. Thus stage theories are not fully applicable to the aerospace industry as competition requires the production of technologically sophisticated products even at an early stage.

In aerospace industry, evolution starts with an emergent phase in which some countries find an emergent niche for their products. In some countries this is followed by a transition to sustained competitiveness, whereas in other countries the transition fails and the industry gets weaker. Newcomers start the race with drawbacks as they need to overcome both market and technology barriers. In the beginning they have no access to technology sources, R&D and a supply of sufficiently trained and skilled labor. Besides they cannot use the advantages of feedbacks of the demand side for further technology development as they lack linkages with advanced country markets (Vertesy and Szirmai, 2010).

The examined portion of aerospace industry within this thesis, which involves greater knowledge-based activities in Turkey (military aircrafts, rocket and missile systems, and space crafts) than the rest of the industry, is closely correlated with defense industry.

Şimşek (1989) posted that there are some significant differences between civilian industry and defense industry as given in Table 4 (Şimşek 1989).

Table 4 The differences between non-military and defense industries

Non-Military Industries	Defense Industries
There are too many firms.	There are a few firms. These are usually large in size.
Prices are determined based on marginal costs.	Prices are determined based on total costs.
Prices are determined based on marginal benefits.	Prices are determined based on required military performances.
Market reaches the balance steadily.	There may be unsteady attitudes in the market.
There are no governmental restrictions.	Decision maker is government.
The volume of market is determined by the seller or customer.	The volume of market is determined by government through laws.
There are too many customers.	There is a single customer, that is, government.
Sellers develop new products based on potential market analysis.	Customer defines its needs. Then seller initiates product development and production activities.

Source: Şimşek (1989)

Although some of the above statements are controversial and open to discussions (there are highly conservative civil industries, like pharmaceutical industry), the general idea behind abovementioned differences in terms of the demand side is largely acceptable. As a result of these differences, ITT projects in defense industry also show different features from the civilian industry, and success measurement models that are being applied to civilian joint ventures may not be applicable in ITT projects in defense industry.

According to Baranson (1970), for an ITT project in defense industry, the transferor government (home) focuses on benefits such as political effect and control, strategy of expanding market and cheap labor force in the transferee (host) country. Although some researchers claimed that ITT affects the transferor country negatively, ITT benefits the transferor country economically and surprisingly technically through gaining access to new possible technical solutions (Reddy and Zhao, 1990).

Moreover, Baranson (1970) stated that transferee government expects from defense related ITT projects to provide "localization of technology" in order to:

- close the technological gap with leading countries,
- achieve independence in related technology,
- prevent the capital flow to foreign countries.

As governments are decision makers in defense industry projects, government level regulations have major influence on the structure and dynamics of cooperation in relevant fields. There are several regulations that affect the international knowledge flow and hence the architecture of ITT projects. Two main examples for such regulations are International Traffic in Arms Regulations (ITAR) and the Missile Technology Control Regime (MTCR).

International Traffic in Arms Regulations (ITAR) is a set of the US government regulations that control the export and import of defense-related articles and services on the United States Munitions List (USML). Any article, service, or related data found to be on the USML requires an export license (issued by the US State Department) to be exported or in other words given to a non-US person. Some license exceptions are available under specific circumstances. The Department of State Directorate of Defense Trade Controls (DDTC) interprets and enforces ITAR. Its goal is to safeguard the US national security and further the US foreign policy objectives.

USML covers 20 categories involving Launch Vehicles and Spacecraft Systems and Associated Equipment. The list of ITAR-controlled technology ("USML items") changes by time. The coverage of the list was extended and enclosed the space related technology especially after the controversial Intelsat 708 mission in 1996. In

1996, Space Systems/Loral (US company) manufactured Intelsat 708, which was a telecommunications satellite intended to be operated by Intelsat containing sophisticated communications and encryption technology. The Chinese launcher Long March 3B was selected to launch the satellite. In February 1996 Long March failed to launch Intelsat 708 satellite due to an engineering defect and crashed into a village near the launch site. The portions of the debris were never located by the satellite's developers and may have been recovered by the government of People's Republic of China. Intelsat and the Clinton administration suffered criticism in the US for allowing a possible technology transfer to China. After an investigation by the US Congress in 2002, the United States Department of State charged Space Systems/Loral with violating the Arms Export Control Act and the ITAR in connection with the failed launch of Intelsat 708. As a result, technology pertaining to satellites and launch vehicles became more carefully protected.

There are damping and obstructive effects of ITAR on international cooperation. For example, ESA has decided to cut off cooperation with NASA on their previously planned several projects, using the excuse that the US arms export regulations are too unilateral. Because of ITAR, instead of trying to work with the US, the Europeans have decided to use ITAR as an excuse to build satellites with no US parts and to export them to China and other nations. Consequently the expression “ITAR-free”, meaning that products are not subject to ITAR’s numerous restrictions and the US government’s licensing requirements, is popular nowadays.

There is a natural tension between scientists, who want maximum levels of international cooperation, and the national security establishment, which wants to keep tight control over the proliferation of technology and knowledge that strengthens other nations. Another related issue is the desire of companies, entrepreneurs, or even nations to freely sell whatever they can develop or make. International space projects present many opportunities for the leakage of militarily useful technology, and getting the balance right between cooperation and security is always hard.

Another barrier to internationalization is the Missile Technology Control Regime (MTCR), which is an informal and voluntary partnership between 34 countries to prevent the proliferation of missile and unmanned aerial vehicle technology capable of carrying a 500 kg payload at least 300 km. MTCR was established in April 1987. USA, Russian Federation and leading EU countries are members of MTCR. Turkey is a member since 1997.

The MTCR Guidelines specifically state that the Regime is "*not designed to impede national space programs or international cooperation in such programs as long as such programs could not contribute to delivery systems for weapons of mass destruction.*" However, the technology used in a Space Launch Vehicle is virtually identical to that used in a ballistic missile, which poses genuine potential for missile proliferation. MTCR has been successful in helping to slow or stop several ballistic missile programs. However, it also negatively affected some space related programs like the Space Launch Vehicle development programs of Brazil, South Africa, South Korea and Taiwan.

As a high-technology industry, aerospace industry needs long-run competitiveness and this depends on the capacity of its sectoral innovation system to provide cost-cutting and productivity-increasing innovations and products with technological features superior to the competitors. However, abovementioned barriers to internationalization in aerospace industry are potentially hindering development of relevant projects and important determinants for ITT projects in aerospace industry.

As it was discussed in Section 3.2, being a latecomer offers opportunities for accelerated technological development as it is possible to avoid risks and uncertainties because of the fact that the path of development has already been taken by frontiers (Gerschenkron, 1962). However, using these opportunities requires systematic approaches and is a costly process. Newcomers' governments need to decide on critical issues such as whether a technology should be acquired or indigenously developed, which funding mechanisms to utilize or how to train required experts.

Governments may set a goal for a specific technology area to be developed up to a certain level of technology readiness. Successful completion of the technology development projects is just the initial step. Achieving the aimed technology may not be enough without having an accurate and well-designed technology roadmap, and more importantly without the environment, which make it possible for sustained competitiveness. According to Vertesy and Szirmai (2010), the successful establishment of the aerospace industry in a latecomer economy depends on the shift from the emerging phase to a phase of sustained competitiveness. The competitiveness of a sector is closely related to the performance of its sectoral innovation system (Malerba et al., 2009).

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 theoretical background, 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 given in Chapter 3, 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, nevertheless the relations between the firm and the relevant sectoral innovation system are also considered.

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, but just in few 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).

On the other hand, this thesis 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 5.

Table 5 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 5 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". In Section 3.2, 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 6.

Table 6 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 11.

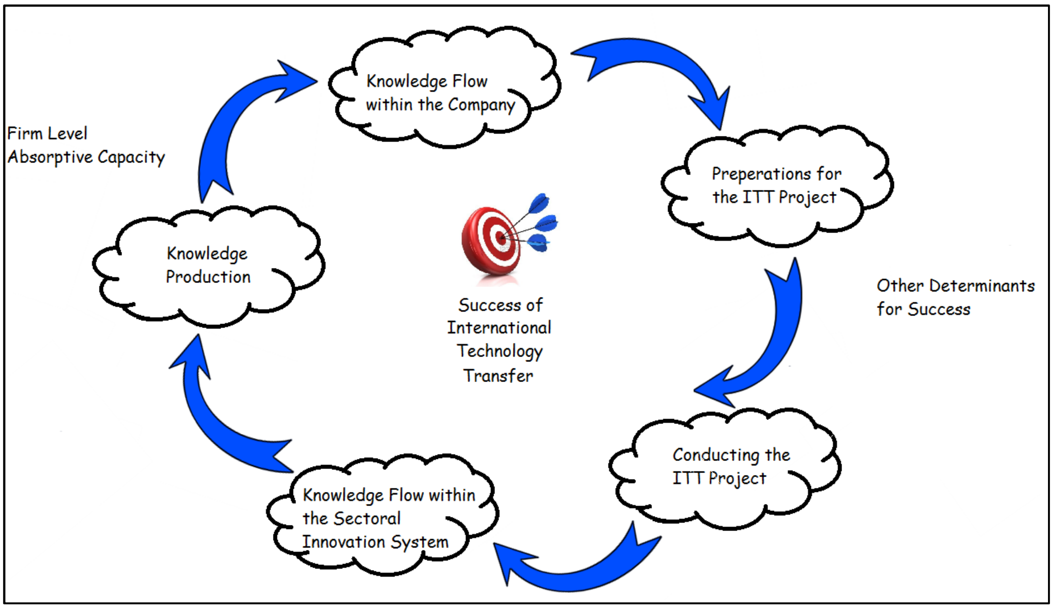


Figure 11 Determinants for the Success of ITT Projects (initial version)

The main goal of this dissertation, 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 thesis 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) is prepared as given in Appendix A 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 as introduced in Section 1.2). 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 varying 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.

Information about the profile of experts, who had contributed to research while determining the variables through semi-structured interviews, is provided in Table 7. Since the profile of experts involves major players who take place in an aerospace ITT project with varying roles (such as policy maker, customer, contractor and acquisition body), it can be stated that the evaluations provide a general framework regarding the circumstances related to aerospace industry in Turkey. The ideas of experts offer an insight into dynamics of aerospace industry inherently with a developing country point of view.

Table 7 Profile of experts who had contributed to research while determining the variables (Step-3)

Industrial Experts		
Number of experts	**Position in the firm**	**Experience in the firm (years)**
5	Upper manager	>20 years
11	Mid-level manager (Design/Development/Production Departments)	>10 years
5	Technical Specialist (Design/Development Departments)	>5 years
Experts from State		
Number of experts	**Position in the Organization**	**Name of the state organization**
8	Upper manager/ Mid-level manager	Undersecretariat for Defense Industries, Ministry of National Defence / R&D Department, Ministry of Maritime Affairs, Transport and Communication, Turkish Air Forces
8	Technical Specialist	Undersecretariat for Defense Industries, Ministry of National Defence / R&D Department, Turkish Air Forces

The description of the research steps were described in Section 1.2. Accordingly, after completing Step-3 through Semi-Structured Interview Questions (Appendix A), 47 variables were determined, elaborated and categorized under the conceptualized framework. Detailed discussions on these variables are given in Chapter 4.

CHAPTER 4

ELABORATION OF VARIABLES

4.1 FACTORS AFFECTING ABSORPTIVE CAPACITY IN AEROSPACE INDUSTRY

In this section, determinants for successful and effective building up of intra-firm absorptive capacity are examined. The elaboration of variables is a part of Step-3 of this research as introduced in Section 1.2. Firstly, variables that are distinguished to be related to indigenous technology development are discussed, such as importance of qualified employees, facilitating access to world literature, ways of performing technology development projects within the firm and efforts on developing indigenous design and analysis tools. Social aspects that are recognized to be effective on firm level absorptive capacity are also discussed and the terminology of "emotional capacity", which is especially based on Turkish culture, is introduced.

Secondly, mechanisms for knowledge flow within the firm are examined. The term of "need to know" is introduced and the importance of a dedicated organizational structure, which coordinates overall knowledge creation activities within the firm, is discussed. Merits of systems engineering and ways of implementing this approach are examined. Additionally, importance of utilizing face-to-face communication to provide knowledge flow, which is especially related to "lessons learned" in the form of tacit knowledge, is elaborated.

As a next step, the interactions of the company with the external environment, that is to say sectoral innovation system, are examined. The mechanisms such as taking part in events like technology platforms or feasibility studies as well as the ways of interaction with national universities are discussed from the perspective of the aerospace industry. The training strategies and the importance of relations with sub-contractors are also discussed. Additionally, relations with the players outside the national borders are addressed separately. For this purpose, mechanisms like taking part in international technology development projects or attending to international events are examined.

The elaborated variables are utilized in quantitative analysis to understand the relations between absorptive capacity and determinants/success indicators of ITT projects. For this purpose it is required to quantify these variables. Therefore, in order to identify and measure relevant variables, questions are generated and given just after the explanations regarding the associated variables. Afterwards, these questions are gathered in a form of questionnaire given in Appendix B.

4.1.1 Knowledge Production; Developing Indigenous Technologies

4.1.1.1 Hiring Qualified Employees and Training

A firm's ability to innovate depends largely upon its ability to capture human intellectual capital effectively. Dolfsma (2008) stated that learning is an investment on human capital. In other words, employees can be seen as very valuable assets of the firms and attracting the right people is a key challenge for fostering innovation.

In most of the leading aerospace companies in Turkey, majority of the employees are graduated from national universities with high reputation. However, it is not possible for companies to hire ready-to-use employees. Most of the undergraduate programs are covering a huge variety of topics while the need of the industry is focused on some specific issues that are not directly covered within the undergraduate programs. It would not be misleading to state that the graduate programs are more relevant to industry needs than undergraduate lectures for the majority of engineering programs.

As the demand from industry increases, the graduate (and even the undergraduate) programs consistently evolves. For example, in most of the mechanical engineering departments of prestigious universities in Turkey, there are lectures related to automobile industry. Even in some universities there are specific automotive engineering departments. On the other hand, it is not the same for some aerospace disciplines like rocketry for example. Although there are graduate lessons provided in aerospace or mechanical engineering departments related to this specific issue, it has not been yet possible to establish a specific academic center focused on rocket science. Therefore, new graduates from the universities come with the knowledge of main principals but most learning process on specific high technology topics takes place during their professional career. The needs of the industry show the path for further studies, which can be performed within a graduate thesis or research projects, to both academic staff and the employees that are enrolled in a graduate program. This may lead to fruitful thesis studies serving to the needs of aerospace industry and at the same time contributes to the academic literature.

Additionally, another way to increase the quality of human capital in medium-term is to perform scholarship programs for doctorate students who have academic titles in universities. The aim of such programs is to support and inspire the students who are interested in the relevant strategic aerospace areas. This approach also helps to increase the number of academicians in the related areas.

1. *My company sets academic goals for graduate programs and supports the students enrolled in these programs.*

There is a continuous need for labor required by other high technology sectors, therefore it is not easy for aerospace companies to attract outstanding graduates. Especially during the rapid growth periods of firms depending on the nature of big projects, companies can be obliged to hire relatively low-quality personnel graduated from some universities other than the top ranked ones. This may result in extended duration of orientation for the new comers, which is not desirable.

2. *My company commonly hires graduates of the top universities.*

Hiring qualified employees is just the initial step for producing assets in form of human capital. Training and providing the sustainability of qualified human resource are the challenges that the companies face in the long run. Training can be provided in different forms such as intra-firm training or through interactions within the Sectoral Innovation System, which also covers the alternative of hiring foreign advisors. These various forms of training methods are discussed in Section 4.1.2 and Section 4.1.3.

4.1.1.2 Facilitating Access to World Literature

For researchers in both developed and developing countries, the initial step for a research activity is to investigate the literature. But especially for the researcher in a developing country, literature provides more opportunities than it does in a developed country. When compared to leading countries, developing countries do not engage in relevant amounts of R&D, but instead most of the time they are technological followers whose technical progress eventually relies upon the ability to adopt appropriate innovations produced by advanced countries. In Section 3.1 we discussed the advantages that ICT provides in modern world to followers in the context of knowledge spillovers. Foray (2004) highlights the potential of ICT to reduce spatial and proximity constraints and states that ICT revolution leads to knowledge reproduction and transmission costs to drop. He also mentioned that knowledge-based economy is an economy in which knowledge externalities are more powerful than ever.

Therefore, as a starting point, the utilization of existing literature is essential for a developing country in pursuance of improvement. This would aid to examine recent projects, applied standards, common procedures, approaches as well as the lessons learned. Companies have to systematically search for external knowledge through memberships to journals, digital sources or by following newly published books in the area of interest.

3. *My company provides facility of access to world literature via highly equipped library or membership to digital libraries.*

It was previously mentioned that, 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. Although, it is not common to use intellectual property (IP) rights to secure rights in respect of patented inventions and registered designs in aerospace industry, for a developing country checking out the patents around the world may bring about new ideas.

4. *My company provides facility of access to patent databases and it is common to use this occasion while making literature survey.*

4.1.1.3 Technology Development Projects

The concept of Technology Readiness Level (TRL), the ways of implementing technology assessment as well as planning technology roadmaps were introduced in Section 3.2.4 and country level examples were also provided. The same approach is valid at the firm level as strategic management process is vital and required to be conducted in a systematic manner to figure out long-term targets of the firm as a part of a strategic plan.

Although complying with the firm level technology plans is not as easy as in other sectors and firms are more dependent on the state, it does not eliminate the necessity for firm level strategies and technology development plans. Companies, with commercial concerns, have to find ways to efficiently take advantage of their existing capabilities, but at the same time they need to explore opportunities for improvement. They need to make use of being path dependent but at the same time they have to be open to opportunities for leap frogging, such as using technology transfer from frontiers. Nevertheless, companies taking part in aerospace industry have to establish their own strategic plans involving firm level technology roadmaps, which need to be compatible with global technological paradigm, the customer vision (national technology roadmaps) and the company's vision. The aimed technologies can possibly be turned out to innovations and at the same time have to be compatible with national goals. Since the state is very overriding, it may not be possible to comply with the firm's strategic plans but firms need to forecast technologies within their line of sight. Because of the ambiguity, alternative technologies may be located in the earlier phases of the technology roadmap and all alternatives have to be developed at the same time to some level of maturity.

As the technology roadmap requires the consideration of different disciplines, harmonization between different expertise areas is crucial during the preparation of the roadmap. The inputs gathered from different departments have to be considered and evaluated with a system-level technology development point of view. In order to establish an effective linkage between different technological areas and different technological goals, continuous trade-off studies have to be conducted and systematic monitoring is necessary. For aerospace companies with huge numbers of employees and expertise areas, this multi-disciplinary and multi-dimensional task has to be assigned to a dedicated organizational department as main responsibility area. This department has to employ "technologists" with responsibility to continuously monitor already existing capabilities within the firm and to set technological goals for other departments complying with the firm's strategic goals.

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.*

Although planning the technology roadmap is very important, if the firm does not have the adequate sources to perform the relevant tasks, the plan will have no meaning. Therefore, firms need to convince their customer, where the state is the customer for most of aerospace projects, to fund the technology development projects. There are different mechanisms for funding R&D efforts by the state in Turkey like TÜBİTAK or SSM funds, which are not easy to initiate.

Moreover, 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. Hence, alternative funding is through own resources and companies will need to take the risk of investing in technologies, which probably will not return in a short time. After careful analysis, for a short list of selected topics, companies may initiate their own development projects funded by own resources. These selected topics might be related to material development, design and analysis tools development, manufacturing process development, test capabilities development or directly devoted to sub-system development.

Whatever the source is used for funding, in order to reach successful results, R&D has to be handled independently of the requirements of ongoing system-level projects. Technology development projects exempted from the commitments of system-level product projects will possibly lead to fruitful alternative solutions for the reason that it is not possible to innovate under performance obligations.

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.*

4.1.1.4 Developing Design and Analysis Tools

Developing indigenous design and analysis tools provides the company to understand the basics of the area of research. Even the modest attempts for developing in-house design and analysis tools will offer an awareness and openness to the subject. These efforts will introduce the company with the ultimate approaches used by leading companies. The simple results obtained from initial versions of the developed tools will make it possible to make conceptual type of design. Such results will make it possible to conduct feasibility studies and to establish the technology roadmaps based on scientific approaches. If a chance can be found to validate the results of initial versions of such tools, like accessing empirical databases or benchmark results, it would be possible to plan the further steps of improvement.

Most of the commercial software programs used in engineering applications are based on simple initial steps. Initial versions can be formed as products of some graduate thesis or outputs of research programs with small budgets. What makes them come together and comprise more sophisticated and efficient tools is a systematic approach. Every small step in development based on previous versions will lead to more capable tools. After some level is achieved, by the help of market type of innovation, such simple tools can be turned into user friendly, expensive and desired commercial products. Therefore, it is possible to state that continuous efforts one after another will lead to capable design and analysis tools. At firm level, this can be achieved by systematically delivering the previous studies to new researchers. For this purpose, previously developed capabilities have to be internalized and institutionalized through codifying the development process of such tools. It is only possible to put some other bricks only after totally understanding the current situation and capabilities of the existing tools. For continuous improvement, firms have to appreciate their assets and find ways to secure and to systematically deliver these to the next generations. Documenting the development process of indigenous tools or preparing user manuals for them can be some ways for codification. Company standards on tool development can also be generated and implemented to make it easy to adopt.

Even though codification might help continuity of improvement process, in order to transfer tacit knowledge to next generation, direct face-to-face interaction is important. A systematic interaction between the originators of the initial versions of design and analysis tools and the new generation of engineers would lead to decreased durations of adoption and considerably decreased loss of information.

By the help of continuous efforts in developing indigenous design and analysis tools, specialists who take part in tool development activities will develop their expertise in the relevant field, and eventually they would be the core team to take action in possible further steps. However, it is not easy to nurture such core teams especially when there are no ongoing related projects with a customer and evidently with no funds. Practically, it is not possible to maintain such teams working in a dedicated way on the development of such design and analysis tools, but instead the team members will have some other tasks within the matrix organization.

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.*

4.1.1.5 Emotional Capability

It was previously mentioned that human resources is the major asset for the firms in the era of knowledge economies and success depends on the commitment of employees. The importance of hiring qualified employees and training provided to employees were discussed above. However, there are also some other important concerns other than technical and academic development for the continuity of human sources such as; employees' satisfaction, health, safety and labor conditions. Satisfaction can be maintained through assigning well defined goals for individuals and continuous and systematic performance evaluation. This will provide the employees to forecast their career path and encourage them to achieve their highest potential. Besides, wage policy within the company has to be fair and when compared to rivals it must be charming to attract the best employees.

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.*

Akgün et al. (2009) introduced the term "emotional capability" as one of the competencies that a firm has and stated that it is vital for the daily life of the organization. According to their conception, emotional capability, involving the dynamics of encouragement, displaying freedom, playfulness, experiencing, reconciliation and identification has a significant effect on the development of new products, services and processes, or in other words on the innovativeness of the firm.

Based on the results of empirical analysis that was conducted by investigating more than 150 Turkish firms, Akgün et al. (2009) obtained results that can be formulated as suggestions to top management of a company as summarized below. Accordingly management should;

- provide an environment where employees are safe to interact with each other without feeling rejected or punished,
- encourage enthusiasm and hope among employees to accomplish their goals,
- promote emotional bonds among employees to increase the organizational commitment and loyalty,
- foster an ongoing dialogue and interactions among employees at social events to reconcile their emotional differences,
- be careful to utilize the emotional dynamics under the different environmental conditions.

These results have to be considered keeping in mind that they contain the essence of Turkish culture. Additionally, in order to improve employees' state of mind, they should be supported to take part in the decision making processes in technology roadmapping, strategic planning or concept selection. It is important to level up members of the company to develop a shared vision. This can be through systematic meetings with top management or through some other mechanisms ensuring to receive and evaluate suggestions/wishes/complaints generated by employees.

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.*

4.1.2 Knowledge Flow within the Company; Access to Already Existing Intra-firm Knowledge

It was previously stated that for knowledge creation within firms; "visions, values, and memories in the form of artifacts, routines and experience" are important articles to consider. Besides, it was introduced in Section 3.1 that creating knowledge can be possible through building the relationship between 'pieces' of information.

As firms are dynamic structures, the members of the firms change by time continuously with a need to transfer already existing knowledge to new generations. According to Hey (2004), knowledge is generally personal and subjective, which means that created knowledge within the firm is found within the heads. Moreover, Ancori et al. (2000) argued that knowledge formation requires continuous feedback loops between knowledge and wisdom, and they emphasized the importance of cognitive abilities of the actors.

In this manner, it is critical to have mechanisms to transfer intra-firm knowledge to the new comers. This can be through systematic institutionalization of organizational knowledge, interactions within the company and systemic meetings. Spraggon and Bodolica (2012) expanded these definitions into more detailed processes such as training programs, meetings, best practice files, coaching, mentoring, informal networks, systemic thinking and cross-functional teams.

Moreover, there are some natural barriers to accessing intra-firm knowledge. The term "need to know", is a widely used term especially in defense and aerospace industry. This term describes the restriction of data, which is considered as sensitive. Under “need to know” restrictions, even if one has all the necessary official approvals to access certain information, one would not be given access to such information, unless one has a specific need to know. In other words, access to information must be necessary for conducting one's official duties.

Although “need to know” approach is crucial in aerospace industry to prevent leakage of knowledge, it is critical to have mechanisms to avoid repeating knowledge creation efforts within the firm. Especially companies, which contain pure project organization structures instead of matrix structures, occasionally prefer to duplicate some organizational capabilities in order to serve one specific project’s need in a more efficient manner. Eventually as an expected result of this duplication different teams may try to reach the same goal without knowing each other’s capabilities and missing out the already existing in-house capabilities. In general, the applied solution to this problem pursuing the aim of optimizing the limits of restriction and opportunities of exploitation within the company is to establish dedicated organizational structures. Such structures have functional roles to coordinate the technology management efforts of overall organization, and to assure the storage of organizational memory with a holistic way instead of guarding a specific project's need.

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.*

4.1.2.1 Codifying the knowledge generated within the company or acquired from external sources for future exploitation

In Section 3.1, terms like knowledge, types of knowledge, tacitness, modes of conversion of knowledge and codification were introduced. Additionally in Section 3.1, relation between the absorptive capacity of a company, codification and learning processes was discussed. In the light of these discussions given in the previous parts, it is possible to state that in order to increase organizational knowledge, knowledge codification processes are vital and indispensable despite the difficulties emerged from the nature of tacitness.

The codification can be performed in forms of various types of reports that are prepared by different departments within the organization on numerous subjects. Output of a task accomplished by a department might be an input for further studies of this department or input for another organizational structure. Scope of such reports, probably that are not direct outputs of ongoing projects, can be as follows;

- Literature review on a specific subject.
- Reports related to indigenously developed design and analysis tools (introducing the related theories and existing literature, in-house development process, benchmarking and case studies, validation and verification results, user manuals, etc.).

- Reports related to results of design and analysis studies (introducing the sophistication level of used methods, trade-off studies, optimization methods, comparisons, etc.).
- Reports related to performed tests (performance of design concept, validation of design and analysis tools, material characterization tests, TRL assessment, etc.)
- Results related to failure analysis studies.
- Status reports on specific technologies, technology roadmap evaluations and risk analysis with an overall perspective.
- Reports related to events such as conferences, exhibitions and trainings.
- Reports related to external interactions such as business development meetings, site visits or meetings with the customer and sub-contractors.

It is essential to encourage employees to prepare reports on abovementioned tasks in order to build up an organizational memory. The mechanisms for planning and monitoring of reporting activities as well as facilitating access to these documents by other employees will provide efficiency in codification as well as formation of organizational knowledge.

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.*

It was introduced in Section 3.3 that aerospace industry has some highly distinctive features and it requires advanced technological capabilities even at the earliest stages of the emergence of the industry. Starting from the initial stages, companies need to comply with high international technological standards. In this context, companies are supposed to generate documents during performing aerospace projects according to some international standards. Some standards, which aerospace companies required to comply with, are as follows;

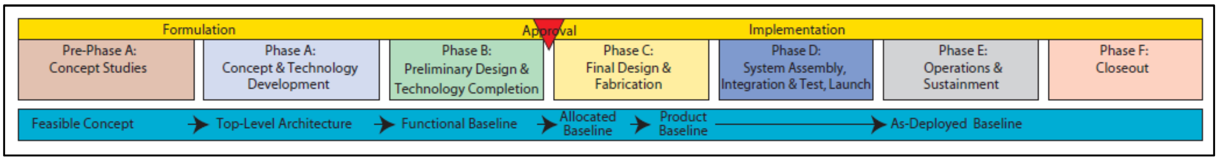
- MIL-STD-973 Configuration Management
- MIL HDBK 61A Military Handbook: Configuration Management Guidance
- MIL-STD-498 Software Development And Documentation
- MIL-STD-499 Military Standard: System Engineering Management
- MIL-STD-1521 Military Standard: Technical Reviews And Audits For Systems, Equipments, And Computer Software
- MIL-STD-1388 Logistic Support Analysis
- ECSS-E-ST-10C Space Engineering: System Engineering General Requirements
- ECSS-E-ST-40C Space Engineering: Software
- Quality management systems such as ISO 9001 or CMMI (Capability Maturity Model Integration)

In conjunction with these requirements companies are supposed to implement "systems engineering processes" in aerospace projects and some documents are inevitably produced under the scope of aerospace projects.

> Systems engineering is a methodical, disciplined approach for the design, realization, technical management, operations, and retirement of a system. A "system" is a construct or collection of different elements that together produce results not obtainable by the elements alone. The elements, or parts, can include people, hardware, software, facilities, policies, and documents; that is, all things required to produce system-level results. The results include system-level qualities, properties, characteristics, functions, behavior, and performance. Systems engineering is a way of looking at the "big picture" when making technical decisions. It is a way of achieving stakeholder functional, physical, and operational performance requirements in the intended use environment over the planned life of the systems. In other words, systems engineering is a logical way of thinking. Systems engineering is the art and science of developing an operable system capable of meeting requirements within often opposed constraints. Systems engineering is a holistic, integrative discipline, wherein the contributions of structural engineers, electrical engineers, mechanism designers, power engineers, human factors engineers, and many more disciplines are evaluated and balanced, one against another, to produce a coherent whole that is not dominated by the perspective of a single discipline.[19]

[19] NASA Systems Engineering Handbook. NASA/SP-2007-6105

In this dissertation, systems engineering approach is referred just to demonstrate the types of documents, which are generally the expected outputs of aerospace projects and at the same time, from the perspective of codification, indicators of organizational knowledge. Different types of documents are produced in different phases of the project in terms of technical maturity. Phase structure of the projects and scope of relevant documentation are schematized in Figure 12 based on NASA Systems Engineering Handbook (NASA/SP-2007-6105).



Source: NASA Systems Engineering Handbook[19]

Figure 12 Project phases

Examples of project documentation that are supposed to be generated within design and development process according to systems engineering approach are as follows;

- Management plans (Configuration and Data Management Plan, Project Management Plan, Systems Engineering Management Plan, Quality Management Plan, Risk Management Plan, etc.)
- Technical specifications
- Analysis results (including Reliability analysis, Compatibility analysis, Safety analysis)
- Test and evaluation master plan
- System interface control documents
- System design documentation
- Sub-system design definition documents
- Detailed sub-system models
- Design verification plan
- Detailed design drawings
- Test and analysis report

12. *My company implements systems engineering approach in compliance with international standards and generated project documents are easily accessible by project personnel.*

In addition to abovementioned reports and project documentation, there are some other forms of documents to codify organizational knowledge such as procedures and process definition documents. These types of firm specific documents quickly bring new members up to speed and make it possible to continuously improve the documents by shared wisdom. Procedures and process definition documents can be used for various purposes such as describing the roles of functional structures, describing "process flows" for different tasks (design, production and test process can be codified) and defining the organizational institutions. Some examples for procedures and processes are as follows;

- Design and development configuration management procedure
- Requirements management procedure for design and development phase
- Sub-system design and development procedure (for relevant sub-systems)
- Tools and equipment design and commissioning procedure
- Personnel training and certification procedure
- Equipment maintenance procedure
- Procedure for preparation of annual production plan
- Procedure for material transportation and storage
- Procedure for preparation of "request for information" and "request for proposal"
- Design and development process
- Requirements definition process
- System design process
- Design verification process
- Software development process
- Electronic hardware development process

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.*

Previously, it was stated that ICT revolution leads to knowledge reproduction and transmission costs to drop, and opened up the new possibility to catch-up along leapfrogging strategies through NC processors, CAD/CAM and PLC. ICT is also supposed to provide an easy access to in-house documentation to offer an effective usage and exploitation of existing knowledge.

4.1.2.2 Interactions within the Company; Exchange of Knowledge and Experience

It is important to have mechanisms by which experience spreads and embeds itself within the company. Codification efforts introduced in the previous section are essential but not adequate for effective exchange of knowledge and experience. In order to provide the suitable environment for tacit knowledge to flow, much more than written forms of knowledge like reports, procedures and process definitions etc. is needed.

As described before, codification is not hundred percent possible in practice. Morone and Taylor (2010) proposed that, as tacit knowledge is hard to encode and communicate and the acquisition of tacit knowledge is highly cognitive process, methods involving direct interaction, that includes face-to-face interaction and practical experiences are more suitable for the transfer of tacit knowledge. Besides, Balconi et al. (2007) stated that tacit knowledge is exchanged face-to-face more effectively than at distance. Therefore, in order to provide effective transfer of tacit knowledge, establishment of environments that provide face-to-face interaction between individuals is essential.

In Section 3.1, definitions in the literature related to the types of knowledge were introduced. Additionally, according to Morone and Taylor (2010) description of "know who" type of knowledge is based on the following argument; because specialized knowledge and skills are essential elements for innovation and are widely dispersed, knowledge of whom to contact is particularly valuable. Especially, in big companies that hold departments with various functions and organizational responsibilities, knowing who is capable of performing a certain task most efficiently becomes a challenging problem.

In the light of abovementioned explanations, platforms to enhance communication between employees and between units have to be provided. These interactions can be organized in following ways;

- Orientation of the newcomers, introducing functional responsibilities of departments and firm capabilities.
- Internal training for newcomers to introduce them the firm culture and familiarize them with applied procedures.
- Continuous training of all employees in order to equip them with necessary capabilities, which suit to their constantly changing roles in the organization.
- Conveying "lessons learned and best practices" obtained from previous experience in order to be utilized in new projects through systematic meetings.
- Evaluation of intra-department relations in order to measure and to develop level of satisfaction of the services and outputs they continuously exchange.
- Continuous and systematic meetings to form "cross-functional systematic thinking teams" that have members from various departments in order to share vision, brainstorming, strategy proposal for top-management and failure analysis if needed.
- Formal and informal coaching and mentoring leaded by experts in order to guide new employees.
- Providing informal networks, encounters and social activities that employees can enhance their relations.

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.*

4.1.3 Knowledge Flow within the Sectoral Innovation System

4.1.3.1 Knowledge Flow between the Firm and Other National Stakeholders

In a knowledge-based economy, in the long-term, the ability to innovate is more important than cost efficiency, and innovations can be seen as combinations of already existing knowledge, ideas and artifacts. This evolutionary approach highlights the importance of interactions with stakeholders as introduced in Chapter 3 in the context of Innovation Systems.

A keen and strong aerospace company is supposed to exchange knowledge continuously with national stakeholders involving customers, decision makers and supportive organizations and sources of knowledge (universities, research centers, etc.). According to "Satellite Space Sub-System and Technologies Road Map"[20] issued by Undersecretariat for Defense Industries and "Aerospace Technologies Commission Report"[21] issued by Ministry of Transport, Maritime Affairs and Communications, the aerospace industry stakeholders are categorized in following groups; Knowledge Institutions; Educational Organizations, Industry, and Government Bodies and Supportive Organizations.

Each stakeholder may have different role within the innovation system. Major roles are given as follows; Politics, Policy and Institutions; Client/End User; Funding Organization; Procurement Authority; Research; Design; Manufacturer; Test; Adopter; Supplier (Materials/sub-systems/COTS products); Subcontractor (Special equipment/sub-systems); Consultant; Investor; Technology Source; Support Organizations (to organize networking events)

---

[20] Uydu Uzay Alt Birim ve Teknolojileri Yol Haritası, Savunma Sanayii Müsteşarlığı (SSM), May 2013

[21] Havacılık ve Uzay Teknolojileri Komisyonu Uzay Teknolojileri Alt Komisyonu Şura Raporu, Ulaştırma, Denizcilik ve Haberleşme Bakanlığı, May 2013

As a result of Step-3 of this research, the relation between the roles and categories of the stakeholders that are related to aerospace area in Turkey is revealed and presented in Table 8.

Table 8 Roles of aerospace stakeholders in Turkey

	Knowledge Institutes	Educational organizations (Universities,)	Industry	Government bodies and Supportive organizations	Individuals
Politics, policy and institutions	+			+	
Client/End User				+	
Funding Organization	+		+	+	
Procurement Authority					
Research	+	+	+		+
Design	+	+	+		+
Manufacturer	+		+		
Test	+	+	+		
Adopter	+		+		
Supplier (Materials/subsystems/COTS products)	+		+		
Subcontractor (Special equipments/subsystems)	+		+		
Consultant		+	+		+
Investor			+		+
Technology Source		+	+		
Support Organizations (to organize networking events)	+	+	+	+	

It can be seen from Table 8 that firms do not have direct policymaking roles related to politics, policy and institutions. Actually, in Turkey there are two top decision-making bodies affecting aerospace industry; Defense Industry Executive Committee and Supreme Council of Science and Technology, both chaired by the prime minister. However, as companies possess the know-how in aerospace fields they are supposed to have an indirect and implicit role on decision-making, which mainly occurs through different forms of consultancy. These efforts can come into existence in the forms of feasibility reports that can be prepared under contracts between firms and state organizations. Moreover, actively taking part in national technology platforms or preparing project proposals according to the state's requirements can also serve this purpose.

From the perspective of firms and in terms of absorptive capacity building, having direct and first-hand information related to national goals and policies assists firms in preparing their own strategic plans. For an aerospace company of a developing country, it is crucial that company visions have to be aligned with the national goals in order to effectively benefit from state investments. Companies need to harmonize their long-term master plans and company level technology roadmaps with the national vision. Besides, technology development efforts funded by company sources have to be planned accordingly.

In addition to above mentioned statements, interactions with other national sources of knowledge like universities and knowledge institutes enable companies to reach valuable knowledge generated nationally. This occasion takes place without facing the barriers to internationalization in aerospace industry, which are encountered during international interactions that were described in Section 3.3. Additionally, such relations within the national boundaries provide companies the benefits of reaching a common mind on technical solutions that most probably accelerates the process of persuasion of decision-makers and fund suppliers.

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.*

In Section 4.1.1, the opportunities that can be taken by aerospace companies to guide the university curriculum and the graduate studies on related high-technology areas were introduced. There are some other means of interactions between companies and universities that can help to build paths for bilateral knowledge flow;

- University - industry cooperation programs [22]; such programs aim the commercialization of the knowledge generated by universities by conversion to products or processes and transfer to the industry in accordance with the needs of companies. (Example; TÜBİTAK 1505 - University - Industry Cooperation Support Program)
- Knowledge transfer offices[23]; these offices provide support to industry with regard to information, project development, project design, implementation,

[22] http://rgp.sabanciuniv.edu/tubitak-technology-and-innovation-funding-programs-directorate-teydeb, accessed on March 02, 2015

[23] Research and Development in 2013, Research Coordination and Industrial Liaison Office, METU, March 2014

evaluation and sharing the project outcomes in order to enhance the effects of project outcomes and enable to get more benefits from project support programs. Additionally, these structures are supposed to carry out matching activities in line with the demands of researchers and industries. (Example; Middle East Technical University - Knowledge Transfer Office)

- Technology transfer offices[23]; aim at providing possibilities for the continuation of research enabling that academic knowledge does not remain restricted to publications, but it is put at the disposal of industry. (Example; Middle East Technical University – TEKNOKENT Technology Transfer Office)
- Researchers training programs for the industry; such training programs intended for graduate and postgraduate researchers specifically designed for students (researchers) who work in aerospace companies and are enrolled in postgraduate programs in universities at the same time. There is an ongoing program for this purpose in Turkey; Researchers Training Program for the Defense Industry (SAYP), which was initiated by SSM. In this program, the dissertations are executed as regimented projects selected to be realized in line with medium and long-term research and development strategies of companies in fields of priority areas as set by the Office of Undersecretary of the Ministry of Defense[23].
- Lectures provided by experts from the industry in Universities; guest lecturers from the industry can provide elective courses in order to share their technical knowledge and their industry originated skills. This helps to inspire the students and may steer them to aerospace industries after their graduation.
- Research centers within universities can be established through collaboration with industry to reinforce knowledge flow. The fields of research can be determined in line with the needs of predefined national technology roadmap.

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.*

It was previously mentioned that the human resource is one of the most important assets for a company. Therefore, personal development with training programs and promoting personal progress within the scope of carrier planning are indispensable. 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, based on the requirements of different departments and in a way that meets with the strategic goals of the company, continuously searches for external sources of knowledge. Training plans have to be prepared according to present and future role of the employees. These trainings can be short-term (weekly or monthly, focused on specific needs) or long-term (supporting employees' or prospective employees' graduate programs).

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.*

For an aerospace company, which has the will to act 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.

Advantages (and for some cases disadvantages) of being a part of a network or a cluster was described in Section 3.1. Networks are "way of seeing" interactions and as firms rely more on external collaboration, the boundaries of the firms get blurred, and the firm becomes a dense collection of communication links within a larger network through which there is continuous knowledge flow.

The most important notion in clusters is introduced as the "value chain" and it was noted that value chain is developed as a result of repeated interactions. The vendors in the value chain 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 the 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 are small and mid-sized enterprises (SME), which have an important place in the value chain. Since these small partners are also a part of the national innovation system, they indirectly serve sustainability of national aerospace programs. This gives the main contractor the responsibility of developing the capabilities of the sub-contractors, especially for their initial attempts on aerospace products and making them benefit spillovers. This can be through on the job training, providing technical support or sharing infrastructure. Besides, it is important to make the vendors aware of the strategic goals of the main contractor company, and also of the national goals, by this way vendors can make appropriate investment scheduling for medium-term to long-term.

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.*

4.1.3.2 Foreign Technology; Following the Global Leaders

In Section 3.2, the mechanisms of international technology transfer were introduced, such as foreign direct investment, foreign licensing and joint ventures. In this section ways of obtaining foreign knowledge other than international technology transfer are discussed. International knowledge flow in aerospace industry can occur through below mentioned alternative ways;

- Following world literature; the importance of having access to leading world literature was discussed before, which is an important way of following the developments achieved by developing countries.

- Attending international conferences and exhibitions; this is one of the most effective ways of understanding the status of maturity in developing countries in the related area of research. Latecomers generally replicate the development experience of the leading countries. 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. While international conferences provide attendees with up-to-date knowledge, they also provide the chance to establish new contacts.
- Taking part in an international technology development program; European Union Framework Programs (FPs) are the main Programs of the European Union by which multinational research and technology development projects are supported. FPs are multi-year programs and since the first program's start in 1984, the budget and the scope of the programs kept increasing. 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. In Turkey, in order to encourage national aerospace industry to take part in FP, information days, coordination and information meetings have been organized systematically by the state. While these programs are intended to develop breakthrough technologies to significantly increase EU capabilities through utilizing human capital around Europe, at the same time they provide the latecomers with the opportunity of working with the leading countries of Europe. Even a small role in an international consortium under the scope of FP, provides lots of benefits to latecomer companies in terms of accessing varying forms of knowledge.
- Supporting employees who want to enroll in graduate programs abroad; as it was discussed previously, 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. A wide variety of training programs can be planned. Supporting

employees who enroll in graduate programs in developed countries is an example of long-term training. A special sponsorship program with the aim of allocating correct employees to correct programs in harmony with company goals needs good coordination in addition to dedicated funds. This approach also helps to attract brilliant new graduates to aerospace industry.

- Hiring experts from leading countries as temporary consultants in order to train the core team in the relevant field.

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.*

4.2 DETERMINANTS AND SUCCESS INDICATORS OF ITT IN AEROSPACE INDUSTRY

In this section, determinants affecting the success of ITT projects other than firm level absorptive capacity are examined. Additionally success indicators of ITT projects are discussed. The elaboration of variables is a part of Step-3 of this research as introduced in Section 1.2.

As a first step, the variables that are distinguished to be related to the preparation period prior to an ITT project are discussed. These variables can be summarized as the policy environment, position of government, existence of a technological roadmap as well as the readiness level to conduct contractual negotiations on the scope of ITT project. Secondly, the variables that are related to the conducting period of the ITT project are examined, such as the responsibilities and the management of the deliverables. Then, the performance indicators of an ITT project are discussed.

The elaborated variables are intended to be utilized in quantitative analysis to understand the relations between absorptive capacity and determinants/success indicators of ITT projects. For this purpose it is required to quantify these variables. Therefore, in order to identify and measure relevant variables, questions are generated and given just after the explanations regarding the associated variables. Afterwards, these questions are gathered in a form of questionnaire given in Appendix B.

4.2.1 Preparations for the ITT Project

4.2.1.1 Are the "Host", "Home" and Global Big Players Ready?

In general aerospace projects are complicated and long lasting projects. For this reason, it is not as easy as some other industries (like software industry) to benefit from the results in a short time after innovation attempts. Besides, generally system (or even sub-system) development projects in aerospace industry have relation to a wide variety of disciplines, which means that overall maturity in many different expertise areas are required simultaneously to achieve successful results. Moreover, even the modest aim to achieve low TRL values for most sub-system technologies causes a need to have specific prototype production and testing infrastructure. Since the initial investment for such an infrastructure is generally expensive, especially in a developing country it will be almost impossible to find angel investors who may find it worth for investing. Therefore, even in developed countries, initial investment is usually made by states.

> In order to guide the national aerospace industry in its progression, the program goals should be stated as a national goal by the national authority. (Seçkin et al. 2005)

It was previously stated that, in Turkey there are two top decision-making bodies affecting aerospace industry; Defense Industry Executive Committee and Supreme Council of Science and Technology, both chaired by the prime minister. For initializing the investment process to aerospace companies, the pronouncements of these top authorities are decisive. The political will and prioritization of related fields of development as national goal is the main motivation and the driving force behind the development and investment attempts.

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.*

In Section 3.2, catch-up theories and opportunities for latecomers were introduced. According to investigated literature, it is possible to briefly state that, the larger the technological gap between leader and follower, the stronger the follower's potential for development. Besides, according to wide range of the authors, for technology-followers the future is already shaped.

In today's paradigm, development of the capacity to take advantage of information and know-how for innovation is much more important. Modern firms have been restructuring their activities in order to use the advantage of ICT technologies, networks and of learning organizations. Incremental innovation, through enjoying the benefits of information age, is the primary source of long-run competitiveness in technology-followers and provides the possibilities of leap frogging. Perez (2001) highlighted that the success of modern latecomers has been due to the absorption of technology from the advanced countries and their own efforts to adopt, adapt, modify and master the corresponding technical know-how.

In addition to catch-up theories, in Section 3.2, the reasons for considering technology transfer from the perspective of both home and host parties were introduced. Once the aerospace industry is considered, the main motivation from the perspective of the host country is to utilize external knowledge while pursuing the national goals. Therefore, an international technology transfer project has to be constructed in a way that harmonizes with the national technology roadmaps. This has to be assured in terms of aimed Technological Readiness Level (TRL) and performance characteristics of the intended technological acquirement. Among the multiple disciplines and varying technologies that build up an overall technological adequacy needed for an aerospace product, the intended technology transfer project is supposed to fill a specific gap of technological capability, rather than targeting an overall competence.

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.*

The intended TRL through an ITT project also designates the type of this project. The TRLs varying from 1 to 9 were introduced in Section 3.2.4. Maturity of the technology can become evident in form of a technology concept, component, sub-system and system according to expected TRL. Previously, the US based categorization for project types was given as follows;

- Technology Development Projects (including "Basic Research", "Applied Research", "Advanced Technology Development")
- Product Development Projects (including "Advanced Component Development and Prototypes", "System Development and Demonstration", "Research, Development, Test & Evaluation Support", "Operational Systems Development")

Abovementioned categorization is devised to characterize the steps and define critical internal milestones for monitoring and evaluation within an already existing holistic technology roadmap. However, generally technology transfer projects do not cover development steps like "basic research" or "applied research". International cooperation with such an aim to discover new areas are generally called as joint technology development projects instead of ITT projects. Therefore, when we consider ITT projects in aerospace industry, instead of above mentioned US-originated categorization, it would be more distinctive to use below mentioned two-dimensional categorization for the types of projects for further evaluation.

Dimension-1 (Categorization in terms of "Level of Product"):

Main goal of the evaluated international technology transfer is to achieve a capability at:

- Component and/or material level
- Sub-system level
- System-level

Dimension-2 (Categorization in terms of "Functional Capability"):

Main goal of the evaluated international technology transfer project is to achieve a capability:

- To assembly and integrate
- To test
- To manufacture
- To design

These dimensions are introduced to cover the full domain of international technology transfer efforts in aerospace industry of a developing country and have been used in this thesis study for the construction of relevant data as described in Section 4.2.2 and Section 5.1.2.

From the perspective of the transferee (host) party, having the political will with a well-defined national technology roadmap is a crucial step. Definition of an ITT project to fill the technological gaps within the technology roadmap in harmony with ongoing national technology development projects is another essential step. But when we consider the readiness of the transferee for such an ITT project, there are much more to consider.

It was previously mentioned that, in developing countries top decision-making bodies affecting the aerospace industry are members of the state. In Turkey, Defense Industry Executive Committee and Supreme Council of Science and Technology are the top decision-makers. Additionally, if we recall Table 8 that was presented in Section 4.1, "client/end user", "funding" and "procurement" roles within aerospace industry in Turkey were undertaken by government bodies and supportive organizations. However, the main actors responsible for performing the ITT projects are industry members. Therefore, firms have to be convinced about the benefits of such an ITT project in a way that, undertaking the responsibility and risks in such a project has to serve the strategic goals of the company and has to be profitable and well-matched with the company's vision.

Moreover, firms, as they possess the know-how in aerospace fields, have an indirect and implicit role on decision-making, which mainly occurs through different forms of consultancy for decision makers. In general, the level of know-how possessed by the industry is much more than governmental organizations' level of knowledge. This gap is greater in developing countries for the reason that firms, with the help of fringe benefits they provide to employees, have advantages to attract human capital, which is one of the most important prerequisites to possess knowledge. This situation places a burden on the shoulders of top management of the aerospace company by means of making wise decisions favorable to both the country and the company. For the long-term benefits, firms have to attach importance to the strategic benefits and the competence with the technology road map instead of possible short-term economical profits.

As expected, end-users have a tendency to request for the "state of the art" solution, which is also a challenging goal for the companies in the leading countries. However, if we recall the development opportunities for latecomers that were introduced in Section 3.2, the opportunity windows that can be utilized through ITT projects generally do not cover the brand new technologies. Therefore, the scope of the ITT project and the expected technical achievements shall be devised reasonably. During the planning period for an ITT project, in most cases firms have a dispute with the end-users to converge to a reasonable technical requirement document.

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)*

If the technological gaps within the technology roadmap are decided to be filled through ITT projects, the next step is to decide on who is going to be the transferor (home) party. In Section 3.3 it was explained that there exist obstacles to the realization of ITT projects due to the nature of aerospace and defense technologies. Because of political relations and global conjuncture it may not be possible to find an eager partner. If there are possible partners, then the difference between their eagerness to share technology has to be the determinant for the selection. Of course the compelling international relations and price may surpass the rational choice.

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.*

Even the home company has great expertise in the relevant technology area, they may not be active in this area any longer (in terms of developing new products, manufacturing and testing) and in practice the technology may be obsolete. This may mean that the available source of technology does not have competitive and modern capabilities in the area 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.*

In the previous paragraphs, the readiness of the transferee (host) party beforehand the ITT project was discussed. In order to perform an effective and fruitful ITT project, it is evident that the host company needs already developed capabilities to absorb and then to improve the obtained technology.

On the other hand, in order to achieve successful results through an ITT project, the transferor (home) party must also be ready and willing to transfer the technology. This means that there are also determinants originated to transferor. From the view of the home party, what they are going to receive in exchange of know-how they possess have to be worth for it and a win-win situation has to be established.

The reasons why a nation transfers technology through ITT projects were described in Section 3.2. For aerospace projects the reasons from the perspective of the transferor can be summarized as follows;

- To achieve economic benefits in the short-term (in the course of ITT project).
- To achieve economic benefits in the medium/long-term through licensing, supplying raw material/sub-components or logistic support.
- To access new markets through host party.
- To achieve political benefits.
- To outsource the development, production or test activities of a sub-component which is a part of a bigger system, for receiving economic benefits and/or risk sharing purposes.
- To fulfill offset obligations emerged from previous trade relations between countries.

6. *International Technology Transfer Project provided valuable benefits to Home Party therefore Home Party set a high value on the realization of the project.*

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. Especially in aerospace projects, it is extremely important to lay the way open for cooperation. Intended win-win situation between home and host may not be enough to initiate and realize the ITT project and profits for third parties in other forms may be needed to be considered. 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. Furthermore, in order to provide more confidence to host and home companies about the continuity and durability of the ITT project, an intergovernmental agreement between two countries can be signed as an indicator of strong political will.

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.*

4.2.1.2 Contractual Negotiations with the "Home" Party

In the previous sections, initial steps of defining the scope of an ITT project were explained and discussed from the perspective of home, host and third parties like developed countries and big companies. After these steps are taken, with a well-defined goal and a selected technological partner with capability, the preparation of the ITT evolves into a form of contractual negotiations.

Contractual negotiations are of the essence for the reason that, mutually agreed and signed contract designates the scope and boundaries of the technology transfer. Therefore, the expectations of the host party for filling the technological gaps have to be clearly defined in a way that leaves no disputable and subjective issues. Obviously, the host party will interpret such indistinct issues in a way forcing the owner of technology to share much more than they intend, while the home party has a tendency to protect the know-how it possesses. The difference in interpreting the contractual issues may lead to retardation or even to suspend the project, which is an unsolicited status for both parties. In order to prevent this, contractual documents have to be prepared in an explicit way. The maturity of contractual preparations is vital for the success of the project.

According to PMBOK Guide (A Guide to the Project Management Body of Knowledge); "project management" is the application of knowledge, skills, tools, and techniques to project activities to meet project requirements. Project management is accomplished through the use of the processes such as initiating, planning, executing, controlling and closing. In other words, project management can be seen as a discipline of planning, organizing, securing, managing, leading and controlling resources to achieve specific goals. From a project management point of view, projects need certain preparations.

In an aerospace ITT project, effective project management shall involve systems engineering philosophy, which means there is a need for some tools to efficiently and successfully perform the project. Below mentioned documents have to be negotiated and mutually agreed during the negotiation phase of the project and need to be designated as annexes to legal part of the contract of the ITT project.

- Project Implementation Schedule (PIS)
- Statement of Work (SoW)
- Work Breakdown Structure (WBS)
- Work Package Descriptions (indicating the scope, responsible party, inputs, outputs and due dates)
- Responsibility Share Matrix (indicating the scope of responsibilities explicitly)
- List of Deliverables (including documents, equipment, configuration items, material, software, etc.)
- Principles of managerial documents (such as Project Management Plan, Qualification Management Plan, Systems Engineering Plan, Configuration and Data Management Plan, Risk Management Plan, etc.)

From the perspective of the host party, as the ITT project has the goal of obtaining (extracting) tacit knowledge from the home party, the abovementioned documents shall be treated with extra care. Naturally the level of maturity of these documents is based on the prior technological readiness of the host party, as it is important to know what to expect before the negotiations. Although the aim is to increase the TRL of the host party through the ITT project, in order to institute the scope of the ITT project, the host party has to be aware of what should be expected from the home party.

According to Öner and Kaygusuz (2007), negotiation phase is full of traps among the complexity fashioned by problems related with copyrights, royalties, technical assistance, know-how, management contracts, ITT modes and balance of payments. Therefore, contractual documents have to be prepared in a way that secures the expectation of the host party. On the other hand, explicit definitions of expectations through defining solid milestones and approval/acceptance criteria will unsurprisingly be reflected to the price of the contract by the home party.

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.*

4.2.2 Conducting the ITT Project

The technical support intended to be obtained from the source of technology may vary according to the type of the ITT project. In this thesis, ITT projects are categorized in two dimensions in terms of "Level of Product" and "Functional Capability". Figure 13 shows the sophistication level of ITT project in terms of the technical support provided by the home party. According to this illustration, the support through an ITT project that is related to system-level design is designated as the most sophisticated international technology transfer model in terms of "Level of Product", hence requires further preparation efforts. Similarly, obtaining the design capability through an ITT project is a very sophisticated process mainly because of the tacit components of knowledge.

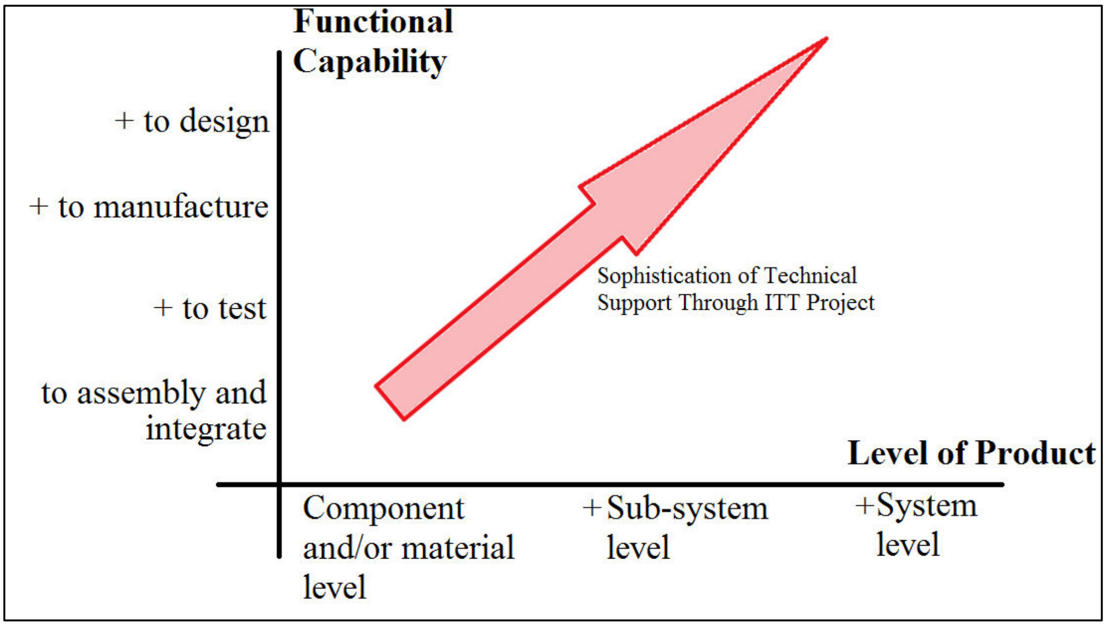


Figure 13 Sophistication level of an ITT project

In order to describe the introduced categorization method, three examples of ITT projects with varying scope of technical support provided by the source of technology are given in Table 9. According to this table, ITT Project-1 is the project with basic technical support and ITT Project-3 is the most sophisticated one.

Table 9 Example of ITT projects in terms of sophistication of technical support provided by the home party

		Level of Product		
		Component and/or material level	**Sub-system level**	**System-level**
Functional Capability	**To assembly and integrate**		ITT Project-1 ITT Project-2 ITT Project-3	ITT Project-2 ITT Project-3
	To test	ITT Project-1	ITT Project-2 ITT Project-3	ITT Project-3
	To manufacture	ITT Project-1	ITT Project-2 ITT Project-3	
	To design	ITT Project-2	ITT Project-3	ITT Project-3

In ITT Project-1, the host party is not involved in any design tasks but capability regarding component level manufacture and test, sub-system level assembly and integration are intended to be obtained. This scenario requires the minimum transfer of technology when compared to other scenarios.

On the other hand, in ITT Project-3, system and sub-system level design capability is supposed to be obtained in addition to newly established manufacturing, assembly and testing infrastructure. This model requires the transfer of know-how in forms of design and analysis tools, equipment, technology data package and preparation of manufacturing data package.

In this thesis, data regarding the sophistication level of ITT project is also collected for the evaluated ITT projects. The method for quantifying the "Sophistication Level of ITT Project" is introduced in Section 5.1.2 (Table 14) and the full set of proposed quantification is given in Appendix D.

4.2.2.1 Responsibilities and Place of Work

Within an ITT project, both home and host parties may have varying levels of responsibilities. Scope of responsibilities is briefly explained in terms of "functional capabilities" as follows;

- Responsibility "to design" is supposed to cover;
  - Preparation of Technical Specifications. (Technical Specifications are expected to include technical requirements, requirements for the development phases and requirements for the patent cleanliness and other articles in specified scope.)
  - Preliminary Design.
  - Detailed Design. (Design documentation are expected to include package of explanatory notes and design drawings.)
  - Preparation of Technical Data Package (TDP).
- Responsibility "to assembly and integrate" is supposed to cover;
  - TDP adaptation and preparation of Manufacturing Data Package (MDP) related to assembly and integration tasks.
  - Supply of the assembly and integration equipment.
  - Preparations for assembly and integration operations (including construction of buildings, equipment assembly/installation, pre-commissioning and commissioning).
  - Assembly and integration operations.
- Responsibility "to test" is supposed to cover;
  - Supply of the test equipment.
  - Preparation of the test facilities (including construction of buildings, equipment assembly/installation, pre-commissioning and commissioning).

    - Preparation of the test program and carrying out the tests.
    - Preparation of the reports with an analysis of the test results.
- Responsibility "to manufacture" is supposed to cover;
    - TDP adaptation and issuing of Manufacturing Data Package (MDP).
    - Supply of the processing equipment.
    - Preparation for manufacturing (including construction of buildings, equipment assembly/installation, pre-commissioning and commissioning).
    - Manufacturing.

In addition to abovementioned responsibilities, supply of the raw material and configuration items as commercial off-the-shelf (COTS) products are other areas for responsibility. However, even these categories are covered within the ITT project, the level of knowledge transfer is assumed to be negligible when compared to abovementioned forms of responsibilities.

For the design activities that are under the responsibility of the home party, involvement of the host party can be in varying forms. Design activities, which also include analysis sort of tasks, will probably be performed in the home (transferor) country in order to utilize background information efficiently. Involvement of host party's experts in such activities in the home country will face natural boundaries in physical participation, and access to background knowledge will not be granted easily by the home party. Consequently, real participation in design activities in home party's premises is not possible in practice.

"Direct Participation" form of models, which are based on participation of host company's experts to tasks carried out in the home country, will obviously not lead to fruitful and favorable results from the perspective of the host party. In practice, it is impossible to absorb the background information related to design capabilities through simple so-called "Direct Participation". For a host party who has a will to improve design capabilities through an ITT project, some other ways of collaboration models have to be generated. Such rewarding modes are introduced in Section 4.2.3.2.

Moreover, in order to participate in design activities that the home party utilizes her existing background information, it would be more efficient to pursue an ITT model in the following ways. The host party has to be involved in the process of design/development/verification and qualification by means of occasional participation in review meetings, held in the home country or host country in order to:

- Understand design requirements of the relevant element level.
- Understand design requirements of interfaces (mechanical, electrical, thermal, etc.) of the relevant element.
- Conduct reviews and give comments on output design documentation and TDP, elaborated by the home party for the relevant element of the product.

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.*

If the ITT project involves technology transfer related to assembly, integrate, testing and manufacturing, then most probably the related equipment for these tasks are also be provided by the home party. If this is the case, then the related documentation for procedures of operating and maintaining such equipment would be as important as equipment itself in terms of embedded knowledge.

The process related to equipment, which is going to be provided by the home party, has to be codified in order to be easily followed by the host party's experts. However, as it is not possible to codify related knowledge definitely, the presence of home party's experts during the installation and commissioning is crucial. Throughout the initial operation of the equipment, face-to-face interactions will help to decrease the time for process optimization and the time required for learning. The documentation provided by the home party has to be rephrased and retyped by the host party under the supervision of the home party in order to be well-suited to host company's culture.

Abovementioned tasks related to equipment might be directly related to establishment of related infrastructure (buildings, structures, etc.). Therefore, responsibilities of the home party within the installation and commissioning phase shall be extended to cover tasks related to the infrastructure (such as; defining the requirements of relevant infrastructure, preparation of the construction projects, construction, commissioning of the infrastructure, etc.).

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.*

Some ITT projects may involve more than one functional capability. Even in some cases all defined functional capabilities might be within the scope of the ITT project; to design, to manufacture, to test and to assembly & integrate. In such projects "ground development tests phase" has additional importance as activities within this phase lead to an indication of the initial performance results of both design and manufacturing. According to the results of ground tests, design and product might be validated or a change requirement for Manufacturing Data Package (MDP) may emerge. While supervision of the home party helps to comment on the results of ground tests, revision of MDP or even TDP can be considered after analyzing the results.

In this phase, the shortcomings of related codification would probably have a retarding effect as inconsistencies between the test results and acceptance criteria would constantly emerge to new questions by the host party. However, in most cases these inconsistencies can easily be interpreted and solved by the help of background information of the home party. Face-to-face discussions and collaboration during this phase will increase the level of knowledge transfer and decrease the Project duration.

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.*

The importance of supervision by the home party during "equipment installation and commissioning phase" was described above. Similarly, the presence of home party's experts in the host country is essential during the "manufacturing phase". In this phase, instead of trial production, final product is supposed to be produced according to issued MDP based on design documentation (TDP). While subscale production might be enough to accomplish the installation and commissioning of relevant equipment, real performance of production line is qualified during "manufacturing phase". Especially for ITT projects, within which equipment is provided by the home party, continuous and effective supervision of the home party is vital for the success of the ITT project. Correspondingly face-to-face interaction will certainly boost the performance of this phase and related process will be optimized according to the host party's conditions.

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.*

4.2.2.2 Deliverables; Effective Management and Monitoring of the Home Country through Accepting and Approving Deliverables

The importance of the contractual negotiations was explained previously. Normally the host party would try to organize and constitute the scope of ITT in a way that extends the boundaries of technology transfer as much as possible. Based on the level of technological readiness in terms of awareness, the expectations from the ITT project could be explicitly mentioned within the contractual documents and would be discussed with the home party prior to the implementation of the project.

Even the host party is well aware of their expectations and the contractual documents are prepared serving this goal, the possessed knowledge in the related technological area is limited and open to manipulations by the home party. In other words, contractual documents are important but the success of ITT is mainly based on how these documents are applied during the execution of the project.

Moreover, the host party would probably challenge organizational problems after the initiation of the ITT project, such as change management and growth management, and most organizational teams would be newly established. The monitoring of contractual goals and requirements would be given foremost importance, and organizational requirements have to be decided accordingly.

Management plans are major tools for the home party to establish and guarantee efficient ways of communication with the home party. Procedures and mechanisms of interactions have to be well-defined within these documentation. Although management plans are supposed to be issued after the effective date of the contract, parties have to be agreed on principals previously. Procedures of reviews, meetings, delivery and approval of outputs and other means of interactions, such as questions/answers and pop-up meetings, have to be formulated before the initiation of the ITT project and the host party has to efficiently utilize these mechanisms to obtain fruitful cooperation.

Additionally, Integrated Project Teams (IPT) can be established and utilized. IPTs, which are supposed to be formed by experts from both home and host parties, can act cooperatively to accomplish, monitor or approve defined tasks within the Project.

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.*

In Section 4.1.2, “systems engineering” approach was introduced as a part of the discussions related to absorptive capacity of the host company. This approach was referred to indicate types of documents that are generally expected to be generated within aerospace projects. Moreover, some international standards were introduced, which aerospace companies are supposed to comply with.

From the perspective of an ITT project, systems engineering approach is also evaluated as one of the determinants of success. In other words, the home party is also supposed to pursue similar approach like the host party in terms of systems engineering. However, because of background knowledge and path dependency, the home party might be accustomed to different standards other than globally accepted international standards. Even in some cases, international standards related to the scope of the ITT project may not exist. In such ambiguous cases, the initial agreements on the templates of outputs and on the scope of reviews are vital.

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.*

For the ITT projects that involve "design" tasks, considerations related to raw materials are as important as the performance of design itself. The best technical solution that can be obtained by using the most advanced materials might not be the best solution for the host party. Especially in aerospace industry, because of international regulations and restrictions, it may not be possible for the transferee (host) party to guarantee the continuity of obtaining advanced materials, even from the transferor (home) party. In order to avoid future dependencies, the design has to be configured accordingly.

However, as the host party is responsible to target globally competitive products, alternative paths have to be considered during the planning phase of the project. Even the scope of ITT project is designed with considerations to avoid such dependencies and as a result moderate results are targeted, the host party needs to continuously look for solutions to reach most advanced solutions independently. This can be possible through well-organized technology roadmaps and generally related coordination is beyond the capabilities of a company but it has to be considered at national level by state organizations.

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.*

The importance of supervision by the home party related to equipment was introduced in the previous paragraphs while discussing "equipment installation and commissioning phase". The equipment is supposed to be obtained from the home party with related documentation such as user guides and maintenance instructions. In addition to these concerns, another important determinant related to equipment, when considering the success of ITT project, is about the features of obtained equipment.

The technology embedded in the equipment might not be as advanced as the globally leading technologies or the user interfaces might not have up to date features. However, obtained equipment, together with the related tacit knowledge that can be transferred during practical on the job trainings, might be highly valuable even compared to other modern possible alternatives.

In any case, the host party has to make detailed evaluations during the preparation phase previous to contract signature with the home party for determining other possible alternatives of sources of equipment. These considerations have to be made in terms of scope, technical capacity, lead times and long-term maintenance and make & buy decisions have to be taken accordingly. Additionally, similar to concerns about raw materials, avoiding future dependencies is crucial from the perspective of the host party.

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.*

Some ITT projects may involve the transfer of in-house design and analysis tools developed by the home party. These can be in a form of independent structure or can be in a form of a batch file that can be used with a Commercial off the Shelf (COTS) software, but in both cases unique in terms of their area of application.

This type of deliveries contains valuable background information of the home party, and in most cases these tools are validated by past experiences or empirical results. Such tools are supposed to enable the host party to conduct design phase independently in future similar projects that will come after the ITT project.

As a result of high level of know-how embraced by such tools, negotiations on IP, approvals and cost would probably take longer time in comparison to other work tasks of ITT project. Besides, the level of readiness of the host party for negotiating on the technical scope of such tools will only be adequate only if the host party had previously studied on similar tools as introduced in Section 4.1.1, while discussing the factors affecting absorptive capacity.

Analogous to delivery of equipment, in-house softwares may require similar "installation and commissioning phase" under the supervision of the home party. Besides, the host party has to be sure about the suitability of the architecture of the software in terms of optimal performance. Delivered tools are supposed to contain no undefined equations or constants that cannot be proved by scientific justifications or empirical databases.

Because of high expectations from such tools, the validation, verification and approval procedures have to be clearly defined within the contract. Additionally, obtained tools must not be dedicated to a specific mission, but instead have to be flexible enough in order to be adapted to different missions and have to be accessible for future modifications and improvements.

Verification and validating of these software tools have to be conducted in three stages;

- Software documentation control
- Verification of the software
- Validating the software and methodology

Software documentation prepared by the home party has to be controlled and approved. For the transferred software; mathematical models of the software's algorithm, hardware requirements and specifications, input-output files and contents and acceptance scenarios have to be provided. Then, source code and auxiliary structures have to be examined in terms of the structural architecture of the software and source code has to be compiled in the environment specified in the relevant documentation. After completing the verification activities of the supplied software, validation activities have to be carried out in order to identify software's ability using different scenario sets in comparison with reference data such as empirical databases.

When we consider evaluating level of obtained design capability through the ITT project, one of the most important parts of the contractual documents are those that are related to verification and validation methodology of obtained design and analysis tools. Especially for the ITT projects that involve transfer of knowledge related to design capabilities, the contract has to clearly indicate the related acceptance processes. There are lots of traps, like complications related to IP rights, hiding knowledge, etc., and therefore it is very difficult to formulate and mutually agree on such a technology transfer contract. Optimally, contract has to be configured in a way that, host party's experts repeat design activities under the supervision of foreign experts and obtain the same results as found by the 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.*

4.2.2.3 Training and Consultancy

It was previously stated that, the host party would probably challenge organizational problems after the initiation of the project, such as change management and growth management, and most organizational teams would be newly established. Consequently, both internal and external trainings would have high importance for the host party (transferee), especially at the initial phases of the Project. In this context, the home party (transferor) would be the best alternative source for providing technical training. Additionally, other external sources have to be considered in order not to be stuck in one dimension provided by the home party. This will also serve to increase the benefits of the training provided by the home party.

Although, scope of technical training that is intended to be obtained from the source of technology may vary according to the type of the ITT project, it would be possible to categorize training in two main categories; "theoretical training" (or in-class training) and "practical training" (or on-the-job-training).

As explained before, in this thesis ITT projects are categorized in two dimensions in terms of "Level of Product" and "Functional Capability". Theoretical training would be appropriate and necessary for all levels of intended functional capabilities and both white & blue collar employees from the host party may attend such training programs. These theoretical trainings can be organized at the home party or the host party enterprises, but the place should be conveniently selected in a way that contributes to the achievements. The scope of the training may cover the principles and methods of designing and the merits of manufacturing/integration/test technologies.

For practical training related to equipment, different levels of training can be organized. At the initial phases of the ITT project, practical training can be provided to introduce the related process and capabilities of the equipment. Additionally, for the equipment, which are going to be provided by the home party, it would be beneficial for the host party to organize pre-commissioning and commissioning activities in a way that involves practical training.

Training related to design tasks has to be considered separately. If ITT project does not cover the transfer of design and analysis tools, then relevant training will be only limited to classroom type. Furthermore, if the transfer of in-house design and analysis tools is within the scope of the ITT project, then the training related to these capabilities has to involve both theoretical and practical trainings, and precautions related to such tools has to be considered as described in the previous section.

The instructors from the home party, despite their deep knowledge in the relevant subject, may not have experience on teaching. Therefore, the preparations for training (planning, preparations of training documentation and translation) and the effective implementation (selection of appropriate training tools, monitoring, etc.) have to be considered and evaluated by training experts (specially from the host party) in a way that would improve the performance of training process within the ITT project. Additionally, if the home party and the host party have the culture of providing internal training and have already developed related procedures, this would help to increase the performance of training process within the ITT project.

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.*

4.2.2.4 Language Constraints on Transfer of Technology across Nations

In today's world, in most international projects, English is used as the common language for communication between international counterparts. English, as a global language, has been spoken internationally, and is learned by many people as a second language all over the world. Consequently, in ITT projects English is generally used as the communication language.

If the native language of the home country is not English, knowledge that is going to be transferred through ITT project has to be translated to English first. As this process may result in loss of information, role of translators are very important and these translators are needed to be highly competent. In addition to their skills in language, they are supposed to be familiar with the technical terminology and international norms. In order to increase the efficiency of communication, a common technical terminology has to be mutually agreed between the home party and the host party. This would help preventing further complications. Besides, number of translators has to be sufficient to translate all exchanged documents, to attend all meetings and not to adversely affect the duration of the ITT project.

In Turkey, especially in aerospace industry, companies generally hire graduates of the top universities and such white-collar employees are equipped with good knowledge of English language and related technical terminology. Therefore, in most cases English-Turkish translation is not necessary and such translators are not needed to be hired. Additionally, at least during the initial phases of the project, as there is no need to translate the documentation obtained from the home party, additional loss of information is avoided. However, the host party may consider hiring translators having skills in the home country's native language to increase the efficiency of communication.

In most cases, the host party is supposed to provide the deliverable documents to funding organizations in Turkish. Moreover, in order to institutionalize the documents and make the knowledge understandable for all employees of the host party, including blue-collars, translation to Turkish is inevitable. The host party has to take precautions in order to shorten the required time for translation to native language.

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.*

4.2.3 Performance of the ITT Project

4.2.3.1 Has the Host Company Really Achieved the Intended Goal?

Previously, the importance of contractual negotiations in the preparation phase of the ITT project was introduced and ways to obtain a solid set of contractual documents were discussed from the perspective of the host party. Since the mutually agreed and signed contract designates the scope and boundaries of the technology transfer, the expectations of the host party for filling the technological gaps have to be clearly defined in the contract in a way that leaves no disputable and subjective issues. Even the maturity level of contractual documents is high, as a result of expectations of the host party and possible discreetness of the home party, different interpretations of the contractual requirements may lead to disputes. In order to denote the ITT project as successful, these disputes have to be resolved in favor of the host party.

Achieving the goals that were set as contractual requirements (in terms of scope, time and budget) is one of the main indicators of success of the outputs of the ITT project. For this purpose, the management plans are important tools, which were introduced before and they have to be implemented throughout the project life cycle and satisfaction of all levels of requirements has to be monitored from the beginning of the project.

In addition to successfully satisfied contractual requirements, another concern that has to be proven is the success of ITT project in bridging preliminary defined technological gaps, which was the main reason of the existence of such an ITT project. This has to be considered from the perspective of both company and national level.

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.*

It was previously stated that the technical support intended to be obtained from the source of technology may vary according to the type of the ITT project. Accordingly, two dimensions in terms of "Level of Product" and "Functional Capability" were introduced. Additionally, it was stated that the home party and the host party might have varying levels of responsibilities and scope of responsibilities were also explained in terms of "functional capabilities". According to the scope of the ITT project, the level of technology that is intended to be transferred from the home party will indicate different sophistication levels of the ITT project. As a result of successfully satisfied contractual requirements and institutionalization of the external knowledge through indigenous procedures, it would be possible for the host party to adopt externally originated technology.

In addition to successful completion of the Project and the success of ITT project in bridging preliminary defined technological gaps, another important indicator to denote ITT as successful is the achieved technical independency of the host party in the relevant field.

This mentioned independency can be in terms of the items in the product breakdown structure, raw material and equipment as well as the logistic support. A successfully completed ITT project is supposed to provide the host party the capability to develop similar projects by its own in the future without the support of the home party. In addition to technical maturity achieved, model on the IP rights has to facilitate this. Through the instrumentality of obtained capabilities after the completion of ITT project, the host party is supposed to be capable of exploring and exploiting new technological areas, new products, new markets and new cooperation alternatives.

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.*

4.2.3.2 Harmonizing the Indigenous Efforts with an aim to Obtain Same Results with the Home Country

For the ITT projects involving design support, the design activities that are under the responsibility of the home party (transferor), will probably be performed in the home country in order to utilize background information efficiently. Previously, it was stated that, involvement of host party's experts in such activities in the home country will face natural boundaries in physical participating, and access to background knowledge will not be granted easily by the home party. Consequently, real participation to design activities in home party's premises is not possible in practice. For a host party who has a will to improve design capabilities through ITT project, instead of "Direct Participating" type of involvement models, some other ways of collaboration models have to be generated. Keeping in mind that, absorbing "to design" capabilities through ITT project is much more sophisticated and difficult when compared with "to manufacture", "to test" and "to assembly and integrate" type functional capabilities, therefore, it has to be considered with special attention. Additionally, the home party naturally and intensely uses background information during performing design tasks, and sometimes may utilize existing results from past projects without repeating the relevant process during the ITT project. This would probably not lead to a technical problem but may lead to a shortcoming in the transferred knowledge.

It is almost impossible for the host party to utilize acquired knowledge with delivered design documentation in further projects, without developing relevant capabilities completely. In order to absorb the design capabilities, in addition to strict monitoring of activities conducted by the transferor party, additional engineering efforts are needed. For this purpose, a special engineering team has to be established and assigned by the host country and the design activities that have been accomplished by the home party have to be repeated using indigenous or transferred design, analysis, modelling and simulation tools in the host party enterprises. For the tools that were transferred from the home party, the acceptance (including verification and validation) procedures have to be conducted as discussed in Section 4.2.2.

These tasks have to be conducted under the supervision of the home party so as to gain complete competence on related tools. Obtained results have to be evaluated and compared with the home party's results. However, these activities have to be planned in a way that would not affect the ITT project's schedule and performance, thus possibly with a delta phase to actual design tasks.

In order to denote ITT project as successful in terms of absorbed design capabilities, abovementioned efforts, which involve the contribution and supervision of the home party, have to be covered in the ITT project. Consequently, the host party would be capable of utilizing obtained design capabilities in similar future projects without the need of further supervision, which is a very difficult but valuable goal to achieve.

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.*

4.2.3.3 Keeping the Team; Preventing "Brain Drain"

A firm's innovative ability depends largely upon its human intellectual capital. As it was previously explained, learning is an investment on human capital, therefore employees are very valuable assets of the firms (Dolfsma, 2008; Ancori et al., 2000; Carlsson, 2006).

Depending upon the duration and scope of an ITT project, it might be necessary to establish big teams with dedicated organizational tasks and responsibilities within the host company. These teams will gain experience during the ITT project and especially employees who had the opportunity to directly work with home party's experts would benefit from the tacit type of knowledge, which is very difficult to codify and institutionalize. At the end of a successfully accomplished ITT project, the home party would have constituted teams equipped with valuable knowledge in varying fields (design, manufacture, test, etc.) according to the type of the project.

At this point, in order to denote the ITT project as a successful one, sustainability of utilizing newly obtained human capital emerges as an important indicator of success for the ITT project. However, unlike other defined success indicators, this indicator mainly depends on the organizational, planning and forecasting capabilities of the host company and the national authorities of the host country.

The technological roadmap, which is supposed to be the initiator of the ITT project, has to target the next directions for incremental improvement in the area of research. Company or state level strong will and strategies, refined marketing and business plans, and continuous funding mechanisms that operate precisely may prevent the brain drain. Moreover, this would help employees to have a trustworthy foresight of near and middle future career planning and to develop loyalty. Else, obtained delicate assets with embraced knowledge may melt away and disappear.

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.*

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 as given in previous sections just after the explanations regarding the associated variables. Afterwards, these questions are gathered in a form of questionnaire given in Appendix B.

CHAPTER 5

QUANTITATIVE ANALYSIS

5.1 CONSTRUCTION OF DATA

5.1.1 Quantitative Data Collection

After the completion of Step-3 through Semi-Structured Interview Questions (Appendix A), 47 variables were determined, elaborated and categorized under the conceptualized framework. Detailed discussions on these variables are given in Chapter 4.

The elaborated variables are intended to be utilized to understand the relations between firm level absorptive capacity and determinants/success indicators of ITT projects. For this purpose it was required to quantify these variables for specific conditions; firm level specific environment and evaluation of completed ITT projects within this environment. Therefore, in order to identify and measure relevant variables, questions are generated as given in Chapter 4 just after the explanations regarding the associated variables. Afterwards, these questions are gathered in a form of questionnaire given in Appendix B, in order to be used in Step-4 of this research as introduced in Section 1.2.

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, knowledge flow within the company and the sectoral innovation system, 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 the ITT project and the evaluation about 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 home party. For this purpose, a method for quantifying "Sophistication Level of ITT Project" is developed as introduced in Section 4.2.2 and Section 5.1.2. In order to quantify this variable, "Functional Capability" and "Level of Product" are questioned within the questionnaire.

The questionnaire is optimized and evolved through initial trials with several experts in order to be sure that questions and way of surveying is clear and explicit in terms of used terminology and examined scope. Afterwards, 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 have evaluated ITT projects that they had previously participated. Information about the profile of experts who had contributed to research by filling in the questionnaire is provided in Table 10.

Table 10 Profile of experts who had contributed to research (Step-4)

Number of experts	Position in the firm	Experience in the firm (years)	Number of ITT Projects Evaluated
3	Upper manager	>20 years	12
17	Mid-level manager (Design / Development / Production Departments)	>10 years	62

All experts were contacted directly and support was provided for further explanation on expectations of the research. At the end of Step-4, 74 evaluations regarding ITT projects were obtained. Note that it is not the number of different projects for the reason that an ITT project might be evaluated by more than one expert.

Detailed information about the variables that were evaluated through the questionnaire is provided in Section 5.1.2. Variety of ITT projects within the sample according to the level of sophistication is calculated with the method introduced in Section 5.1.2 and the results are provided in Section 6.1 (Figure 16).

5.1.2 Definition of Variables for Quantitative Analysis

STATA®, which is a general-purpose statistical software package, has been used for quantitative analysis in this thesis. Therefore, in order to be utilized in STATA®, "variables for quantitative analysis" are created.

Variables are generated in such a way that the notation shows which variable group it belongs to. For example, ABS and ITT denote absorptive capacity and international technology transfer respectively, or KP and KF denote knowledge production and knowledge flow.

The relations between generated variables, variable groups (that was conceptualized in Section 3.3) and questions to discover the variable (as introduced in Section 4.1, Section 4.2 and Appendix B) are provided in a table form. "Definitions of the Factors Affecting Absorptive Capacity in Aerospace Industry" and "Definitions of the Determinants and Success Indicators of ITT Projects in Aerospace Industry" are given in Table 11 and Table 12 respectively. A brief definition for each variable is also given in these tables to maintain easier evaluation during utilization of STATA®.

Table 11 Definitions of the Factors Affecting Absorptive Capacity in Aerospace Industry

Variable Group	Variable	Definition	Question
Knowledge Production	ABS-KP-1	Setting academic goals for universities	1 My company sets academic goals for graduate programs and supports the students enrolled in these programs.
	ABS-KP-2	Hiring graduates of the top universities	2 My company commonly hires graduates of the top universities.
	ABS-KP-3	Access to world literature	3 My company provides facility of access to world literature via highly equipped library or membership to digital libraries.
	ABS-KP-4	Culture of utilizing patent databases	4 My company provides facility of access to patent databases and it is common to use this occasion while making literature survey.
	ABS-KP-5	Firm level strategic plan and technology roadmap	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.
	ABS-KP-6	Intra-firm technology development projects	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.
	ABS-KP-7	Development of indigenous design and analysis tools	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.
	ABS-KP-8	Fringe benefits	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.
	ABS-KP-9	Emotional capability	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.

Table 11 Definitions of the Factors Affecting Absorptive Capacity in Aerospace Industry (Cont'd)

Variable Group	Variable	Definition	Question
Knowledge Flow within the Company	ABS-KF-1	Coordinating intra-firm knowledge creation activities	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.
	ABS-KF-2	Culture of codification within the company	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.
	ABS-KF-3	Culture of implementing systems engineering approach within the company	12 My company implements systems engineering approach in compliance with international standards and generated project documents are easily accessible by project personnel.
	ABS-KF-4	Utilizing codified procedures and processes within the company	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.
	ABS-KF-5	Face-to-face intra-firm communication	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.

Table 11 Definitions of the Factors Affecting Absorptive Capacity in Aerospace Industry (Cont'd)

Variable Group	Variable	Definition	Question
Knowledge Flow within the Sectoral Innovation System	ABS-SIS-1	Interactions with national players	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.
	ABS-SIS-2	Solid interactions with universities	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.
	ABS-SIS-3	Well-organized training to reach external knowledge	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.
	ABS-SIS-4	Improving capabilities of sub-contractors	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.
	ABS-SIS-5	Interactions with players outside national borders	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.

Table 12 Definitions of the Determinants and Success Indicators of ITT Projects in Aerospace Industry

Variable Group	Variable	Definition	Question
Preparations for the ITT Project	ITT-PREP-1	Strong political will	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.
	ITT-PREP-2	ITT fills a gap in the technology roadmap	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.
	ITT-PREP-3	Significant strategic benefits of the ITT	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)
	ITT-PREP-4	Selection Process of Home Company	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.
	ITT-PREP-5	Transferred technology is not practically obsolete	5 Selected Home Company is still actively performing similar tasks defined in the Technology Transfer Project and the technology is not practically obsolete.
	ITT-PREP-6	Motivation of the Home Party	6 International Technology Transfer Project provided valuable benefits to Home Party therefore Home Party set a high value on the realization of the project.
	ITT-PREP-7	Response of developed countries and big companies	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.

Table 12 Definitions of the Determinants and Success Indicators of ITT Projects in Aerospace Industry (Cont'd)

Variable Group	Variable	Definition	Question
Preparations for the ITT Project (Cont'd)	ITT-PREP-8	Well-prepared contractual documents	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.
Conducting the ITT Project	ITT-CON-1	Benefits of "design phase"	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.
	ITT-CON-2	Benefits of "equipment installation and commissioning phase"	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.
	ITT-CON-3	Benefits of "ground development tests phase"	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.
	ITT-CON-4	Benefits of "manufacturing phase"	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.
	ITT-CON-5	Mechanisms for effective absorption	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.
	ITT-CON-6	Implementing systems engineering approach by Home Company	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.

Table 12 Definitions of the Determinants and Success Indicators of ITT Projects in Aerospace Industry (Cont'd)

Variable Group	Variable	Definition	Question
Conducting the ITT Project (Cont'd)	ITT-CON-7	Various sources for raw materials	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.
	ITT-CON-8	Benefits of the "equipments" provided	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.
	ITT-CON-9	Benefits of the "in-house softwares" provided	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.
	ITT-CON-10	Benefits of the "training" provided	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.
	ITT-CON-11	Managing the language constraints	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.

Table 12 Definitions of the Determinants and Success Indicators of ITT Projects in Aerospace Industry (Cont'd)

Variable Group	Variable	Definition	Question
Performance of the ITT Project	ITT-PER-1	Fulfilling contractual requirements	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.
	ITT-PER-2	Reduced external dependency	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.
	ITT- PER-3	Obtained design capability is verified and validated	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.
	ITT-PER-4	Preventing "brain drain"	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.

In Section 3.3 a preliminary schematization of the introduced concept was given in Figure 11. After completing Step-3 through "Semi-Structured Interview Questions", the variables are elaborated within these groups and as a result, the schematization has been improved as indicated in Figure 14.

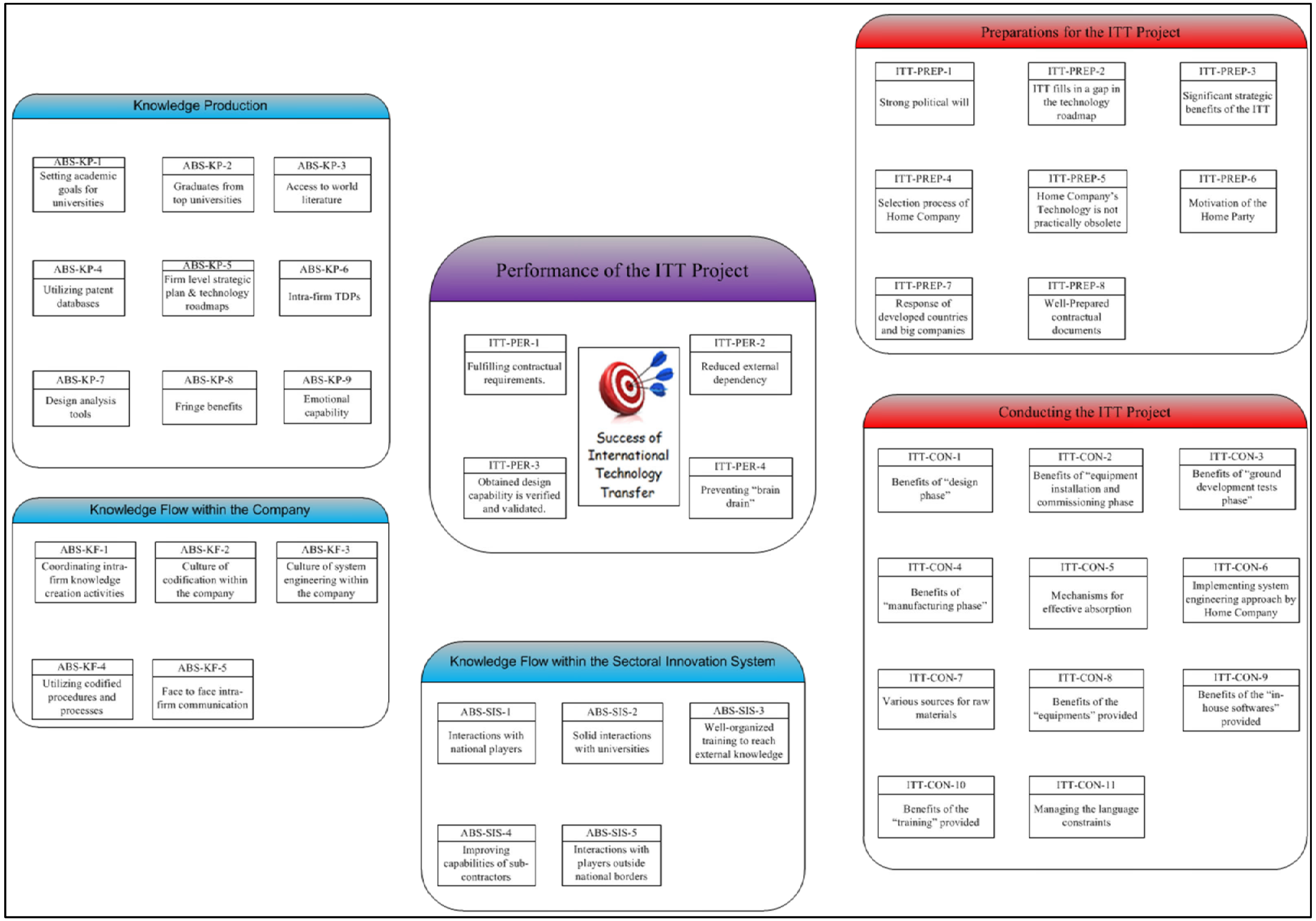


Figure 14 Determinants for the Success of ITT Projects (improved version)

In the questionnaire given in Appendix B, the total number of questions related to firm level absorptive capacity is 22 and the number of the ones related to the evaluation of ITT projects is 25. However, the total number of related variables are 19 and 23 respectively, as given in Table 11 and Table 12.

The reason for this difference is that, for each variable group an additional question is embedded into the questionnaire (Appendix B), such as "In general, my company is successful in knowledge production". "General evaluation" questions are indicated with bold and underlined fonts within the questionnaire. The answers to these additional questions are intended to be used in an alternative quantitative analysis for verification purpose as described in Section 5.2.

The number of variables within the variable groups can be summarized as given in Table 13.

Table 13 Summary of number of variables within the variable groups

Explanatory Variables		**Number of Variables**
Factors affecting absorptive capacity	1) Knowledge Production	9 + 1*
	2) Knowledge Flow within the Company	5 + 1
	3) Knowledge Flow within the Sectoral Innovation System	5 + 1
Determinants of success for ITT Project	4) Preparations for the ITT Project	8 + 1
	5) Conducting the ITT Project	11 + 1
Dependent Variable		
Success Indicators of ITT Projects	6) Performance of the ITT Project	4

(*) Note: "+ 1" denotes that there is an additional variable obtained from "general evaluation" questions (indicated with bold and underlined fonts within the questionnaire, Appendix B).

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. In Section 4.2.2, it was introduced that 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 14.

Table 14 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 15. 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. Moreover, in Section 4.2.3.2, the difficulties in transferring knowledge related to design capability were introduced. The complexity of capability related to design increases with the increasing level of product, due to the tacit component of knowledge.

The full set of proposed quantification is given in Appendix D.

Table 15 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 15. In the following section, the quantitative data analysis which utilizes the dataset is given.

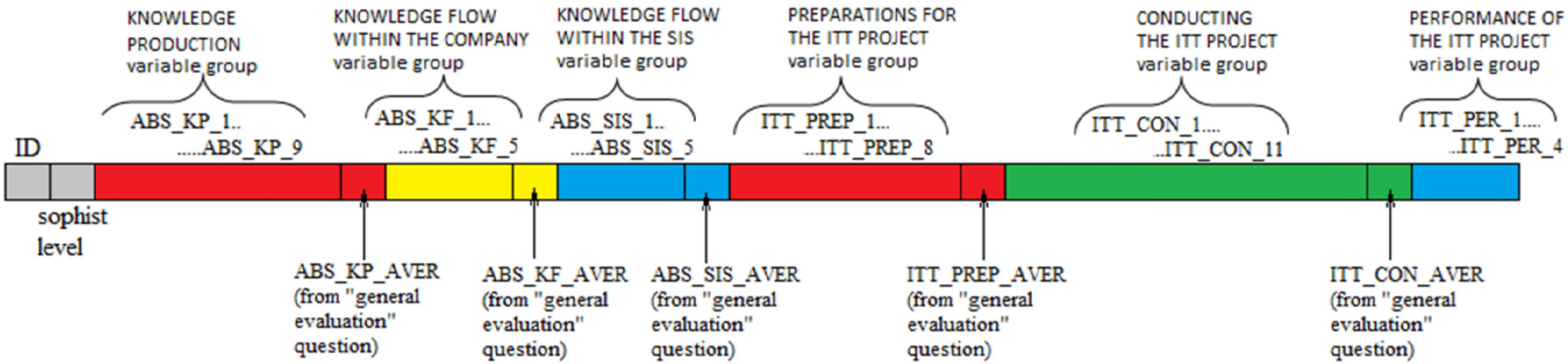


Figure 15 Schematization of the structure of a row in the dataset

5.2 QUANTITATIVE DATA ANALYSIS

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 introduced in Section 3.3, 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.

Both models are described in details in the following sections.

5.2.1 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 introduced in Section 3.3, with an aim of achieving higher degrees of freedom. In order to gather variables in groups numerically, representing variables are generated to be used in regression as follows;

- MEAN_ABS_KP (representing variable for "Knowledge Production" variable group)

- MEAN_ABS_KF (representing variable for "Knowledge Flow within the Company" variable group)
- MEAN_ABS_SIS (representing variable for "Knowledge Flow within the Sectoral Innovation System" variable group)
- MEAN_ITT_PREP (representing variable for "Preparations for the ITT Project" variable group)
- MEAN_ITT_CON (representing variable for "Conducting the ITT Project" variable group)
- MEAN_ITT_PER (representing variable for "Performance of the ITT Project" variable group)

However, as there are missing observations for some variables in the variable group, "egen rmean" command of STATA® is used.

> egen rmean command: It creates the (row) means of the variables in varlist, ignoring missing values; for example, if three variables are specified and, in some observations, one of the variables is missing, in those observations newvar will contain the mean of the two variables that do exist. Other observations will contain the mean of all three variables. Where none of the variables exist, newvar is set to missing.[24]

Accordingly, new variables are generated by using a STATA® command like the example given below;

```
egen MEAN_ABS_KP = rmean(ABS_KP_1 ABS_KP_2 ABS_KP_3 ABS_KP_4
ABS_KP_5 ABS_KP_6 ABS_KP_7 ABS_KP_8 ABS_KP_9)
```

As a result new variables (representing variables), which are going to be used in regression analysis, are generated as shown in Table 16. Note that variables with observations less than %70 of total observations are not included in these calculations and indicated with a star (*) sign.

---

[24] http://www.stata.com/manuals13/degen.pdf accessed on January 30, 2015

Table 16 New variables generated to be used in Regression Analysis-1

Variable Group	Variable	Obs.	Definition	New Variable Generated
Knowledge Production	ABS-KP-1	74	Setting academic goals for universities	MEAN_ABS_KP
	ABS-KP-2	74	Hiring graduates of the top universities	
	ABS-KP-3	74	Access to world literature	
	ABS-KP-4	74	Culture of utilizing patent databases	
	ABS-KP-5	74	Firm level strategic plan and technology roadmap	
	ABS-KP-6	74	Intra-firm technology development projects	
	ABS-KP-7	74	Development of indigenous design and analysis tools	
	ABS-KP-8	74	Fringe benefits	
	ABS-KP-9	74	Emotional capability	
Knowledge Flow within the Company	ABS-KF-1	74	Coordinating intra-firm knowledge creation activities	MEAN_ABS_KF
	ABS-KF-2	74	Culture of codification within the company	
	ABS-KF-3	74	Culture of implementing systems engineering approach within the company	
	ABS-KF-4	74	Utilizing codified procedures and processes within the company	
	ABS-KF-5	74	Face to face intra-firm communication	
Knowledge Flow within the Sectoral Innovation System	ABS-SIS-1	74	Interactions with national players	MEAN_ABS_SIS
	ABS-SIS-2	66	Solid interactions with universities	
	ABS-SIS-3	74	Well-organized training to reach external knowledge	
	ABS-SIS-4	74	Improving capabilities of sub-contractors	
	ABS-SIS-5	65	Interactions with players outside national borders	

Table 16 New variables generated to be used in regression (Cont'd)

Variable Group	Variable	Obs.	Definition	New Variable Generated
Preparations for the ITT Project	ITT-PREP-1	74	Strong political will	MEAN_ITT_PREP
	ITT-PREP-2	72	ITT fills in a gap in the technology roadmap	
	ITT-PREP-3	74	Significant strategic benefits of the ITT	
	ITT-PREP-4	74	Selection Process of Home Company	
	ITT-PREP-5	74	Transferred technology is not practically obsolete	
	ITT-PREP-6	74	Motivation of the Home Party	
	ITT-PREP-7	74	Response of developed countries and big companies	
	ITT-PREP-8	74	Well-prepared contractual documents	
Conducting the ITT Project	ITT-CON-1	43*	Benefits of "design phase"	MEAN_ITT_CON
	ITT-CON-2	57	Benefits of "equipment installation and commissioning phase"	
	ITT-CON-3	37*	Benefits of "ground development tests phase"	
	ITT-CON-4	59	Benefits of "manufacturing phase"	
	ITT-CON-5	74	Mechanisms for effective absorption	
	ITT-CON-6	74	Implementing systems engineering approach by Home Company	
	ITT-CON-7	50	Various sources for raw materials	
	ITT-CON-8	57	Benefits of the "equipments" provided	
	ITT-CON-9	47*	Benefits of the "in-house softwares" provided	
	ITT-CON-10	70	Benefits of the "training" provided	
	ITT-CON-11	57	Managing the language constraints	
Performance of the ITT Project	ITT-PER-1	74	Fulfilling contractual requirements	MEAN_ITT_PER
	ITT-PER-2	70	Reduced external dependency	
	ITT-PER-3	35*	Obtained design capability is verified and validated	
	ITT-PER-4	74	Preventing "brain drain"	

(*) Note: Variables with few observations are not included in the calculation of the "new variable generated". (ITT-CON-1, ITT-CON-3, ITT-CON-9 and ITT-PER-3)

The summary of the dataset for generated variables are given in Table 17. Among these variables, MEAN_ITT_PER is considered as the dependent variable.

Table 17 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 regression results are given in Table 18.

Table 18 Regression results (Regression Analysis-1)

	MEAN_ITT_PER
MEAN_ABS_KP	0.284 (2.32)**
MEAN_ABS_KF	0.010 (0.10)
MEAN_ABS_SIS	-0.027 (0.43)
MEAN_ITT_PREP	0.850 (5.99)***
MEAN_ITT_CON	0.221 (1.97)*
_cons	-1.239 (2.15)**
R^2	0.71
N	74

* p<0.1; ** p<0.05; *** p<0.01

The R-squared indicates that 71% of the variance of MEAN_ITT_PER is explained by the regression model. As we check for the hypothesis “there is no relationship between explanatory variable and dependent variable controlling for the rest of the explanatory variables”; it is found out that the hypothesis can be rejected for some variables (MEAN_ABS_KP, MEAN_ITT_PREP) which have significant P values.

The severity of multicollinearity between the variables is examined through Pearson's correlation and the results are given in Table 19.

Table 19 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 as shown in Table 20. The regression results for these models are given in Table 21.

Table 20 Explanations for the regression models (Regression Analysis-1)

MODEL	**EXPLANATION**
Regression Model-1 :	All variables are included in the regression model.
Regression Model-2 :	MEAN_ABS_KP is included in the model. *But correlated variables; MEAN_ABS_KF and MEAN_ABS_SIS are excluded.* MEAN_ITT_PREP is included in the model. *But correlated variable; MEAN_ITT_CON is excluded.*
Regression Model-3 :	MEAN_ABS_KP is included in the model. *But correlated variables; MEAN_ABS_KF and MEAN_ABS_SIS are excluded.* MEAN_ITT_CON is included in the model. *But correlated variable; MEAN_ITT_PREP is excluded.*
Regression Model-4 :	MEAN_ABS_KF is included in the model. *But correlated variables; MEAN_ABS_KP and MEAN_ABS_SIS are excluded.* MEAN_ITT_PREP is included in the model. *But correlated variable; MEAN_ITT_CON is excluded.*
Regression Model-5 :	MEAN_ABS_KF is included in the model. *But correlated variables; MEAN_ABS_KP and MEAN_ABS_SIS are excluded.* MEAN_ITT_CON is included in the model. *But correlated variable; MEAN_ITT_PREP is excluded.*
Regression Model-6 :	MEAN_ABS_SIS is included in the model. *But correlated variables; MEAN_ABS_KP and MEAN_ABS_KF are excluded.* MEAN_ITT_PREP is included in the model. *But correlated variable; MEAN_ITT_CON is excluded.*
Regression Model-7 :	MEAN_ABS_SIS is included in the model. *But correlated variables; MEAN_ABS_KP and MEAN_ABS_KF are excluded.* MEAN_ITT_CON is included in the model. *But correlated variable; MEAN_ITT_PREP is excluded.*

Table 21 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 19.

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. The results are discussed in Chapter 6 in details.

5.2.2 Regression Analysis-2

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 15). 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 22. Among these variables, MEAN_ITT_PER is considered as the dependent variable.

Table 22 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 23.

Table 23 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 19) 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 as shown in

Table 24. The regression results for these models are given in Table 25.

Table 24 Explanations for the regression models (Regression Analysis-2)

MODEL	EXPLANATION
Regression Model-1 :	All variables are included in the regression model.
Regression Model-2 :	ABS_KP_AVER and ABS_KF_AVER are included in the model. *But correlated variable; ABS_SIS_AVER is excluded.* ITT_PREP_AVER is included in the model. *But correlated variable; ITT_CON_AVER is excluded.*
Regression Model-3 :	ABS_KP_AVER and ABS_KF_AVER are included in the model. *But correlated variable; ABS_SIS_AVER is excluded.* ITT_CON_AVER is included in the model. *But correlated variable; ITT_PREP_AVER is excluded.*
Regression Model-4 :	ABS_KP_AVER and ABS_SIS_AVER are included in the model. *But correlated variable; ABS_KF_AVER is excluded.* ITT_PREP_AVER is included in the model. *But correlated variable; ITT_CON_AVER is excluded.*
Regression Model-5 :	ABS_KP_AVER and ABS_SIS_AVER are included in the model. *But correlated variable; ABS_KF_AVER is excluded.* ITT_CON_AVER is included in the model. *But correlated variable; ITT_PREP_AVER is excluded.*

Table 25 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. The results are discussed in Chapter 6 in details.

CHAPTER 6

CONCLUSION

6.1 RESEARCH FINDINGS AND RECOMMENDATIONS FOR FIRM LEVEL STRATEGIES

The main goal of this thesis, 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 as given in Section 3.3, 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 given in Chapter 5 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.

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

Knowledge Production (KP):
According to the results of quantitative analysis provided in Section 5.2, 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. These variables were explained in Chapter 4.

- 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 as described in Section 4.1. 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" that was introduced in Part 3.1 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. These variables were explained in Chapter 4.

- 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 in Section 6.2.

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) that was introduced in Section 2.2 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 analysis provided in Section 5.2, 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 Section 6.2.

Conducting the ITT Project:

In this research a new metric to quantify the "Sophistication Level of ITT Project" is introduced as described in Section 4.2.2 and Section 5.1.2. 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 thesis 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, as defined in Section 3.2.4, 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 16. 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.

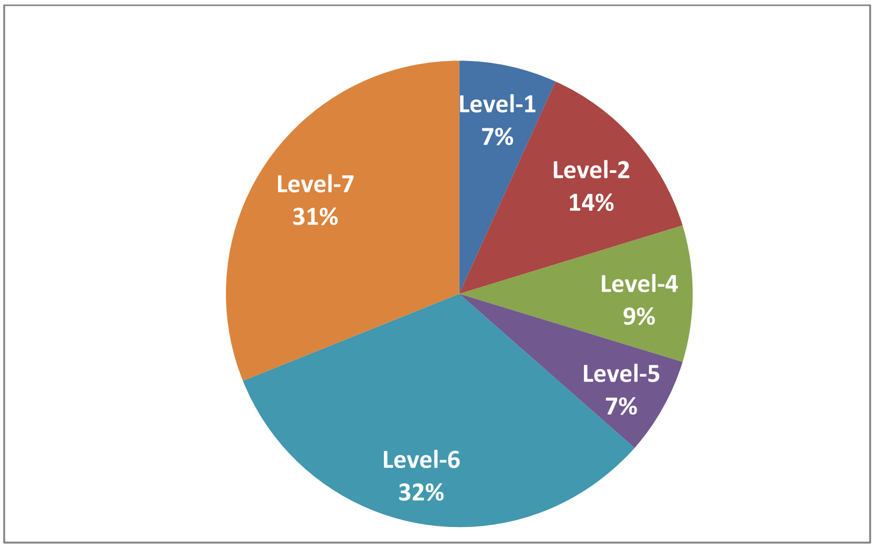


Figure 16 Proportion of ITT projects within the sample according to the Level of Sophistication

According to the results of the quantitative analysis provided in Section 5.2, 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 in Section 3.3, 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 Section 6.2.

Recommendations for firm level strategies to improve the identified weaknesses within the explanatory variable groups are summarized in Table 26.

Table 26 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 26 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.

6.2 CONCLUDING REMARKS AND POLICY IMPLICATIONS

In the previous section, 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?

In this section, 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.

6.2.1 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.

In Section 3.2, it was 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.

6.2.2 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 in Section 4.1, 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 thesis 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 in Section 6.1. 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).

As discussed in Section 3.1, 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.

6.2.3 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 in Section 6.1. 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 27.

Table 27 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 26 and Table 27 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.

6.3 DIRECTIONS FOR FURTHER RESEARCH

This thesis generates some significant contributions to the existing literature on firm level absorptive capacity and ITT performance. One of the major contributions of the thesis 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 thesis 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 thesis may be utilized in different application areas. First of all, the thesis 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 thesis can be utilized in a repeatable manner. The questionnaire that was used in the thesis 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?

Note: Information about the profile of experts who had contributed to research through semi-structured interviews is provided in Section 3.3 (Table 7).

APPENDIX B
QUESTIONNAIRE

Note: Information about the profile of experts who had contributed to research by filling in the questionnaire is provided in Section 5.1 (Table 10).

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.	☐	☐	☐	☐	☐	☐
<u>**In general, there is an efficient and fruitful knowledge flow within my company.**</u>	☐	☐	☐	☐	☐	☐
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.	☐	☐	☐	☐	☐	☐
In general, evaluated ITT was successfully conducted.	☐	☐	☐	☐	☐	☐
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;

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

Example-1;
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

APPENDIX E
TURKISH SUMMARY

FİRMA SEVİYESİ ÖZÜMSEME KAPASİTESİ VE ULUSLARARASI TEKNOLOJİ TRANSFERİNİN BAŞARISI; TÜRKİYE HAVACILIK VE UZAY SANAYİ ÖRNEĞİ

Bu tez çalışmasında firma seviyesi özümseme kapasitesi (ÖK) ve uluslararası teknoloji transferinin (UTT) başarısı arasındaki ilişkinin incelenmesi amaçlanmıştır. Ayrıca UTT'nin başarısını etkileyen diğer etkenler de belirlenmiştir. Araştırmada teknolojiyi alan ülke açısından ve gelişmekte olan ülke perspektifinden değerlendirme yapılmış ve Türkiye'deki havacılık ve uzay sanayisine odaklanılmıştır.

Öncelikle havacılık ve uzay sanayisinde ÖK'yı belirleyen etkenler belirlenmiştir. Bu amaçla özgün teknoloji geliştirme yöntemleri, bilgiye ulaşma kanalları ve sektörel inovasyon sisteminin (SİS) yapısı incelenmiştir. İlave olarak havacılık ve uzay sanayisinde UTT'nin başarısını belirleyen etkenler ve ilgili göstergeler belirlenmiştir. Tezin literatüre önemli katkılarından biri, çeşitli UTT projelerinde görev almış sanayiden uzmanlar ile yapılan görüşmeler sonrasında tespit edilmiş olan etkenler ve göstergelerdir. Tespit edilen bu etkenlerden bir kısmı havacılık ve uzay sanayisine özel nitelikler içermektedir.

Bu tez "firma seviyesi ÖK'yı neler oluşturur" sorusuna bütünsel bir yaklaşım ile cevap aramaktadır. Bu kapsamda ÖK oluşumunu etkileyen değişkenler 3 grupta toplanmıştır; "Bilgi Üretimi", "Firma İçi Bilgi Akışı", "SİS içi Bilgi Akışı". Çalışma, firma seviyesi yeteneklere odaklansa da değişkenler SİS perspektifinden belirlenmiştir.

Etkenleri tespit edebilmek ve ölçebilmek amacıyla bir soru seti oluşturulmuş, bu soru seti kullanılarak sanayiden uzmanların daha önce görev aldıkları UTT projelerini ve ilaveten firmalarının ÖK'sını değerlendirmeleri sağlanmıştır. Çalışmada, literatüre katkı sağlayacak şekilde, teknolojiyi veren tarafın katkısı temelinde UTT projesinin karmaşıklık seviyesini ölçmeyi sağlayacak bir metrik oluşturulmuş, bunun için "Fonksiyonel Yetenek" ve "Ürün Seviyesi" tanımlanmıştır.

Ekonometrik analizler ile elde edilen sonuçlar, açıklayıcı değişkenler ve UTT'nin başarısı arasında doğrudan bir ilişki göstermektedir. Buna göre, gelecekte gerçekleştirilecek UTT projelerinin başarısının öngörülmesinin, firma seviyesi ÖK'nın belirlenmesi ile mümkün olabileceği değerlendirilmektedir.

Teknolojiyi kazanan ülke perspektifinden kurgulanan bu tez çalışması, kapsamı itibariyle özgün bir çalışma niteliği taşımaktadır. Ayrıca, bu araştırma havacılık ve uzay sanayisini gelişmekte olan ülke perspektifinden değerlendiren ilk çalışmalardandır. Çalışma, ilgili alanda UTT projelerinin performansını etkileyen firma düzeyinde dinamikler ve SİS arasındaki ilişkileri araştırmak üzere bu kapsamda yürütülmüş Türkiye'deki muhtemelen ilk uygulamadır.

Tanımlanan değişkenler ve soru seti UTT projelerinin planlanması aşamasında faydalı bir araç olarak kullanılabilir. Gelişmekte olan ülkelerde çeşitli yüksek teknoloji alanlarına uygulanabilir ve UTT projeleri öncesinde politika yapıcılara değerli bilgiler sağlayabilir.

GİRİŞ

Modern ekonomilerde bilgiye dayalı değerlerin önemi gün geçtikçe artmakta ve bu tip ekonomiler "bilgi ekonomisi" olarak adlandırılmaktadır. Bilgi ekonomisine yönelik çalışmalar içerisinde ele alınan "özümseme kapasitesi" (ÖK) kavramı yeni bir bilgiyi anlama, içselleştirme ve uygulama kabiliyeti olarak tarif edilebilir.

Bu tezin başlıca amaçlarından birisi firma seviyesi bilgi üretim mekanizmalarını anlamak ve firma içi/dışı bilgi kanallarını tespit etmektir. Firma seviyesinde yürütülen bu çalışmada uygulama alanı olarak havacılık ve uzay sanayisi seçilmiş, sektörel inovasyon sisteminin etkileri de incelenmiştir. Tezin odaklandığı bir diğer konu ise uluslararası teknoloji transferinin (UTT) başarısıdır. İnsan kaynağının niteliği, dışsal bilgiye erişim kültürü, UTT öncesinde öğrenmeye hazır olacak şekilde yetkinliklere sahip olunması gibi örnek etkenler UTT başarısı ve ÖK arasında bir ilişki olduğunu göstermektedir. Bunun dışında UTT başarısını etkileyecek şekilde; ilgili politikalar, söz konusu alanda ulusal teknoloji yol haritası, üçüncü tarafların etkileri gibi firma seviyesi ÖK dışında UTT başarısını etkileyen etkenler de bulunmaktadır. Bu örnekler doğrultusunda tezin araştırma soruları aşağıdaki gibi tanımlanmıştır.

Araştırma Sorusu-1:
Firma seviyesi özümseme kapasitesi ile havacılık ve uzay alanındaki uluslararası teknoloji transferi projelerinin başarısı arasında bir ilişki var mı?

Araştırma Sorusu-2:
Firma seviyesi özümseme kapasitesi dışında havacılık ve uzay alanındaki uluslararası teknoloji transferi projelerinin başarısını etkileyen başka etkenler var mı?

Araştırma Sorusu-3:
Hangi yöntemler ile havacılık ve uzay alanındaki uluslararası teknoloji transferi projelerinin başarı ile sonuçlanma olasılığı artırılabilir?

Tez çalışması aşağıda tarif edilen altı adımda yürütülmüştür;

Adım 1: ÖK ve UTT'ye yönelik literatür araştırılmıştır.

Adım 2: Literatürü temel alarak, "ÖK'yı Etkileyen Etkenler" ve "UTT Başarısını Etkileyen Etkenler ve Başarı Göstergeleri" kavramları ve bu kavramlar altındaki değişken grupları oluşturulmuştur.

Adım 3: Bir önceki adımda oluşturulan kavramlar geliştirilmiştir. Bu amaçla yarı yapılandırılmış bir soru seti kullanılarak sanayiden ve ilgili sektörel inovasyon sisteminden uzmanların görüş ve önerileri alınmıştır.

Araştırmanın bu adımı tamamlandığında 47 farklı değişken tanımlanmıştır.

Adım 4: Bir önceki adımda tanımlanan değişkenlerin sayısallaştırılarak ekonomik bir analiz kapsamında değerlendirilmesi amacıyla bir soru seti hazırlanmıştır. Likert ölçeği kullanılarak hazırlanan soru seti vasıtasıyla; bir firmanın ÖK'sının değerlendirilmesi, firma tarafından tamamlanmış olan UTT projelerinin değerlendirilmesi ve söz konusu UTT projelerinin kapsamı hakkında bilgi alınması hedeflenmiştir. Araştırmanın bu adımı tamamlandığında farklı özelliklerdeki UTT projelerine ilişkin 74 değerlendirme elde edilmiştir.

Adım 5: Değişkenler arasındaki ilişkilerin tespit edilmesi amacıyla en küçük kareler yöntemi ile çoklu regresyon analizi yapılmıştır.

Adım 6: Bir önceki adımda gerçekleştirilen analizin sonuçları tartışılmış ve bir UTT projesinin başarılı bir şekilde sonuçlanmasını sağlayacak firma seviyesi stratejiler ve ulusal ölçekte politikalar önerilmiştir.

HAVACILIK VE UZAY SANAYİSİ

Havacılık ve uzay sanayisi ekonomik büyüklük ve çalışan sayısı açısından dünyadaki en büyük ileri teknoloji sektörlerinden birisidir. Havacılık ve uzay sanayisi, sivil ve askeri uygulamalara yönelik iki alt sektör altında ele alınabilir. Sivil uygulamalara yönelik küresel ölçekte bir işbirliği ağı ve dolayısıyla görece yüksek miktarda bilgi akışından söz edilebilirken, askeri uygulamalara yönelik uygulamalarda bilginin dolaşımına ve küreselleşmesine yönelik engeller bulunmaktadır. Havacılık ve uzay sanayisinin askeri alt sektöründe ele alınan UTT projelerinin yapısını da etkileyen uluslararası düzenlemelere örnek olarak Silahların Dolaşımı Konusunda Uluslararası Kurallar (*International Traffic in Arms Regulations - ITAR*) ya da Füze Teknolojisi Kontrol Rejimi (*Missile Technology Control Regime - MTCR)* gösterilebilir.

Türkiye'de havacılık ve uzay sanayisi; bilgi üretimi, yeni teknolojilerin geliştirilmesi ve Ar-Ge faaliyetlerinin yoğunluğu açısından değerlendirildiğinde, askeri uygulamalara yönelik alt sektörün sivil alt sektörden daha etkin olduğu belirtilebilir.

Türkiye'de askeri alandaki havacılık ve uzay uygulamaları; askeri uçaklar, roket/füze sistemleri ve uydu/uzay sistemleri olarak özetlenebilir.

Türkiye'de havacılık ve uzay sanayisi ile ilişkili devlet yatırımları konusunda etkin olan başlıca kamu kurumları Savunma Sanayi Müsteşarlığı ve Ulaştırma, Denizcilik ve Haberleşme Bakanlığı'dır. Son yıllarda uygulanan politikalar ile söz konusu alandaki ihtiyacın yerli katkıyı azami seviyede tutacak şekilde karşılanması hedeflenmektedir.

ÖZÜMSEME KAPASİTESİ (ÖK)

Özümseme kapasitesi konusunda literatürde sıkça atıfta bulunulan çalışmalardan birisi Cohen ve Levinthal (1990) tarafından yürütülmüştür. Bu araştırmacılar ÖK'yı bir firmanın yeni bir bilgiyi anlama, içselleştirme ve uygulama kabiliyeti olarak tarif etmektedirler. Ayrıca bilgiyi alan tarafın ilgili alandaki geçmiş bilgisi ve tecrübesinin bilginin alınma sürecine etkisi olduğu belirtilmiştir. Öte yandan Ernst ve Kim (2002), bilginin yayılımının ancak içselleştirme süreçlerinin başarıyla işletilmesi ile mümkün olacağını belirtmiştir. Bu araştırmacılar, ÖK ile organizasyonel ve bireysel öğrenme süreçlerini ilişkilendirmişlerdir.

Mowery ve Oxley (1995) bilginin örtük bileşenlerine odaklanmış ve ÖK'nın bu tip bilgiyi kazanabilmedeki etkisi üzerinde çalışmıştır. Çalışmalarını ulusal inovasyon sistemi temelinde yürütmüş, bu kapsamda bir ülkedeki eğitim düzeyi, Ar-Ge personeli sayısı gibi etkenlerin ÖK ile ilişkisini belirlemeyi hedeflemişlerdir. Kim (1998) ise ÖK'yı öğrenme ve problem çözebilme yeteneği ile ilişkilendirmiştir. Bu kapsamda kurumsal öğrenme sistemi, geçmiş tecrübe ve öğrenmeye yönelik çabanın önemini vurgulamıştır.

Zahra ve George (2002) ÖK'nın bir firmanın rekabetçiliği üzerindeki etkilerini incelemiştir. Çalışmalarında bilgiyi elde etme, içselleştirme, güncelleme ve kullanmaya yönelik kurumsal rutinlerin önemini vurgulamışlardır. Özellikle ÖK'nın dinamik nitelikleri üzerinde çalışmalarını yoğunlaştırmışlardır. Bu kapsamda literatüre "potansiyel ÖK" ve "gerçekleşen ÖK" terimlerini kazandırmışlardır.

Takiben Jansen et al. (2005) gibi araştırmacılar tarafından bu terimler kullanılarak kapsamlı firma seviyesi çalışmalar yürütülmüş ve ÖK'yı etkileyen etkenler üzerinde sayısal analizler gerçekleştirilmiştir.

ULUSLARARASI TEKNOLOJİ TRANSFERİ (UTT)

Teknolojik bilginin ülkeler arasında dolaşması için UTT projeleri önemli bir araçtır. Bir tedarik projesinden ya da üretim dokümanlarının başka bir ülkeden alınarak üretim süreçlerinin işletilmesinden farklı olarak, UTT projeleri, alınan hizmetin özümsenmesi ve içselleştirilmesi için önemli bir çaba gerektirmektedir. Özellikle transfer edilen bilginin örtük bileşeni bu çabayı çok daha önemli kılmaktadır.

Hikino ve Amsden (1994) gelişmekte olan ekonomiler için yönetsel ve organizasyonel yetkinliklerin önemini vurgulamıştır. Çalışmalarında süreç ve ürün performansının kademeli olarak iyileştirilmesinin önemini öne çıkarmışlardır. Forbes ve Wield (2003) ise gelişim için ulusal politikaların önemine değinmiştir. Benzer şekilde Kim ve Lee (2009) de gelişmekte olan ülkelerde UTT ile ilişkili olabilecek devlet teşviki mekanizmaları üzerinde çalışmalar yapmıştır. Forbes ve Wield (2003), gelişmekte olan ülkelerin teknolojik sıçramaya ilişkin sahip oldukları avantajlarını belirtmiş, inovasyonun ve planlamanın uzun vadede gelişmekte olan ülkeleri de küresel ölçekte rekabetçi bir pozisyona getirebileceğini belirtmiştir. Abramovitz (1986), "sosyal yetenek" terimini tanıtmış, eğitim, sanayi politikaları, finans düzenlemeleri gibi ülkedeki doğrudan teknoloji alanı ile ilgili olmayan yeteneklerin önemini vurgulamıştır. Bu kapsamda bir ülkenin bir alandaki teknolojik olarak geri kalmışlığının gelişmiş sosyal yetenekleri sayesinde hızlıca telafi edilebileceğini belirtmiştir.

Ramanathan (1999), bir UTT projesinin sözleşmesinin imzalanmasından önceki dönemi "UTT-Öncesi" olarak adlandırmaktadır. UTT-Öncesi dönemde, teknolojiyi verecek tarafın seçilmesi, transfer edilecek teknolojinin kapsamının ve maliyetinin belirlenmesi gibi hususlar öne çıkmaktadır. Öner ve Kaygusuz (2007), UTT-Öncesi dönemde teknolojiyi alan tarafın ÖK'sının değerlendirilmesinin kritik bir öneme sahip olduğunu belirtmiştir. Reddy ve Zhao (1993) ise söz konusu dönemde UTT Projesine yönelik sözleşme görüşmelerinin önemini vurgulamıştır.

ÖNERİLEN KAVRAM

ÖK ile ilgili incelenen literatürde daha çok "ÖK'nın tipleri nelerdir?" sorusuna cevap arandığı görülmüştür. Lane ve Lubatkin (1998) "bağıl ÖK"yı, Zahra ve George (2002) ise "ÖK'nın dinamik özellikleri"ni tanımlamıştır. Geçmiş çalışmalarda ÖK derinlemesine incelenmiş, kurumsal öğrenme, kurumsal yapılanma ve çevresel etkiler gibi birçok alanda ÖK ile ilişkili değerlendirmeler yapılmıştır.

Öte yandan, bu tez "ÖK'yı neler oluşturur?" sorusuna bütünsel bir yaklaşım ile cevap aramakta olup, literatürde belirtilen ve havacılık ve uzay sanayisi ile ilgili olabileceği değerlendirilen etkenlerin tümünün bir arada değerlendirilmesine çalışılmıştır. Bu kapsamda ÖK'yı etkilediği değerlendirilen etkenler aşağıdaki gruplar altında ele alınmış ve bu grupların literatür ile ilişkisi de Tablo 1'de verilmiştir.

- Bilgi Üretimi
- Firma İçi Bilgi Akışı
- Sektörel İnovasyon Sistemi içinde Bilgi Akışı

Tablo 1 Literatüre göre ÖK'yı etkileyen etkenler

Özümseme Kapasitesini Etkileyen Etkenler	**İlgili Literatür**	**Anahtar Kelimeler/Açıklamalar**
Bilgi Üretimi	Dosi ve Nelson (2010), Perez (2001), Bernard ve Ravenhill (1995), Spender (1996), Mathews (2004)	Teknolojik paradigma, teknolojik değişimin evrimsel gelişimi, teknoloji geliştirme projelerinin planlanması, Ar-Ge stratejileri, rutinler, stratejik yönetim
	Ancori et al. (2000), Carlsson (2006), Dolfsma (2008), Omidvar (2013), Abramovitz (1986), Mowery ve Oxley (1995)	Bilişsel beceriler, işgücü becerileri, insan sermayesine yatırım
	Cohen ve Levinthal (1990), Kim (1998), Zahra ve George (2002), Jansen et al. (2005), Lane ve Lubatkin (1998), Van den Bosch et al. (1999)	Farklı ÖK kavramları, ÖK'yı etkileyen etkenler, geçmiş tecrübe ve bilgi, önceki yatırımların çeşitliliği, kurumsal rutinler, firma hafızası, teknolojik değişime açıklık
	Foray (2004), Simon (1999), Brynjolfsson ve Hitt (2000), Hikino ve Amsden (1994), Scherrer (2005), Zahra ve George (2002)	Bilginin yazılı forma çevrilmesi, bilişim ve iletişim teknolojilerine yönelik yatırımlar
	Akgün et al. (2009)	Duygusal yetenek
Firma İçi Bilgi Akışı	Romer (1986), Lall (1992), Malerba (1992), Forbes ve Wield (2003), Bathelt et al. (2002)	Öğrenmenin endojen şekilleri
	Katz (1999), Dutrénit (2004)	Öğrenme stratejisini etkileyen mikro seviye ekonomik etkenler, teknolojik yetenek oluşturma
	Polanyi (1969), Dosi ve Nelson (2010), Morone ve Taylor (2010), Dolfsma (2008), Balconi et al. (2007), Ancori et al. (2000), Hey (2004), Mowery ve Oxley (1995), Szulanski (1996)	Örtük bilginin paylaşılması, kolektif öğrenme, ortak vizyon
	Jansen et al. (2005), Dutrénit (2004)	Koordinasyon yetenekleri, karar alma süreçlerine katılım

Tablo 1 Literatüre göre ÖK'yı etkileyen etkenler (devam)

Özümseme Kapasitesini Etkileyen Etkenler	İlgili Literatür	Anahtar Kelimeler/Açıklamalar
Sektörel İnovasyon Sistemi içinde Bilgi Akışı	Romer (1986), Bathelt et al. (2002), Chaudhuri ve Tabrizi, (1999), Christensen (1997), Foray (2004), Morone and Taylor (2010), Ernst ve Kim (2002)	Dışsallıklar, bilginin yayılımı
	Katz (1999), Mowery ve Oxley (1995)	Rekabetçiliği teşvik eden düzenlemeler, politikalar, ülke seviyesi ÖK
	Ancori et al. (2000), Lane ve Lubatkin (1998)	Ortak terminoloji, ortak dil
	Shariff (2006), Metcalfe (1997), Kline and Rosenberg (1986), Carlsson (2006), Malerba ve Mani (2009), Bergek et al. (2005), Vertesy ve Szirmai (2010), Vermeulen ve Barkema (2001)	İnovasyon sistemleri, inovasyon modelleri, organizasyonlar arası ilişkiler
	Crispolti ve Marconi (2005), Korhonen (1994), Akamatsu (1962), Kasahara (2004), Vernon (1971), Abramovitz (1986), Mathews (2004), Teitel (1984), Scherrer (2005)	Yakalama politikaları, gelişmekte olan ülkelerde teknolojik gelişim politikaları
	Porter (1998), Bathelt et al. (2002), Özman (2009), Granovetter (1983)	Kümeler, ağlar

Literatür araştırmasının sonucunda UTT ile ilgili olabilecek etkenler ve UTT başarım göstergeleri aşağıdaki gruplar altında ele alınmış ve bu grupların literatür ile ilişkisi de Tablo 2'de verilmiştir.

- UTT Projesi Öncesi Hazırlıklar
- UTT Projesinin İcrası
- UTT Projesinin Performansı

Tablo 2 Literatüre göre UTT'yi etkileyen etkenler ve başarı göstergeleri

UTT'yi Etkileyen Etkenler ve Başarı Göstergeleri	İlgili Literatür	Anahtar Kelimeler/Açıklamalar
UTT Projesi Öncesi Hazırlıklar	Forbes ve Wield (2003), Kim ve Lee (2009), Gerschenkron (1962), Akamatsu (1962), Korhonen (1994)	Politik ortam, stratejik sektörler ve devletin rolü, devlet müdahalesi, gelişmekte olan ülkelerde gelişmiş teknoloji alanları
	Forbes ve Wield (2003), Hikino ve Amsden (1994), Dutrénit (2004)	Teknoloji yol haritaları, yönetsel ve organizasyonel yetenekler
	Ramanathan (1999), Öner ve Kaygusuz (2007), Reddy ve Zhao (1993)	UTT-Öncesi dönem, teknolojiyi verecek tarafın seçimi, teknolojik boşluk değerlendirmesi, ÖK değerlendirmesi, sözleşme görüşmelerinin önemi
	Mansfield ve Romeo (1980), Balconi et al. (2007)	Transfer edilen teknolojinin niteliği
	Baranson (1978), Krugman (1979), Mansfield ve Romeo (1980), McCulloch ve Yellen (1982), Wilking (1974)	Teknolojiyi veren tarafın bakış açısıyla UTT'nin değerlendirilmesi
UTT Projesinin İcrası	Reddy ve Zhao, (1990), Mansfield (1975)	UTT'nin farklı tipleri
	Öner ve Kaygusuz (2007)	Teknoloji ya da ürünün yerlileştirilmesi
UTT Projesinin Performansı	Aharoni (1991), Forbes ve Wield (2003), Reddy ve Zhao (1990), Öner ve Kaygusuz (2007)	Teknolojiyi alan tarafın bakış açısıyla UTT'nin performansının değerlendirilmesi

Yukarıda belirtilen ÖK ve UTT ile ilgili grupların altında yer alan etkenlerin belirlenmesi amacıyla sanayiden ve kamudan uzmanların görüşleri alınmıştır (araştırmanın Adım-3'ü). Yarı yapılandırılmış bir soru seti üzerinden uzmanlar ile yapılan görüşmeler sonrasında yukarıdaki etken grupları altındaki etkenler belirlenmiştir. Söz konusu etkenler Tablo 3'te özetlenmiştir.

Tablo 3 ÖK ve UTT ile ilgili etkenler

<table>
<tr><th colspan="2">Etken Grupları</th><th>Etkenler</th></tr>
<tr><td rowspan="3">ÖK'yı Etkileyen Etkenler</td><td>1) Bilgi Üretimi</td><td>• Üniversiteler için akademik hedeflerin belirlenmesi,
• Başlıca üniversiteleri mezunlarının istihdamı,
• Dünyadaki literatüre etkin erişim,
• Patent veri tabanının kullanım kültürü,
• Firma seviyesi stratejik plan ve teknoloji yol haritası,
• Öz kaynak teknoloji geliştirme projeleri,
• Özgün tasarım ve analiz araçlarının geliştirilmesi,
• Maaş dışında verilen haklar,
• Duygusal kapasite.</td></tr>
<tr><td>2) Firma İçi Bilgi Akışı</td><td>• Firma içi bilgi üretim aktivitelerinin koordinasyonu,
• Bilgiyi yazılı hale getirme kültürü,
• Sistem mühendisliği yaklaşımının uygulanması kültürü,
• Prosedürler ve süreçlerin uygulanması kültürü,
• Yüz yüze iletişim kanalları.</td></tr>
<tr><td>3) Sektörel İnovasyon Sistemi içinde Bilgi Akışı</td><td>• Diğer ulusal aktörler ile iletişim,
• Üniversiteler ile işbirliği,
• İyi planlanmış eğitim,
• Alt yüklenicilerin geliştirilmesi,
• Uluslararası aktörler ile iletişim.</td></tr>
<tr><td rowspan="2">UTT'yi etkileyen etkenler</td><td>4) UTT Projesi Öncesi Hazırlıklar</td><td>• Güçlü siyasi irade,
• UTT'nin bir teknolojik boşluğu doldurması,
• UTT'nin belirgin stratejik faydaları,
• Teknolojiyi veren tarafın seçimi,
• Alınan teknolojinin statüsü,
• Teknolojiyi veren tarafın motivasyonu,
• Gelişmiş ülkelerin ve büyük firmaların tepkisi,
• İyi hazırlanmış sözleşme.</td></tr>
<tr><td>5) UTT Projesinin İcrası</td><td>• "Tasarım" döneminin faydaları,
• "Ekipman kurulum ve devreye alma" döneminin faydaları,
• "Yer testleri" döneminin faydaları,
• "Üretim" döneminin faydaları,
• Etkin özümseme mekanizmalarının işletilmesi,
• Teknolojiyi alan tarafta sistem mühendisliği süreçlerinin etkin olarak işletilmesi,
• Ham malzeme kaynağının çeşitli olması,
• Tedarik edilen "ekipman"ın faydaları,
• Tedarik edilen "özel yazılımlar"ın faydaları,
• Alınan "eğitim"in faydaları,
• Dil farklılığından oluşan kısıtların yönetilmesi.</td></tr>
<tr><td>UTT başarı göstergeleri</td><td>6) UTT Projesinin Performansı</td><td>• Sözleşme gereksinimlerinin karşılanması,
• Dışa bağımlılığın azaltılması,
• Kazanılan tasarım yeteneğinin geçerlenmesi ve doğrulanması
• "Beyin göçü"nün önlenmesi</td></tr>
</table>

SAYISAL ANALİZ

ÖK ve UTT ile ilgili etkenler arasındaki ilişkiyi belirlemek için gerçekleştirilecek sayısal analizlerde kullanılmak amacıyla söz konusu etkenlerin sayısal olarak ölçülebilmesi gerekmektedir. Bu amaçla bir soru seti oluşturulmuş ve bu soru seti kullanılarak sanayiden uzmanların daha önce görev aldıkları UTT projelerini ve ilaveten firmalarının ÖK'sını değerlendirmeleri sağlanmıştır. Likert ölçeği ile oluşturulan soru seti iki bölümden oluşmaktadır. İlk bölümde yer alan sorular firma seviyesi ortama (insan kaynağının niteliği, teknoloji geliştirme konusunda bir stratejik planın bulunması, kurumsal yapının ve kültürün yenilikçi çalışmalara uygunluğu, vb.) yönelik cevaplar aramaktadır. İkinci bölümde ise, soruları cevaplayan uzmanların daha önce görev aldıkları bir UTT projesini farklı açılardan değerlendirmeleri (projenin yürütüldüğü alanda güçlü siyasi iradenin bulunması, UTT projesinin planlama ve icra süreçlerinin niteliği, UTT projesinin sonuçlarının değerlendirilmesi, vb.) istenmektedir. İlave olarak, değerlendirilen UTT projesi ile alınan teknik desteğin kapsamının belirlenmesini sağlayacak sorular da soru setinde yer almaktadır.

Soru setinin, Türkiye'deki havacılık ve uzay sanayisinde yer alan başlıca firmalardan birinde çalışan 10-25 yıl sektör tecrübesi bulunan 20 farklı uzman tarafından doldurulması sağlanmış, böylece farklı özelliklerdeki UTT projelerine ilişkin 74 değerlendirme elde edilmiştir.

Araştırmanın Adım-4'ü tamamlandığında daha önce Tablo 3'te verilen etkenlerin Likert ölçeğinde sayısallaştırılması mümkün olmuştur. İlave olarak, soru seti sayesinde, değerlendirilen UTT projelerinin "Fonksiyonel Yetenek" ve "Ürün Seviyesi" de öğrenilmiştir. "Fonksiyonel Yetenek"; tasarım, üretim, test, montaj/entegrasyon kabiliyetleri açısından, "Ürün Seviyesi" ise; komponent/malzeme seviyesi, alt sistem seviyesi ve sistem seviyesi sınıflarında değerlendirilmiştir. Böylece ilgili proje için "UTT projesinin karmaşıklık seviyesi" 1 ve 10 arasında sayısal bir değer olarak bulunabilmiştir.

Sayısallaştırılan değişkenler arasındaki ilişkilerin tespit edilmesi amacıyla en küçük kareler yöntemi ile çoklu regresyon analizi yapılmıştır.
Regresyon Analizi-1: Değişken sayısının (47 adet), gözlem sayısına (74 adet) oranla fazla olması nedeniyle, değişkenler yukarıda açıklanan "önerilen kavram" ile uyumlu olarak 6 grup altında toplanmış, bu amaçla her bir grup için o grupta yer alan değişkenleri temsil eden yeni bir değişken oluşturulmuştur.

Regresyon Analizi-2: "Önerilen kavram" ile uyumlu olarak 6 değişken grubu kullanılmış, ancak Regresyon Analizi-1'den farklı olarak her gruba ilişkin "genel değerlendirme sorularının cevapları" kullanılmıştır.

Regresyon Analizi-1'de kullanılan değişkenler Tablo 4'te verilmiştir. Bu değişkenler arasından MEAN_ITT_PER (UTT Projesinin Performansı) bağımlı değişken olarak değerlendirilmiştir.

$$
\begin{aligned}
MEAN\_ITT\_PER &= \beta_0 + \beta_1 MEAN\_ABS\_KP + \beta_2 MEAN\_ABS\_KF + \beta_3 MEAN\_ABS\_SIS \\
&+ \beta_4 MEAN\_ITT\_PREP + \beta_5 MEAN\_ITT\_CON + e
\end{aligned}
$$

Tablo 4 Regresyon Analizi-1'de kullanılan değişkenler

Değişken Grubu	***Açıklama***	***Göz.***	***Ort.***	***Std. Dev.***	***Min***	***Maks.***
MEAN_ABS_KP	Bilgi Üretimi	74	3.67	0.34	2.78	4.44
MEAN_ABS_KF	Firma İçi Bilgi Akışı	74	3.38	0.38	2.60	4.60
MEAN_ABS_SIS	Sektörel İnovasyon Sistemi içinde Bilgi Akışı	74	3.31	0.63	1.67	4.60
MEAN_ITT_PREP	UTT Projesi Öncesi Hazırlıklar	74	3.71	0.52	2.63	4.88
MEAN_ITT_CON	UTT Projesinin İcrası	74	3.51	0.57	2.38	4.63
MEAN_ITT_PER	UTT Projesinin Performansı	74	3.68	0.66	1.67	5.00

Değişkenler arasındaki korelasyon incelenmiş ve aralarında ilişki tespit edilen açıklayıcı değişkenlerin bir arada yer almadığı regresyon modelleri oluşturulmuştur. Bu şekilde gerçekleştirilen analizlerin sonuçları Tablo 5'te verilmiştir.

Tablo 5 Regresyon sonuçları (Regresyon Analizi-1)

DEĞİŞKEN	(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)
Sabit	-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)
Gözlem	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 hata değerleri parantez içinde verilmiştir
*** p<0.01, ** p<0.05, * p<0.1

Bu sonuçlara göre MEAN_ABS_KP (Bilgi Üretimi) ve MEAN_ITT_PREP (UTT Projesi Öncesi Hazırlıklar) değişkenleri, tüm modellerde UTT projesinin performansını en baskın şekilde etkileyen değişkenler olarak ortaya çıkmaktadır. Tüm modellerin bir diğer ortak özelliği de bağımlı ve bağımsız değişkenler arasında tespit edilen kuvvetli ilişkilerin doğru yönlü olmasıdır.

Aralarında korelasyon içermeyen bağımsız değişkenler ile oluşturulan modellerin sonuçlarına göre en kuvvetli etkisi olan bağımsız değişken MEAN_ITT_PREP'tir. Bu değişken aynı zamanda en büyük sabite sahiptir. Örneğin Model-2 sonuçlarına göre MEAN_ITT_PREP (UTT Projesi Öncesi Hazırlıklar) değişkenindeki 1.00 birimlik artış, MEAN_ITT_PER (UTT Projesinin Performansı) değişkeninde 1.04 birimlik artışa neden olmaktadır.

Tablo 5'e göre en etkili ikinci değişken MEAN_ITT_CON (UTT Projesinin İcrası) değişkenidir. MEAN_ITT_PREP ve MEAN_ITT_CON arasında yüksek korelasyon tespit edildiği için bu beklenen bir sonuçtur.

Model-2 ve Model-3 sonuçlarına göre MEAN_ABS_KP'nin (Bilgi Üretimi) de, MEAN_ITT_PREP ve MEAN_ITT_CON kadar baskın olmamakla birlikte, etkili bir değişken olduğu anlaşılmaktadır. Öte yandan, Model-4 ve Model-5 sonuçlarına göre MEAN_ABS_KF (Firma İçi Bilgi Akışı) ve UTT projesinin performansı arasındaki ilişki tam olarak belirgin değildir.

Tablo 5'e göre MEAN_ABS_SIS (Sektörel İnovasyon Sistemi içinde Bilgi Akışı) ve UTT projesinin performansı arasında bir ilişki olmadığı anlaşılmaktadır. Bu sonuç literatür ile çelişmesi nedeniyle şaşırtıcıdır. Türkiye'deki havacılık ve uzay alanındaki sektörel inovasyon sisteminin tam olarak olgunlaşmadığı şeklinde yorumlanabileceği değerlendirilmektedir.

Regresyon Analizi-2, "genel değerlendirme sorularının cevapları" kullanılarak yapılmış ve sonuçları Tablo 6'da verilmiştir. Bu sonuçlar, Regresyon Analizi-1'in sonuçları ile büyük oranda benzerlikler içermektedir.

Tablo 6 Regresyon sonuçları (Regresyon Analizi-2)

DEĞİŞKEN	(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)
Sabit	0.353	0.511	0.915	0.381	0.935
	(0.608)	(0.561)	(0.565)	(0.581)	(0.617)
Gözlem	74	74	74	74	74
R-squared	0.555	0.541	0.451	0.544	0.451

Robust standard hata değerleri parantez içinde verilmiştir
*** p<0.01, ** p<0.05, * p<0.1

SONUÇ VE DEĞERLENDİRME

Regresyon analizi sonuçlarına göre bir UTT projesinin başarısını etkileyen etken grupları yukarıda açıklanmıştır. Soru setine verilen cevaplara göre söz konusu gruplar altında yer alan ve zayıf olduğu tespit edilen etkenler için firma seviyesi strateji önerileri oluşturulmuş ve özet olarak Tablo 7'de verilmiştir. Elde edilen sonuçlar doğrultusunda araştırma soruları özetle aşağıdaki şekilde cevaplandırılabilir.

Araştırma Sorusu-1 için kısa cevap:

Firma seviyesi özümseme kapasitesi ile havacılık ve uzay alanındaki uluslararası teknoloji transferi projelerinin başarısı arasında bir ilişki vardır. Ancak tespit edilen ilişki ÖK'nın sadece "Bilgi Üretimi" bileşeni için belirgindir. "Firma İçi Bilgi Akışı" ve UTT projesinin performansı arasındaki ilişki belirgin değildir. "Sektörel İnovasyon Sistemi içinde Bilgi Akışı" ve UTT projesinin performansı arasında ise bir ilişki tespit edilmemiştir.

Araştırma Sorusu-2 için kısa cevap:

Firma seviyesi özümseme kapasitesi dışında havacılık ve uzay alanındaki uluslararası teknoloji transferi projelerinin başarısını etkileyen başka etkenler de vardır. Bu etkenler "UTT Projesi Öncesi Hazırlıklar" ve "UTT Projesinin İcrası" etken grupları altında ele alınmış olup, analiz sonuçlarına göre her iki grubun da UTT projelerinin başarısına kuvvetli etkisi olduğu anlaşılmıştır. Bu sonuçlar bir UTT projesinin başarı ile sonuçlanması için firma seviyesi çabaların yeterli olmadığını göstermektedir.

Araştırma sonuçları göstermektedir ki, oluşturulan kavram üzerinden bir firmanın ÖK'sı değerlendirilerek gelecekte firma tarafından yürütülecek bir UTT projesinin başarısının önceden kestirilmesi mümkündür. Özellikle ÖK'nın "Bilgi Üretimi" bileşeni üzerinde yapılacak değerlendirmeler ile havacılık ve uzay alanındaki UTT projeleri öncesinde bu değerlendirme yapılabilir. İlave olarak, "UTT Projesi Öncesi Hazırlıklar"ın değerlendirilmesi ile kestirim sonuçları geliştirilebilir.

Tablo 7 Firma seviyesi strateji önerileri - özet

Etken Grubu içinde Belirlenen Zayıflıklar	**Firma Seviyesi Strateji Önerilerinin Kısa Açıklaması**
Bilgi Üretimi (*KP*):	
• Maaş dışında verilen haklar	• Cazip çalışma ortamı
• Duygusal kapasite	• Ortak vizyon, sistematik toplantılar
Firma İçi Bilgi Akışı (*KF*):	
• Firma içi bilgi üretim aktivitelerinin koordinasyonu	• "Bilmesi gereken prensibi"nin olumsuz etkilerini azaltmak amacıyla özel kurumsal yapılar teşkil edilmesi
Sektörel İnovasyon Sistemi içinde Bilgi Akışı (*SIS*):	
• Altyüklenicilerin geliştirilmesi	• Tekrarlanan işbirliğinin temin edilmesi, planlı bir şekilde bilginin altyüklenicilere yayılımının sağlanması (bu amaçla işbaşı eğitimi, teknik destek sağlanması, altyapı paylaşılması gibi yöntemler kullanılması), altyüklenicilerin stratejik hedeflerden haberdar edilmesi
• İyi planlanmış eğitim	• İnsan varlıklarının sürekli olarak gelişiminin sağlanması, eğitim konusunda atanmış kurumsal yapıların teşkil edilmesi
• Uluslararası aktörler ile iletişim	• Uluslararası etkinliklere katılım sağlanması (konferans, fuar, vb.), uluslararası teknoloji geliştirme projelerinde görev alınması, Avrupa Birliği Çerçeve Programlarını takip eden atanmış bir kurumsal yapı teşkil edilmesi, SSM tarafından uygulanan offset rejimini avantaja çevirecek şekilde sistematik yaklaşımlar uygulanması
UTT Projesi Öncesi Hazırlıklar (*PREP*):	
• UTT'nin bir teknolojik boşluğu doldurması	• Firma seviyesi teknoloji yol haritasına sahip olunması, öz kaynaklar ile teknoloji geliştirme projelerinin yürütülmesi ve bu yaklaşımın sürekliliğinin sağlanması, özgün tasarım ve analiz araçlarının geliştirilmesi ve bu yaklaşımın sürekliliğin sağlanması, firma seviyesinde ve ulusal seviyede güvenilir teknoloji değerlendirme yöntemlerinin uygulanması, teknolojik boşlukların tespit edilmesi.
• Gelişmiş ülkelerin ve büyük firmaların tepkisi	• Uluslararası lobi faaliyetleri yürütülmesi
UTT Projesinin İcrası (*CON*):	
• Ham malzeme kaynağının çeşitli olması	• UTT projelerinin kapsamının belirlenmesi sırasında esnek bir tasarımın hedeflenmesi, ileri teknoloji içeren malzemeler için teknoloji geliştirme projelerinin yürütülmesi

Yukarıda açıklandığı gibi bir UTT projesinin başarı ile sonuçlanması için firma seviyesi çabaların yeterli olmadığı anlaşılmıştır. Bir başka deyişle bu amaca hizmet etmek üzere politika araçlarına ihtiyaç bulunmaktadır. Araştırma Sorusu-3'e cevap olarak oluşturulan politika önlemleri ve araçları özet olarak Tablo 8'de sunulmuştur.

Tablo 8 Politika önerileri - Özet

Politika Önerisi	Politika Önlemleri ve Araçları
Yerli Teknolojilerin Gelişiminin Teşvik Edilmesi	Havacılık ve uzay sanayisinin ihtiyaçlarına göre üniversitelerin müfredatının düzenlenmesi.
	İlgili alandaki teknoloji yönetimi sorumluluğunun atanmış ve geniş yetkilerle donatılmış bir kurumda toplanması ve merkezileştirilmesi
	Ar-Ge projelerinin fonlanması amacıyla uygulanan mevzuatın, bu projelerin kapsamına ve tipine göre güncellenebilmesini sağlayacak şekilde esnek bir yapıda formüle edilmesi
	Havacılık ve uzay alanında faaliyet gösteren firmaların yenilikçi ortamlar yaratmasını sağlamak üzere mevzuat düzenlenmesi
	Havacılık ve uzay alanında faaliyet gösteren büyük firmaların çalışma alanlarının belirlenmesi ve çakışmayı engelleyecek şekilde sınırlandırılması
Sektörel İnovasyon Sistemi içinde Bilgi Akışının Teşvik Edilmesi	Havacılık ve uzay alanında ulusal teknoloji platformlarının düzenlenmesi ve bu etkinliklerin sürekliliğinin sağlanması
	Havacılık ve uzay alanında faaliyet gösteren firmalar ve ulusal üniversiteler arasındaki bağları kuvvetlendirecek şekilde kanallar kurulması ve kurulmasının teşvik edilmesi
	Havacılık ve uzay alanında faaliyet gösteren firmaların, sektörel bilgi akışı mekanizmalarını etkin bir şekilde kullanmasının teşvik edilmesi.
UTT Projesi Öncesinde Hazır Olunmasının Temini	İlgili teknolojik alana yönelik güçlü siyasi iradeyi ortaya koyacak şekilde ilgili teknoloji alanının öncelikli bir alan olarak belirlenmesi
	İlgili alanda bir Ulusal Teknoloji Yol Haritası kurgulanması ve bu kapsamda; teknolojik adımların tarif edilmesi, ilgili alt teknolojiler arasındaki ilişkilerin tespit edilmesi ve teknolojik boşlukların belirlenmesi.

Bu tez çalışmasında "firma seviyesi ÖK'yı neler oluşturur" sorusuna bütünsel bir yaklaşım ile cevap aranmıştır. Bu kapsamda ÖK oluşumunu etkileyen değişkenler 3 grupta toplanmıştır; "Bilgi Üretimi", "Firma İçi Bilgi Akışı", "SİS içi Bilgi Akışı". Çalışma, firma seviyesi yeteneklere odaklansa da değişkenler sektörel inovasyon sistemi (SİS) perspektifinden belirlenmiştir.

Etkenleri tespit edebilmek ve ölçebilmek amacıyla bir soru seti oluşturulmuş, bu soru seti kullanılarak sanayiden uzmanların daha önce görev aldıkları uluslararası teknoloji transferi projelerini ve ilaveten firmalarının özümseme kapasitesini değerlendirmeleri sağlanmıştır. Çalışmada, literatüre katkı sağlayacak şekilde, teknolojiyi veren tarafın katkısı temelinde uluslararası teknoloji transferi projesinin karmaşıklık seviyesini ölçmeyi sağlayacak bir metrik oluşturulmuş, bunun için "Fonksiyonel Yetenek" ve "Ürün Seviyesi" tanımlanmıştır.

Ekonometrik analizler ile elde edilen sonuçlar, açıklayıcı değişkenler ve UTT'nin başarısı arasında doğrudan bir ilişki göstermektedir. Buna göre, gelecekte gerçekleştirilecek uluslararası teknoloji transferi projelerinin başarısının öngörülmesinin, firma seviyesi özümseme kapasitesinin belirlenmesi ile mümkün olabileceği değerlendirilmektedir.

Teknolojiyi kazanan ülke perspektifinden kurgulanan bu tez çalışması, kapsamı itibariyle özgün bir çalışma niteliği taşımaktadır. Ayrıca, bu araştırma havacılık ve uzay sanayisini gelişmekte olan ülke perspektifinden değerlendiren ilk çalışmalardandır. Çalışma, ilgili alanda UTT projelerinin performansını etkileyen firma düzeyinde dinamikler ve SİS arasındaki ilişkileri araştırmak üzere bu kapsamda yürütülmüş Türkiye'deki muhtemelen ilk uygulamadır.

Tanımlanan değişkenler ve soru seti UTT projelerinin planlanması aşamasında faydalı bir araç olarak kullanılabilir. Gelişmekte olan ülkelerde çeşitli yüksek teknoloji alanlarına uygulanabilir ve UTT projeleri öncesinde politika yapıcılara değerli bilgiler sağlayabilir.

Soru setinin ilk bölümünün belirli sürelerde tekrar edilmesi sayesinde değerlendirilen firmanın özümseme kapasitesinin zaman içindeki değişimini takip etmek mümkün olacaktır. Böylece gelecekte firma tarafından gerçekleştirilecek bir uluslararası teknoloji transferi projesinin başarısının daha hassas bir şekilde öngörülmesi mümkün olacaktır. İlave olarak, bu tip bir değerlendirme sayesinde firmanın kuvvetli ve zayıf özellikleri de tespit edilebilecek, iyileştirmeye/geliştirmeye yönelik tedbirler alınabilecektir.

Daha çok gözlem ile oluşturulacak bir veri seti regresyon analizlerinin güvenilirliğini artıracaktır. Bu şekilde uluslararası teknoloji transferi projesinin karmaşıklık seviyesi de ekonometrik modele dahil edilerek bu değişken açısından da istatistiksel olarak yorumlanabilecek sonuçlar elde edilebilir. Gözlem sayısının çoğaltılması için sektörel inovasyon sisteminde yer alan diğer firmaların da değerlendirilmesi gerekecektir. Ancak, böyle kapsamlı bir çalışmanın, kamu kurumları tarafından koordine edilmesi halinde yürütülebileceği değerlendirilmektedir.

APPENDIX F
CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Seçkin, Başar
Nationality: Turkish
Date and Place of Birth: 1976, İzmit
email: basarseckin@gmail.com

INTEREST AREAS

Engineering

- Propulsion Systems
- Satellite Launch Vehicles
- Space Propulsion Systems
- Systems Engineering
- Experimental Methods and Test Set-up Development

Science and Technology Policies

- Technology Management and Innovation
- Aerospace Industry
- Sectoral Innovation Systems
- Space Policy

EDUCATION

- Ph.D. in Science and Technology Policy Studies,
  Middle East Technical University, Ankara, Turkey

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

- M.S. in Mechanical Engineering,
  Middle East Technical University, Ankara, Turkey

  Thesis Topic: "Rocket Nozzle Design and Optimization"

- B.S. in Mechanical Engineering,
  Middle East Technical University, Ankara, Turkey

- High School, TED Ankara Koleji, Ankara, Turkey

WORK EXPERIENCE

1999-Present ROKETSAN Inc.

2015-Present Space Programs Manager

2012-2015 Space Projects Manager

2008-2012 Unit Head in Satellite Launch Vehicles Design Unit

1999-2008 Propulsion Design Engineer in Propulsion Systems Design Unit

PUBLICATIONS

- **Seçkin B.**, Arkun U.,Tınaztepe T.H, Toker K.A., "Estimates for the Future Space Launcher Projects for Turkey",Recent Advances in Space Technology 2005 (RAST 2005), İstanbul, June 2005.
- Boysan M.E., Ulaş A., Toker K.A., **Seçkin B.**, "Comparison of Different Aspect Ratio Cooling Channel Designs for a Liquid Propellant Rocket Engine", Recent Advances in Space Technology 2007 (RAST 2007), İstanbul, June 2007.
- Songür E., Aydoğmuş A., **Seçkin B.**, "Multi Axis Thrust Measurement Systems for Solid Rocket Motors", 4^{th} Defense Technologies Congress (SAVTEK 2008), Ankara, June 2008.
- Civek E., **Seçkin B.**, Tınaztepe T.H, "An Industrialisation Model for Satellite Propulsion System Manufacturing, Assembly, Integration and Test", Recent Advances in Space Technology 2009 (RAST 2009), İstanbul, June 2009
- Yaman I., **Seçkin B.**,"Effect of Atmosphere Model on Suborbital Launch Vehicle Trajectory Analysis for a Hypothetical Launch from Turkey", Recent Advances in Space Technology 2011 (RAST 2011), İstanbul, June 2011.
- Akbulut I., Çilli A., **Seçkin B.**,"Trajectory Prediction Tools for Conceptual Design of Orbital and Suborbital Launch Vehicles", Recent Advances in Space Technology 2011 (RAST 2011), İstanbul, June 2011.
- Yılmaz A., Akbulut I., **Seçkin B.**, Özgören K.,"A Comparison of Traditional Orbit Transfer Methods and Genetic Algorithm Based Orbit Transfer Method - *Klasik Yörünge Transferi Yöntemleri ile Genetik Algoritma Tabanlı Genelleştirilmiş Yörünge Transferi Yönteminin Karşılaştırılması*", 6^{th} Defense Technologies Congress (SAVTEK 2012), Ankara, June 2012.
- **Seçkin B.**,"The New US Space Policy and Opportunities and Obstacles for International Partnership - *Yeni ABD Ulusal Uzay Politikası ve Uzay Alanında Uluslararası İşbirliği İçin Engeller ve Fırsatlar*", 6^{th} Defense Technologies Congress (SAVTEK 2012), Ankara, June 2012.
- Coşkun E.C., Yaman I., **Seçkin B.**, "A Conceptual Design Methodology for Satellite Launch Vehicles - *Uydu Fırlatma Sistemleri için Kavramsal Tasarım Metodolojisi*", 6^{th} Defense Technologies Congress (SAVTEK 2012), Ankara, June 2012.

APPENDIX G

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☐

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : Seçkin

Adı : Başar

Bölümü : Bilim ve Teknoloji Politikası Çalışmaları

TEZİN ADI (İngilizce): Firm Level Absorptive Capacity and the Success of International Technology Transfer: the Case of Aerospace Industry in Turkey

TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ☐

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
3. Tezimden bir (1) yıl süreyle fotokopi alınamaz. ☐

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: