IMPACT ASSESSMENT OF VISION 2023 TECHNOLOGY FORESIGHT IN DEFENSE SECTOR

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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.

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ABSTRACT

IMPACT ASSESSMENT OF VISION 2023 TECHNOLOGY FORESIGHT
IN DEFENSE SECTOR

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This thesis was conducted in the scope of impact analysis of technology foresight intervention which was conducted to influence policies and decisions to benefit from sience and technology to create a knowledge society and innovative economy.

The first objective is to assess the long-term ex-post impact of Vision 2023 technology foresight in defense sector. The second objective is the development of a model to assess the impact.

An impact assessment scale was developed by implementing program-based theory and qualitative-quantitative analysis methods. The impact types of the scale are; Influencing, Awareness Raising and Informing, Enabling, Cooperation between Government-University-Industry, and Foresight Culture. “Influencing” has the highest weighting score. The total impact level is measured as “Some Contribution” with 3.04 out of 5.0 score. Selection and approval of research and development projects were influenced by the foresight program. Some cultural impact and awareness increase on science technology and innovation, and foresight are achieved. The technology foresight had some contribution to the increase of long-term planning activities, development and use of technology taxonomies, the increase in use of foresight techniques.

Establishment of a high rank committee as the sponsor of the foresight, and assignment of Undersecretariat for Defense Industry for the success of technology foresight are recommended to overcome the lack of ownership, commitment, and monitoring and evaluation of technology foresight.

An impact assessment model is developed based on Capability Maturity Model for Integration at macro level. The staged process improvement principles, and process area approach are benefitted in the development of the model.

Keywords: Technology Foresight, Science Technology Innovation, Assessment, Program-Based Theory, Capability Maturity Model.

ÖZ

VİZYON 2023 TEKNOLOJİ ÖNGÖRÜSÜNÜN SAVUNMA SEKTÖRÜNDE ETKİSİ

Burhan, Mukaddes
Doktora, Bilim ve Teknoloji Politika Çalışmaları
Tez Yöneticisi: Doç. Dr. Serhat Çakır

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Bu tez, bilgi toplumu ve yenilikçi ekonominin yaratılmasında bilim ve teknolojiden yararlanılmasını sağlayacak politika ve kararları etkilemek üzere gerçekleştirilen Vizyon 2023 teknoloji öngörü müdahalesinin etki analizi çerçevesinde yapılmıştır.

Tezin birinci amacı Vizyon 2023 Teknoloji Öngörüsünün savunma sektöründe uzun vadeli etkisinin ölçülmesi ve değerlendirilmesidir. İkinci amaç ise teknoloji öngörüsünün uzun vadeli etkilerinin değerlendirmesi için bir model geliştirilmesidir.

Etki değerlendirme ölçeği program bazlı teori ile nitel ve nicel araştırma metodları uygulanarak geliştirilmiştir. Ölçeğin 5 etki tipi ‘Etkileme’, ‘Farkındalığı Artırma ve Bilgilendirme’, ‘Araç’, ‘Kamu-Üniversite-Sanayi İşbirliği’ ve ‘Öngörü Kültürü’dür. Etki tipleri göreceli önemlerine göre farklı ağırlık katsayılarına sahiptir. ‘Etkileme’ en yüksek ağırlık katsayısına sahip etki tipidir. Toplam etki 3.04 puan ile (en yüksek 5.0) ‘Biraz Katkı’ seviyesindedir.

Bu çerçevede teknoloji öngörüsü, araştırma ve geliştirme projelerinin seçilmesi ve onaylanmasına; Bilim, Teknoloji, Yenilik ve öngörü konusunda farkındalık artışına; uzun vadeli planlama, teknoloji taksonomisi ve öngörü tekniklerinin kullanılması ile kültürel gelişmeye biraz katkı sağlamıştır.

Teknoloji öngörüsünün etkisini arttırmak için öngörü ve neticelerinin sahiplenilmesi, izleme ve değerlendirmesinin yapılması için sponsor olarak üst seviye bir kurul kurulması, Savunma Sanayii Müsteşarlığı’nın öngörünün başarısından sorumlu olarak görevlendirilmesi önerilmiştir.

Etki değerlendirme modeli Kabiliyet Olgunluk Modeline dayalı olarak geliştirilmiştir, makro seviyede uyarlanmasıdır. Süreçlerde aşamalı gelişmeyi sağlayan ölçme sistemi ve süreç alanı yaklaşımından faydalanılmıştır.

Anahtar Kelimeler: Teknoloji Öngörüsü, Değerlendirme, Bilim Teknoloji ve Yenilik, Program Bazlı Teori, Kabiliyet Olgunluk Modeli.

To my beloved daughter Özge and my husband Nejat for their ever lasting love and support.

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LIST OF ABBREVIATIONS

3ie	International Initiative on Impact Evaluation
BA	Behavioural Additionality
CI	Confidence Interval
CMM/CMMI	Capability Maturity Model/Capability Maturity Model for Integration
CoP	Community of Practice
CSF	Critical Success Factor
CTFP	Colombian Technology Foresight Programme
CVR	Content Validity Ratio
DAS	Defense AeroSpace
DIEC	Defence Industry Executive Committee
EC	European Commission
EERE	Office of Energy Efficiency and Renewable Energy
EFMN	European Foresight Monitoring Network
EU	European Union
FFF	Full Fledged Foresight
FOREN	Foresight for Regional Development Network
IA	Input Additionality
GUIC	Government-University-Industry Cooperation
KI	Key Indicator
KPI	Key Performance Indicator
METU	Middle East Technical Univeristy
MoND	Ministry of National Defense
MODSIM	Modelling and Simulation
MoSIT	Ministry of Science, Industry and Technology
MTP	Medium-Term Plans
NATO	North Atlantic Treaty Organization

NBC	Nuclear, Biological, Chemical
NDP	National Development Plans
NISTEP	National Institute for Technology and Science
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
OTA	Organisation of Technology Assessment
OA	Output Additionality
R&D	Research and Development
RTO	Research and Technology Organisation
SaSaD	Defense and Aerospace Industry Manufacturers Association
SAVTEK	Defense Technologies Congress
SCST	Supreme Council for Science and Technology
SMART	Specific, Measurable, Achievable, Reasonable and Timing
SECI	Socilization, Externalization, Combination and Internalization
SME	Small and Medium Enterprise
SSM	Undersecretariat for Defense Industry
STEPI	National Science and Technology Policy Institute
S&T	Science and Technology
SFM	Systemic Foresight Methodology
STI	Science, Technology and Innovation
STA	Science and Technology Agency
STO	Science and Technology Organization
SW-HW	Software-Hardware
SWOT	Strenght Weakness Oppoortunity Threat
TA	Technology Assessment
TAF	Turkish Armed Forces
TAFF	Turkish Armed Forces Foundation
TBMM	The Grand National Assembly of Turkey
TDZ	Technology Development Zones
TEP	Technology Foresight Programme
TF	Technology Foresight

TIKA	Turkish International Cooperation and Development Agency
TNoE	Technology Networks of Excellences
TOBB	The Union of Chambers and Commodity Exchanges of Turkey
TRL	Technology Readiness Level
TTGV	Technology Development Foundation of Turkey
TTM	Technology Transfer Mechanisms
TUBITAK	The Scientific And Technological Research Council Of Turkey
TUIK	Turkish Statistical Institute
UK	United Kingdom
UNDP	United Nations Development Program
UNIDO	United Nations Industrial Development Organization
USA	United States of America
USMOS	National Modelling and Simulation
WB	World Bank
YOK	Council of Higher Education

CHAPTER 1

INTRODUCTION

Foresight is a well known and widely used method to build mid-to-long term vision for technological, social and economic developments. It was first used in 1930s. The foresight term was used in future technologies, technology policy areas for the first time by Martin and Irvin in 1984. Since 1990, the number of national technology foresight projects has increased in Europe.

Foresight studies have been discussed in literature since 1990s and these exercises have focused more on design and execution of the foresight programs. However, the importance given to impact evaluation of foresight studies has increased after 2000s. Although there are many national foresight intervention programs, foresight evaluation exercises are very limited. UK, Germany, Japan, Korea and Colombia can be listed among the countries that have good history records in conducting national foresight programs and in linking the findings to follow-up programs and policy processes. Although, there are number of foresight exercises conducted around the world, there are no widely accepted evaluation or impact assessment frameworks. Therefore, foresight evaluation and impact assessment exercises and frameworks are still in the development phase.

In the literature, there are few evaluation studies conducted on Vision 2023 Technology Foresight which focus more on process and output evaluation of the foresight program. This thesis will provide an impact assessment scale, empirical data on the long-term (>13 years time lapse) impact of Vision 2023 Technology Foresight in a vertical industrial sector. Organisational structures and functions are recommended to increase the success of technology foresight intervention. An impact assessment model based on Capability Maturity Model Integration (CMMI) process area approach is developed. Process areas and tangible indicators are defined to benefit the measurement and staged process improvement framework of the model.

1.1 Research Questions

The first objective of this dissertation is to analyze and assess the (in)direct, positive or negative and (un)intended impact of Vision 2023 Technology Foresight on Science Technology and Innovation (STI) polices and decision making in defense sector. The second objective is to develop an assessment model to be implemented in the upcoming foresight studies and long term planning activities. The research is bound to explore three essential questions:

1. What are the quantitative or qualitative methods used to assess the ex-post impact of technology foresight?
2. What is the (in)direct, (un)intended, positive or negative impact of a technology foresight exercise?
3. What is the ex-post long-term impact of Vision 2023 Technology Foresight in defense sector and what are the impact levels?

At the beginning of the this study, pre-interviews were carried out with 14 professionals, experts, scientists and senior decision/policy makers from defense industry, universities and government organisations to understand if there is a need and an interest in this topic. 7 people set the core group I have consulted throughout this study, starting from defining impact variables to selecting participants of interviews and the focus group. During these pre-interviews, the need for evaluation and assessment of the technology foresight program was brought up as a much delayed study. Some interviewees were quite positive, and some were negative regarding the impact of Vision 2023 Technology Foresight. Additionally, in the literature there are studies indicating experts’ perception patterns of foresight impact on policy making differ by their age, institution, participation in foresight exercises, and the Science and Technology (S&T) areas of their expertise or occupation. The changes in the views of interviewees on impact of Vision 2023 Defense Aerospace

(DAS) Technology Foresight and the information obtained from literature review directed me to expand the analysis further to cover if there is statistically significant difference in the impact perception of the stakeholders. Based on this pre-research, main objectives of the research and hyphotesis are formulated as:

1. What are the assessment methods used to measure the impact of technology foresight?
2. What are the ex-post impact and impact level of Vision 2023 Technology Foresight in defense sector?
3. Are there significant differences in the impact perception of the stakeholders?

Hypothesis: There is statistically significant difference in impact perception of stakeholders by their information level on the Vision 2023 Technology Foresight, and by their age, institution, and company type (public or private company).

1.2 Organization of the Dissertation

Chapter 2 includes highly comprehensive theoretical information about foresight, evaluation and impact assessment. Based on the literature review, analysis of foresight definitions, generations, goals, underlying theories, processes and critical success factors are examined under the heading ‘foresight’. Evaluation and assessment, the differences and relations are analysed under the heading ‘evaluation’. The terms evaluation and assessment are sometimes used interchangibly, although there are significant difference between them. In order to clarify this misconception, definitions, scope, rationales, quantitative and qualitative evaluation methods, approaches, and frameworks of evaluation and assessment, and aspecially technology foresight impact assessment are extensively reviewed through an extensive literature study. Answer to the first research question is analysed in this chapter. Briefly, this chapter provides the therotical background information in the context of evaluation, assessment and technology impact assessment. The selection criteria of the evaluation theory, methods, and impact assessment frameworks will be applied to the thesis research is analysed in this chapter.

Chapter 3 presents examples of national technology foresight evaluation and assessment exercises around the world. Evaluation goals, methods, criteria, and results of these exercises are analysed. The findings are presented at the end of the chapter. The results were used as input to develop an impact assessment model and develop recommendations. Evalution studies covering Vision 2023 Technology Foresight are also presented in this chapter.

Chapter 4, Turkey's endeavour of S&T policy is reviewed. Turkey's long-term planning efforts, mid-term policies, and S&T policies are examined. The success and failure of the STI policies are reviewed. Especially evolution of the defense sector, defense layer of national STI system, and long-term planning efforts in regard to S&T is analyzed.

In chapter 5, the research methodologies, techniques, and tools used in this study are explained. The impact assessment is based on Program-Theory-Based Evaluation approach, and Program-Logic Model is used. Due to difficulty in defining "attributions" and finding tangible indicators, "contribution" of the foresight to the impact is questioned. Through the document analysis, tangible impact of the technology foresight in defense sector is researched. Quantitative and qualitative techniques are both implemented in the research. Document analysis, in-depth interview, focus group and survey techniques are applied to define impact types, impact, and to develop impact assessment scale, to develop a new STI vision for the sector, and to develop recommendations. Interview data is analysed with Microsoft Excell software program. Survey data of the impact scale is analysed with SPSS software tool. Methodologies are explained in detail with underlying theories.

Chapter 6 includes an evaluation and interpretion phase of the findings. Based on the outputs of quantitative and qualitative research, an impact assessment scale is developed, impact, and impact levels are measured. A technology foresight impact evaluation model is developed based on process area concept of CMM/CMMI by combining process and practices executed throughout the research. Key indicators are defined as measures to monitor and assess the realization of foresight objectives. An organisational structure is recommended to increase the impact and sustainability of technology foresight. At the end of the chapter, the findings are discussed by comparing the literature. The last chapter is devoted to conclusions, policy implications including policies and policy tools, and possible future studies.

CHAPTER 2

TECHNOLOGY FORESIGHT, EVALUATION AND ASSESSMENT: THEORETICAL BACKGROUND

It is obvious that mankind has always been interested in the future and they have tried to predict the potential changes in life. To this end, forecasting of future technologies were the focus of 50s and 60s which was the cold war era of World War II, especially for defense purposes. Formation of a collective and participative foresight is a relatively new practice. Foresight covers a wide swath of issues and associated with policy making and decision making. Impact of science and technological developments on economy, welfare, globalization, and increasing importance of knowledge economy, and increasing compexity of the societies and systems in the world are the drivers of wellcoming foresight experiences.

2.1 Technology Foresight

Foresight in the early years was used especially in technology areas and for the forecast of technological developments. Foresight studies give direction into Science, Technology and Innovation (STI) systems to realize their goals. Foresight studies lead to definition of investment priorities and expansion of the swath of stakeholders having interest in STI polices. Foresight exercises are important instruments to monitor and assess the impact of STI policies. Foresight studies are being carried out in more than 40 countries including USA, Japan, South Korea, Germany and China (Figure 1). Until today, Japan has conducted its 9^{th}, Korea its 4^{th}, Germany and England their 3^{rd}, and Colombia its 2^{nd} foresight study.

According to European Foresight Monitoring Network (EFMN) report published in 2009, policy advices are the most used technology foresight output. Trends and

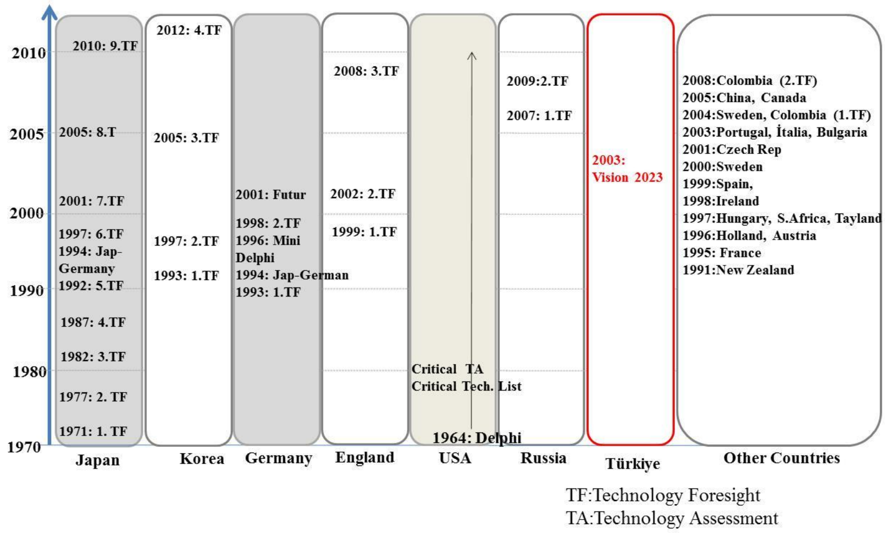


Figure 1 Foresight exercises around the World (Author elobrated)

driving forces analysis reports are the second most used outputs of the foresight exercises. Scenarios are the least used products.

2.1.1 Evolution of technology foresight definitions

Definition and context of foresight has changed and evolved in time, as it was implemented to meet the needs and expectations. In literature, 'foresight' and 'technology foresight' is used interchangibly. Foresight term was first used by H.G.Wells in 1930s. The focus of the terms differentiated in the early uses of Irvine and Martin in 1984 and Coates in 1985.

The first definition of Technology Foresight term done by Martin and Irvin in 1984 is;

Technology Foresight is a process which seeks look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research and the emerging generic technologies likely to yield the greatest economic and social benefits (Martin, 1995, p.140)

Foresight is defined as *"a process by which one comes to a fuller understanding of the forces shaping the long-term future which sould be taken into account in policy formulation, planning and decision making…*" (Coates, 1985, p.343).

As seen from the early definitions, the key concepts are process, long term study, impact of S&T to society and economy, and socio-economic benefits. The following aspects and details are added to the concepts and definitions by time as shown in Table 1.

To summarize, specifications and ground principles of technology foresight are systematic, participative, future oriented, interdisciplinary, evidence based, process, building networks, shared long-term vision, joint ownership, focus on creation of knowledge, coordination and transform of knowledge into activities. These key words of foresight definitions, goals and objectives will be used as guiding tools and codes in the design of an impact assessment scale for Vision 2023 Technology Foresight in defense sector.

2.1.2 Foresight generations

Throughout its evolution, the definition of foresight has categorized under different generations. The generations are based on differences in goals, focus, actors, program structure and evaluation criteria (Georghiou, 2001, 2003; Georghiou & Keenan, 2006, 2008; Harper, 2013a):

- First generation: Definition of foresight only covers the technology perspective and deals with the accuracy of technology forecast and technology diffusion.
- Second generation: Market perspective is included to the scope. Interaction of participants from industry and academy is the main issue.
- Third generation: Social perspective is included to the context. Participant breadth and coverage of social issues are taken into consideration.
- Fourth generation: Definition of foresight is expanded further to cover innovation ecosystem. Role of actors shifted from central to distributed structure. Coordinating role among instutions is adopted instead of commanding role.
- Fifth generation: Policy issues in STI systems, learning, and behavioral additionality are the focus.

Table 1 Evolution and codes of foresight definitions

Author (s)	New Specifications (Key Words) Added to Foresight Definitions
(Irvine & Martin, 1984)	• Process • Long-term future • Science, technology, economy and society • Identification of research areas • Identification of emerging generic technologies • Socio-economic benefit
(Coates, 1985)	• understanding forces shaping future • policy formulation, planning & decision making
(Martin & Irvine, 1989)	• systematic • plausible future • prioritising • facilitating, enabling policy making
(Luke Georghiou, 1996)	• industrial competiveness • welfare creation & quality of life
(Slaughter, 1999)	• Ability • Forward view • Guiding policies • Shaping strategies • exploring new markets, products & services
(FOREN NETWORKS (IPTS, PREST, CMI, 2001)	• participatory • mobilizing joint activities
(Rémi Barré, 2001)	• collective learning; • interaction among industry, academia, government instutions, public and social actors; • diffusion of strategic intelligence among actors; • emergence of hybirid networks; • building joint agenda;
(Miles & Keenan, 2002)	• informing todays decisions • mobilization of joint activites
(Salo & Cuhls, 2003)	• policy intelligence tool • alignment of R&D to social needs; • focus in R&D cooperation; • coverage of public policies and social problems
(Miles & Keenan, 2003)	• Participative process; • building networks (different socio-economic partners) • ties with decision making agenda • engagement of networks with decision making agendas
(Harper, 2003)	• consultation & discussion • joint ownership of strategies • exploration of joint space for open thinking on future
(Keenan et al., 2007)	• Evidence based • interdisciplinary
(Popper, R., Georghiou, L, Miles, I. and Keenan, 2010)	Fully-Fledged Foresight (FFF): • Long-term opportunities, alternative futures • Participative networks • Directing policies
(European Foresight Platform, 2017)	• Open • Participatory • Action Oriented
(Samet, 2012)	• Relation with business & management
(Piirainen & Gonzalez, 2015)	• Social process & intervention • Creation of knowledge • Transform of knowledge into activites

In real world foresight generations exist at the same time, not sequentially. According to another classification, foresight programs are grouped under three categories (Havas, 2011):

- Type A: S&T issues are the focus. It is about forecast of technology and technological developments, extrapolation of percieved trends.
- Type B: The focus expanded to cover techno-economic issues. Empowering the relationship between industry and academy increases the competitiveness and extends business horizon.
- Type C: Socio-economic issues are included to the context. It involves government employees and non-governmental organizations as stakeholders, in addition to academicians and business people.

In applications three generations exists together.

2.1.3 Foresight, Technology Assessment and Future Studies

In literature there are different names for future-related studies. Based on the differences in the context, they are referred as foresight, technology foresight, technology assessment, future studies, future research, horizon scanning and a variety of foresight. In order to eliminate confusion throughout this dissertation, each concept is explained briefly.

Technology Assessment (TA): TA was used for the first time in USA in 1960s. In 1990s, it became an important tool for sustainable development and technology management. The first definition of TA is "*...the sytematic study of the effects on society, that may occur when a technology is introduced, extended, or modified, with emphasis on the impact that are unintended, indirect, or delayed.*" (Coates, 1976, p.372). The meaning and definiton of TA has changed by time as summarized below:

- TA has four schools which are regulatory, promotional, constructive and experimental, and participating.
- TA has a systems approach for the technology management and extends beyond technology and industrial aspects into society and environmental areas. It is focused on risk assessment of technologies, its effects and consequences. TA is

an input to strategic planning, and also a forecasting function looking into the opportunities and skills development. TA is a consensus building and policy process.

- TA has been evolved to foresight analysis tool customized for users (Porter, 1995).

TA process is defined as monitoring emerging technologies to determine TA timing, organizing TA, updating information and projection as new information was received and curiosity increased. TA covers decision support, policy options coming from early warning intelligence knowledge. TA is defined with a system perspective as well.

Future studies and horizon scanning: In literature, studies related with future are named as ‘future studies’, ‘future research’, or ‘horizon scanning’. Definitions slightly differ from each other. Future Studies try to understand and catch potential developments, and the development of policy options which would shape plausible future and society vision (Slaughter, 1999, 2002). Futures Research is bounded with environment and geographic, infrastructure and socio-technic systems. Futures Studies are social, political and economic science (Samet, 2012). Future Study areas focus on methodological exploration of what future could be, and Horizon Scanning is a systematic information gathering method about the issues which would impact future (Bourgeois, 2014).

Similiarly, there are several types of foresight as well. These are strategic foresight, participatory foresight, operational foresight, political foresight, consumer foresight, competitor foresight, revolutionary foresight, transformative foresight, innovative foresight. These foresight types could be defined as focused and confined to policy, consumer, customer, competitor, etc., contexts.

Strategic foresight is the closest to the foresight definition. Briefly, it is expanding of perception boundaries, expanding awareness about the emerging issues and situations. The process is analysis of information and early perception, production of foresight information for the development of policy options of future. It is also defined as integration of trend analysis and future studies (Slaughter, 2002).

2.1.4 Goals and benefits of foresight

According to Martin, the goal of foresight is the systematic exploration of alternative futures. Benefit of foresight process is defined as 5Cs which are communication, concentration, coordination, consensus and commitment (Martin, 1995). Outstanding common goals of foresight projects are; Participation of new stakeholders to strategic debates; establishment of new networks and connections around sectors, areas, markets and problems (Georghiou, 2004); Strengthening STI cooperation and networks, formulation of policies and direction of decisions, identification of STI challenges and drivers, incentives of strategic and future-oriented thinking, identification of research investment opportunities, creation of vision and imagination of future, support to cope with barriers, stimulation of activities and support to be discussed by public (Georghiou, 2004; Popper et al., 2007; Butter et al., 2009). The further contributions to the discussion are; Increase of public awareness about new science and future technologies; Meeting increasing expectations of public for participation and transparency in decision making; Increase of trust among policy makers, business and government instutitions; Increase in commercial success of newly developed products (Cagnin, Loveridge, & Saritas, 2011). Main and sub goals and objectives of foresight are outlined by Calof and Smith, (2010) as given in Table 2.

The first main objective of foresight is to increase the social and economic welfare by providing economic growth, national competitiveness, developing an understanding and increasing interaction between society and technology. The second main objective of foresight is the definition of priority areas of S&T for technology policies. It is focused on S&T to align with the first main objective. The sub-objectives are the technological developments in prioritized areas, stimulation and increase of R&D in these areas, benefiting from interaction among technologies, industrial competitiveness and allocation of funds for R&D.

Table 2 Objectives of foresight

Main Objective	Sub-Objectives
Increase of social and economic welfare	• Economic growth and national competetiveness • Social welfare covering environment, culture, social, economic factors • Identifying solutions for problems focused to needs • Understanding interaction between society and technology (Tetrad model)
Definition of priority areas for technology policies	• Research of national technological developments • Stimulation of R&D in priority areas • Understanding of interaction among technologies and obtaining gain • Allocation of funds for research and industrial competitiveness
Development of technology and innovation policies	• Development of cooperation among different stakeholders • Development of technology polices and applications • Application of foresight and understanding of best methods

Source: (Calof & Smith, 2010)

After defining the S&T priority areas, the STI policies need to be defined and developed to realize the first and second main objectives. The third main objective of foresight is the development of STI policies. The sub-objectives are the development and increase of cooperation among stakeholders, development of STI policies, and development of a foresight capacity, application of foresight and implementation of the best methods.

Briefly, the main objectives are defined and aligned in a way that, ultimate objective is to increase the socio-economic welfare of the nation through defining and prioritizing S&T fields and then, designing STI policies, and in turn, enabling the STI policies to benefit the nation in terms of power and leverage for the transformation to knowledge-society.

2.1.5 Foresight cycle, scoping elements and foresight methods

Foresight cycle consists of networking, consulting, debate, joint development of future vision, joint commitment to realization, out-of-the-box thinking about future

and incubation of strategic decisions. Foresight process has five phases which are pre-foresight (scoping), recruiting, generation, action, and renewal (Miles, 2002).
The pre-forsight phase is the starting point of the process. Preforesight activities are called as the scoping phase or the design phase. Pre-foresight phase deals with the schedule of foresight exercise, horizon, methods to be used, information resources, identifying stakeholders and having them involved in the exercise. It draws the boundaries of the context of the foresight exercise. These decisions affect the knowledge which will be produced throughout the foresight.

Twelve elements of preforesight activities are grouped under two categories as framing conditions and context decisions (Keenan & Miles, 2008). Framing conditions are locus, environment, rationale, resources. Context decisions are coverage, time, organization and management, participation, diffusion, methods and application. Locus is the foresight level as national, regional, local, or political, economic or social. The environment is cooperation culture, long term thinking culture, existence of policies to think upon strategic developments in the future. Rationale is the reason of foresight exercise, and its objectives, time and outcomes. Resources are financial, human resorces, infrastructure, cultural resources, and political support. Coverage is the sector, issue or problems will be covered by foresight exercise. Time is the horizon which foresight is looking into a time frame that is for 15 or even 30+ years. Organization and management is the steering committees, expert panels, etc. Participation is the involvement of stakeholders in the foresight exercise. Diffusion is the spread of foresight products to stakeholders who are not involved in the foresight exercise and the transformation into messages receivable by these stakeholders.

Recruitment phase is the activities of analysis and decisions for determining stakeholders and key sources of information to generate knowledge and the carriers of the foresight to wider communities. Generation phase is the creation of new visions and images of the future through analysis of existing knowledge and transforming tacit knowledge to explicit knowledge, in other words, implementing knowledge-creation theory. Action phase involves decision-making and prioritization activities. Development of policy instruments, generation of

technology roadmaps and scenarios are the outputs of this phase to disseminate the future vision, underlying thinking and knowledge, and increase the awareness.
As for the final phase, the renewal phase is the continous monitoring and evaluation process to assess the effects of foresight process to the realization of objectives and to what extend results are achieved. Renewal and action phases are about transformation. The main challenges of the process are the development of success indicators. Monitoring of linkages, drawing causality of events and results are other challenges of the process.

The ways of realization of objectives are management of expectations through foresight and planning of how to present the results. Foresight products' action plans are the list of solutions, derived from foresight for the problems. It defines activities, responsible actors and agents, and identifies success indicators to monitor developments and to measure the degree of success. Especially identification of key activities, objectives and responsible agents is vital. It is important to link activities to responsible actors. Objectives should be SMART (Specific, Measurable, Achievable, Reasonable and Timing). Involvement of decision makers to the foresight process eases to link actors to activities. In the management of expectations, the benefit of foresight should be defined and transferred explicitly in the scoping phase. Information should be avaliable in the forms that stakeholders could analyze. The feedback obtained from this process will provide input information to the modifications of expectations. Realization of foresight objectives is a demanding task and should be followed by activities (Keenan & Miles, 2008).

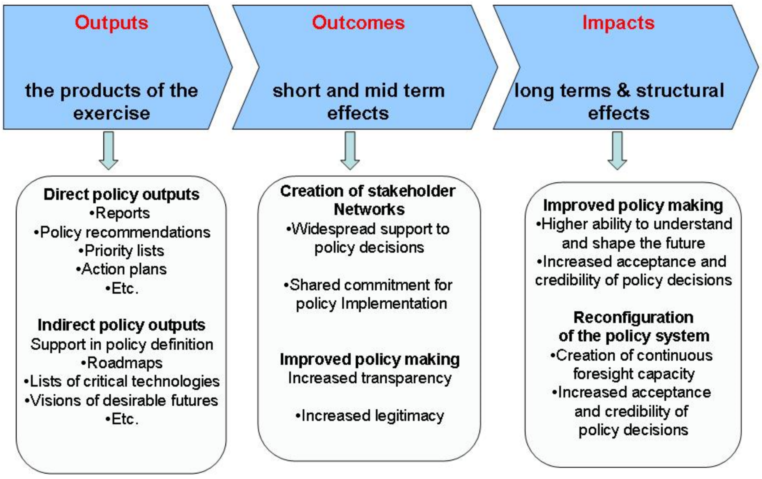
The foresight cycle developed by (Miles, 2012), proposes the execution of activities as they may overlap and foresight elements are repetitively used in different phases. Different quantitative and qualitative methods are used in different phases of foresight cycle. The methods such as interviews, brainstorming, workshops, scenarios, expert panels, logic graphs, benchmarking, and impact analysis contributed to the renewal phase the most. Applications could be product-focused foresight (reports, plans, roadmaps, critical lists, etc.,), process-focused foresight (building networks, information exchange) or both in balance.The methods used in all phases of foresight are mapped in Foresight Diamond based on information source, techniques (quantitative-qualitative), and approach (exploratory, formative) of the method type (Popper, 2008).

2.1.6 Foresight Outputs, Outcomes and Impact

Foresight exercise outputs, outcomes and impact given in Figure 2 are different from each other and are realized at different time periods. Outputs are more tangible products and obtained at the immediate time frame of foresight exercise. Outcomes are more related with foresight process and commitment of application of policies. Impact is observed when the outputs interact with economy, society and culture. Therefore, impact is actualized with transformation of outputs to application plans and adaption of policy measures.

Outcomes and impact could be more intangible and unintended. They are derived from foresight process and go beyond expectations or change from the headed directions. Long term impact are about the realigment of the system, a major change in the way of thinking and policy approach or start a new direction (Harper, 2013a; Havas, Schartinger, & Weber, 2010).

The most important goal of foresight at macro level is the realization of foresight program impact through policies. “Impact” and “sustainability” are the most dominant criteria for the success of foresight. Impact of foresight is long-term and structural effects, which focuses on policy making and policy system. Improve policy making impact means development of the understanding and ability to shape the future, increased ownership of policy decisions and development foresight capacity.



Source: http://www.foresight-platform.eu/community/forlearn/why-do-foresight/ functions)

Figure 2 Foresight outputs, outcomes and impact

Secondly, reconfiguration of the policy system impact provides the continuity of the foresight capacity and increased ownership and credibility of policy decisions. This is the impact on the policy system providing the "Sustainability" success criteria of the foresight.

2.1.7 Foresight, Systems Thinking and Systemic Foresight Methodology

As the technology changes at an accelerated speed, the world is becoming more connected, interdependent and complex than ever. It is a complex system of sytems. Foresight shapes the world through policies as it is shaped by the developments. New generation foresights need to understand the complex system with its structure and behaviours to be able to respond it. New generation foresight requires a systems thinking notion. The systems concept has been added to foresight definitions. Systematic thinking uses the terms and ideas of system discipline as input, process, output, elements, relations, feedbacks, boundaries, communication. These concepts are the main features of systematic thinking. These main features are causality, holism, hierarchy and continuity. Foresight learns evolves and intervenes the systems through norms, policies, and modification of objectives. Context (inner and outer), content and process of foresight study should be interactive among each other and have the arrangement skills. Foresight has open and soft system characteristics with involvement of different actors and stakeholders and interaction with other systems.

Systemic Foresight Methodology (SFM) provides a conceptual base for the design, organization and application of foresight. SFM is used for the understanding of context, development of alternative future models and networks, transforming outputs to policies and strategies through building joint vision and joint learning, and thus achieving outcomes. SFM cycle consists of intelligence, imagination, integration, interpretation, intervention, and impact phases (Saritas, 2013). Intelligence phase provides input to overall activity. Comprehensive understanding of situations, issues and influencing factors, systematic analysis of threats, opportunities, trends and future developments are parts of intelligence phase. Imagination phase requires creativity and innovative thinking. It is the development of future models (possible, plausible, and desirable future systems) to cexplore alternative images of future. Interpretation phase is the development of strategic level decisions and strategies to transform present systems to future. Intervention is the action phase of creation plans, policies and activities required for the transformation. Activity plans, operational plans, critical technology lists, priority lists, roadmaps are the outputs of this phase.

Impact phase is the review, evaluation and renewal of the foresight. Impact through the process is generation of reports, building vision, creation of new connections; later on new projects and programs, and quite time later new groups and innovation effects. Impact should be considered at the beginning of the foresight process and the methodology should be designed to realize this impact. Impact is measured against three criterias:

- appropriateness of objectives and methodology,
- efficiency of foresight application and proper use of funds. It is focused to process organization and management,
- impact and effectiveness, understanding of results, creation of foresight culture, and generation of networks.

Impact phase brings a strong learning element into the foresight process and defines how to design a better foresight exercise and implementation.

2.1.8 Foresight Theory Development Studies

Foresight is beyond forecasting future, it is about shaping future. In studies, foresight is based on different theories. According to Foresight Theory Pyramid approach foresight, analysis is defined at three levels which are the creation of foresight knowledge, foresight process, and the development of theories about the future of a socio-economic system (Piirainen & Gonzalez, 2015).

The first level is the knowledge creation activity of foresight. Knowledge creation is the epistomologic perspective of foresight. It is focused on how to generate future related information. The second level is the foresight as process which leads to social and organizational intervention. It is focused on efficiency of foresight activity, how to design a better foresight, and its expected impact and casualities. Theory development about the future of socio-technic system is the third level.

According to another study about foresight theory, foresight is analysed at three levels (Amanatidou, 2014). These are building knowledge, building networks, and building participation and action. Knowledge building leads to the production of knowledge which is evidence based, participatory, multidisciplinary, increasing joint learning, covering strategic vision and alternative futures. Building networks is the joint production process of stakeholder communities, and tool for dialog, debate, cooperation, transformation, and alignment of stakeholders. Building participation and action is the third level of the theory. At this level more stakeholders and their insights are involved into decision making processes, informing today’s decisions, shaping behaviours and rutins to set tangible steps toward the realization of jointly developed vision.

In both approaches, the first level of foresight theory, the unit of analysis is the knowledge creation. It is based on knowledge creation theory - Socilization, Externalization, Combination and Internalization (SECI). In both approaches second level is an interactive, participative and joint production process of foresight. The third level, although there is difference between definitions, it is about development of decisions, behaviours and rutins which effect realization of future vision.

2.1.9 Success of Foresight and Critical Success Factors

The most important goal of foresight at macro level is the realization of program impact through policies. It is difficult to provide sustainability of foresight without its positive and observable effects on policies. Therefore, impact and sustainability are two dominant criteria of foresight success. Eight Critical Success Factors (CSFs) of government-led foresight programs are defined (Calof & Smith, 2010) as follows;

1. Focus on clearly identified client: Clearly identification of user of foresight results and responsible from success of foresight.
2. Clearly linking foresight to policy agenda: The use of technology foresight methods to link between foresight and government actions.
3. Linking with senior policy makers directly: Setting strong links with senior policy makers for bi-directional understanding the needs.
4. Public-private partnerships: Integration of private sector actors into national policy and decision making processes in collaboration, co-operation, and consultation forms.
5. Development of new methodologies and competencies: Development and implementation of methodologies and skills which were not exploited fully by other agents.
6. Development of strong and open communication strategies: Setting communication strategy to keep stakeholders aware and informed of foresight objectives, planned and ongoing projects and activities.
7. Integration of stakeholders to foresight program: Integration of key stakeholders into technology foresight process.
8. Development of an academic receptor capacity: Development of a capacity on foresight domain.

The challenge in convincing government requestor and authorities for the renewal of foresight is to justify and demonstrate the value of foresight initiative. CSFs are part of impact assessment, ex-ante, in-process and ex-post (immediate, intermediate, ultimate) evaluation.

2.2 Evaluation and Assessment

Throughout the life cycle of every planned project or program that has specific goals, evaluation should be done and be part of the management system. The problem is the existence of different views and applications about what the evaluation is and how it should be carried. Especially there are differences in evaluation methods of projects and programs when the goals are defined in the long-run, huge budgets are allocated, and wide-breadth of stakeholders is affected. There are studies defining the essentials of the evaluation and impact assessment of international aid programs or huge investment programs. The guidelines and reports of World Bank (WB), International Initiative on Impact Evaluation (3ie), Asia Investment Bank (AIB) are used as reference in the evaluation of projects funded by them.

2.2.1 Evaluation and Assessment definitions

In the field of evaluation, the gap is blurred between terms especially for the long-term *results, outcomes, and impact,* and the terms are used interchangeably. The terms mostly used in evaluation are; *effect, efficiency, productivity, effectiveness, evaluation, result, output, outcome, impact*. It will be helpful to draw the boundaries of the terms by giving the definitions at the beginning of the study, and to show how they differentiate at different sources.

Effect is the change caused by an intervention. This change could be intended or not. Change could be caused by the intervention directly or indirectly. *Impact* is defined as the long-term effect caused by intervention, it could be primary or secondary, direct or indirect, intended or unintended, and positive or negative long term effects. *Effectiveness* is the degree of realization or not realization of the intervention goals based on their relative importance. *Effectiveness* deals with outputs and results. It is the realization of results above expected output. *Evaluation* measures the effectiveness of an ongoing program for the realization of its goals in order to distinguish program effect from other reasons, it is based on project design standarts and aims to improve the program through process modifications (TİKA, 2007). Evaluation is systematic and objective assessment of continuing or completed project, program or policy. It is the identification of objectives, development efficiency, effectiveness, impact and sustainability and its relevance. Evaluation should provide credible, usefull information, and lessons-learned to be applied to decision making process of the parties who execute the project, program and policies. Evaluation is the process of identifying the value or importance of activity, program or policy. Evaluation is the objective and systematic assessment of planned, continuing or completed intervention (OECD, 2010).

As evaluation covers the end-to-end phases and time frame of project or program, impact counts the long-term effect caused by the intervention. Evaluation provides credible information and lessons-learned to improve the program, influence the policies and applications. Evaluation is more valuable if it is part of the learning process. Impact provides the proof to continue the program. By definition, the relation between impact and evaluation is, impact is the sub-criteria of evaluation.

2.2.2 Evaluation Types

Evaluation differs according to different phases of intervention project. Evaluation types are *ex-ante evaluation, ex-post evaluation, program evaluation, process evaluation, outcome evaluation, impact evaluation, and cost-benefit evaluation*. *Ex-ante evaluation* is performed before implementation of the intervention (OECD, 2010). It aims supporting decision-making activities to decide whether the project should be implemented. It is the planning phase and a formative evaluation (active, shaping, constructive concept (Cuhls, 2011). It concerns with design of intervention project, definining project objectives and the ways they will be achieved (Polt & Rojo, 2002). *Ex-post evaluation* is the evaluation type done after intervention is completed (immediate or long time after (OECD, 2010). *Program Evaluation* is the evaluation of performance in every phases of a program. Program evaluation types differ according to program phases (development, application or completed). *Process Evaluation* is the evaluation of the process application if it is applied as planned or operated as it is aimed and identifies improvement and development opportunities. It evaluates efficiency and effectiveness of program application process (EERE, 2006). *Outcome Evaluation* is the evaluation of intended and unintended outcomes of the program, and identifies the reasons of the difference between predetermined goals and outcomes. It analyzes the reasons of the difference of outcomes than determined goals and targets, and evaluates outcomes, achievement of goals and targets. Findings indicate how successfully program objectives were achieved in a specific time frame (EERE, 2006). *Impact Evaluation* is a subset of outcome evaluation. It evaluates the relation, causality between program activities and realized outcomes. It is the benchmark of observed results (intended or unintended) with the forecasted values in case of absence of the intervention. It evaluates the contribution of intervention to observed results. *Cost-Benefit Evaluation* compares the benefits and cost of the program. It shows the difference between the cost and results of program and the cost of the realization of this benefit (EERE, 2006).

Effective evaluation of program leads to improvements in the program and to obtain better results in the future. Evaluation should influence policies and applications (Carol Hirschon Weiss, Murphy-Graham, & Birkeland, 2005). Goal of evaluation is to measure the effects of program against the goals which are set out to be accomplished by means of contributing to subsequent decisions about the program and improving future programming (Carol H Weiss, 1972). People who makes evaluation, first of all should understand the program and its operations. Evaluation should be part of learning process. Learning differentiates evaluation from audit, performance management. It should be designed to be used by policy makers, stakeholders, and applicators (Patton, 2001).

A good impact evaluation provides information, evidence about the mechanism leading the outcomes to be achieved. The integrity, quality, credibility of the impact evaluation is enhanced if it is done external and independent. Goverments and organisations should strength their internal and external monitoring systems, dedication for resource allocation to impact evaluation, improve standards for evidence, access to knowledge, and build capacity for impact evaluation (Savedoff, Levine, & Birdsall, 2006).

Evaluation is a participative process designed to define how well a program or project is completed. Evaluation is always test of established or experimental variables or indicators and benchmarking of the application with these standards. Result of evaluation provides information for managers to continue of the program as it is, expand or limit the expenses or to halt the program.

2.2.3 Impact Evaluation and Impact Assessment

In recent years the interest in impact evaluation has been increased. This change shows the shift of focus from inputs to outcomes. Impact assessment is defined as the effect partially or fully caused due to intervention. Different definitions are in use for impact evaluation. Differences in definitions do not mean that one of them is true or wrong, it is about the difference in meaning. Impact evaluation deals with outcomes or impact not with inputs, activities and outputs. It tries to attribute the outcomes and impact to a specific program. It does not only monitor the change in results, it uses techniques related to attribution problems. Impact indicators could be effected by events other than the subject intervention project or program. Impact evaluation is the establishment of causality link between interested results, impact variables and intervention project. Impact assessment which falls under impact evaluation, deals with outcomes and impact, and rely largely on qualitative approaches (White, 2010).

In impact evaluation quantitative and qualitative approaches are implemented. The techniques used in impact evaluation are *counterfact analysis, comparison of groups project applied and not applied, comparison group method (comparison of group at pre and post of intervention); and qualitative techniques*. C*ounterfact analysis* technique is used in quantitative evaluation. It requires the guess of the case, in absence of the intervention. Aim of quantitave impact evaluation is to guess the latent counterfact results and outcomes. *Comparison of group at pre and post of intervention technique* is the comparison of results on the group before and after the intervention. *Comparison of groups project applied and not applied* technique is the measurement and comparison of results on the project applied group and the project not applied group (Asian Development Bank, 2006). WB requires counterfact analysis for impact evaluation (Kappor, 2002).

In qualitative method counterfact analysis is not used. It is based on understanding the process, observation of the behaviours, and conditions of the change. Review of project application process, interview with beneficiaries of the project to gather insights, focus group meetings and secondary data analysis techniques are used to make an inference.

The trend in impact evaluation is to attribute the change in the selected results to the specific intervention. Quantitative method is more appropriate to link results to intervention project. However, qualitative evaluation techniques are started to be widely accepted, since it gives more information about intervention project and in-depth information regarding observed qualitative analysis results. It is suggested that quantitative and qualitative techniques should be used together.

There are two types of assessment, *formative and summative*. These terms are more common and used in assessment of education. *Formative Assessment* is a tool used throughout the project. At different points of the project, it is used to structure or modify the project in order to realize the vision and program activities. *Summative Assessment* evaluates the success of the project. This type of evaluation is carried to judge the effect of project after it is used. ‘Impact assessment’ and ‘summative assessment’ could be seen as synonymous. *Impact assessment* is a management support tool to obtain program goals better (Cohen & Gaile, 1998).

2.2.4 Program Theory Evaluation Approach

Evaluation theory and applications has started to develop since 1950. Use of program evaluation has been increased in 1990s by instutions to increase the value, quality and competitiveness of the services. Client Centered Responsive, Utilization Focused Evaluation, Outcome Value-Added Assessment, Case Study, Program Theory-Based Evaluation, Mixed Methods, Benefit-Cost Analysis are counted among the most applicable and useful program evaluation approaches. The different evaluation methods are used for program evaluations based on their goals, strenghts and weaknesses (Stufflebeam, 2001).

Program theory-based evaluation starts with a well defined and validated theory or development of a theory in the scope of program under evaluation. Many program evaluations start with development of theory that will be guiding throughout the evaluation. Development of the program theory helps understanding of program activities which produce the program outcomes, defining the context, identifying observable and latent variables, and help to reveal of relations. The main goal of theory based program is to define a sound program theoretically, understand success and failure reasons, and to show ways to improve program. The questions used in program evaluation are derived from this guiding theory. Successess of theory-based evaluation depends on how sound is the theory development and its validation. Therefore, program's logic model is developed for theory based program evaluation. Program's logic model is the detailed flowchart of how inputs processed and transformed to plausible outcomes. Program evaluation starts with the research of the existence of program plan and program theory. Development of program model could be more appropriate to define measurement variables.

Distinguishing features of program theory based evaluation: It directs improvement of the program and identifies causality relations of the program, evaluates theoretical soundness of the program. It directs evaluation questions. Strength of the theory is it generates information about program and how outcomes are generated. If evaluation is based on insufficient program theory, it could turn to a never ending theory development exercise (Treasury Board of Canada Secretariat, 2012). Positive features of program based theory are: It is used in where experimental aproaches could not be applied; evaluators and program managers provide insights about program contribution; program based theory helps to understand of program and to draw causality releations; it focuses on areas where information needs to be collected. Challenges of program based theory are measurement of contribution with quantitative tehniques, difficulty in developing a change theory, requirement of time and huge amount of data to develop the theory, and may be the emergence of more than one theory.

Theory based approach is referred under a variety of names as change theory, program theory, program logic, impact pathways, change pathways. Programs are generally complex and require a program theory for evaluation. Program theory illustrates causality linkage of program inputs to observed outcomes. Change theory consists of logic model, assumptions, risks, mechanisms of relations in logic model, experimental data supporting assumptions, external factors effecting expected results. Change theory is an open roadmap for change, defined as logic model. It is a visual mapping technique to show link between initiative strategies of change theory and outcomes.

More than 20 years, the theory based approach is in agenda in an increasing way, in how intervention is designed, identified, measured and evaluated. Along with positive features of theory based approach, unfortunately it is difficult to use it, if there is not an explicit or embedded theory that program is based on, or if the program changes over time. Theory based approach is debated in evaluation literature for a long time, there is little consensus on terminology and concepts, but there is consensus on the value it provides (White, 2010).

The observed results could be due to many other reasons beside intervention. It is almost impossible to find the reason causing the observed results of the program, to link the results to causes, to illusturate point to point causality. Therefore, instead of finding the attributes causing observed results, contribution of the program to the results, and in what way this contribution is provided are investigated, and analyzed. Since counterfact comparison technique could not be implemented in the thesis, it is tried to understand the contribution of the program to the results.

2.2.5 Behavioural Additionality

Behavioural Additionality (BA) concept is relatively new compared to Input Additionality (IA) and Output Additionality (OA). Input Additionality (IA) deals with the additional increase in R&D expenses of the organizations from their own funds, as return to each net amount provided to them to support their R&D. Aim is to support R&D investments in case they would not be realized otherwise and to prevent public funds to be used for private R&D acitivies. EU regulations object to directing public funds for R&D incentives of companies core acitivities (OECD, 2006).

Output Additionality (OA) focuses on output ratio which would not be realized without public support. Output could be marketable like patent and innovation, or commercial output like sales or profit which depends on direct R&D support.
Behavioural Additionality (BA) concept brought in agenda first time by Buisseret (Buisseret, Cameron, & Georghiou, 1995). Government instutions and companies making R&D programs with public incentives are generally affected by these experiences. BA is the change in the way of doing R&D of companies due to policy activities. Georghiou (1997) says this change should be permanent and lead to transform of innovative inputs to more efficient and innovative outputs. It analysis if the intervention is involved in STI acivities of stakeholders. In general, focus of BA is building innovative capabilites and competencies. It is also the capability and ability of companies to use new technologies and R&D procedures in other fields. Focusing on building new capabilities corresponds to resource-based view. In resource-based view theory, companies are seen as total of resources (people, technical information, culture, etc.,) which are difficult to imitate. Dynamic capabilities are use, reorganization, and reconfiguration of resources to create competitive advantage. Change in dynamic capabilities related with management of innovative processes of companies receiving R&D support could be seen as BA effect. R&D support or grant could create BA effect by changing company strategies (Georghiou & Clarysse, 2006).

Impact Additionality is defined as increase of productivity or better competitive position. Output or impact additionality is problematic in verification and validation of impact for the case of commercial outputs. Innovation process is spread in time and in this period impact of public support gets blurry. In addition it gets diffucult to attribute impact to one particular intervention. This case is called ‘Project Fallacy’ or ‘attribution problem’ (Polt & Streicher, 2005). For that reason applications mostly condensed on marketable outputs. In analysis of impact additionality of public funds, IA and OA should be analysed together. In literature, BA is defined as multidimensional concept and in addition to above classifications, a variaty of BA are brought up. These are Project Additionality, Scope Additionality, Network-Cooperation Additionality, Acceleration Additionality, Cognitive Capacity Additionality, Management Additionality, and Follow up Additionality.

Davenport, Grimes, and Davies (1998) emphasis on persistance of BA and argue that policy makers should focus on BA compared to IA or OA. BA effect is expected to continue after R&D period and to be integrated to the capabilities of the firm (Pegler, 2005). Other BA dimensions (cognitive capacity, management) create a spillover effect leads to more innovation (J Larosse, 2004). Gaps among BA types are not clear there are overlaps.

In general it is assumed that grants are always have positive and intended behavioural effect. The behavioural effects could be negative and unintended, negative and intended which is called Negative BA. Negative BA could lead firm to collobrate or to undertake high risk R&D which leads to unintended results. BA impact of R&D incentives differs and it could be more impactful compared to tax incentives (Georghiou, 2004).

BA classified in four categories: Change in non-persistent behaviour in R&D and innovation; change in the persistence bahaviour as one distinct phenomenon; change in the persistence behaviour with minor references to building blocks; change in general conduct of firm beyond R&D and innovation (Gök & Edler, 2011).

2.3 Foresight Evaluation and Foresight Impact Assessment

Research Question 1: What are the assessment methods used to measure the impact of technology foresight?

The answer of the Research Question 1 is detailed under this sub-heading.

2.3.1 Foresight evaluation

Foresight evaluation programs gain importance since year 2000s. Foresight evaluation framework with rationales, expected outcomes and evaluation focus are defined by Georghiou and Keenan (2006) as given at Table 3. The rationales are to provide policy, building networks producing advices and to provide social forums for networks to generate advises. Driven by these rationals, the expected outcomes are formulation of policy decisions by evidence based information and increase in rationale decision making. Impact/outcome evaluation focuses on linking decisions to foresight, improvement in decision making process.

Table 3 Foresight evaluation framework

Rationale of Foresight	Expected Outcomes	Evaluation Focus
Provide policy advise	Policy decisions and funds transfer	Linking decisions to foresight study
	By time increase in rationale decision making	Change in decision making process
Building networks produce advices	Emergence of new networks and societies	Nature of networks
	Breadth of commitment to realize joint vision	Undertaken roles
Providing social forums	Extending participation and democratic renewal	Number or actors involved and breadth
		Quality and focus of debates
		Benefit to participants

Source: Georghiou and Keenan, 2006

Expected outcome of building network rationales are the emergence of new networks and societies to produce information, intelligence, and through these networks and synergy to generate a shared vision of future and joint commitment to realize the vision. The evaluation focuses on structure of networks and responsibilities undertaken through these decision / policy making processes. Wide breath participation, involvement of all stakeholders and democratic renewal is another expected outcome of the foresight. Evaluation of these outcomes focuses on variety and involvement of participants, quality of debates, benefit and learning impact on participants.

Different approaches are adopted and reflected to foresight evaluation models as evaluation theories, systems thinking, and project management. Foresight evaluation and impact assessment frameworks are summarised in Table 4.

Table 4 Summary of foresight evaluation & impact assessment Frameworks

		Ex-Ante	In Process	Ex-Post		Evaluation												
															Impact			
Authors	Year	Input	Process	Output	Outcome		Efficiency	Appropriateness	Behavioural Additionality	Utility	Sustainability	Fairness	Effectiveness	Impact	Awareness Raising	Policy Informing	Enabling	Policy Influence
Martin	1995	√	√	√	√													
Alsan, Öner	2004	√	√	√	√	IFM: • Human, Organization, System • Management levels: Normative, Strategic, Operational												
Saritaş	2004	√	√	√	√	Systems Thinking												
Georghiou, Keenan	**2006**	**√**	**√**	**√**	**√**	**Evaluation: -Accountability, -Justification & Verification, -Learning**												
Destate	**2007**	**√**	**√**	**√**	**√**		**√**	**√**	**√**	**√**	**√**	**√**	**√**	**√**				
Georghiou, Keenan	**2008**		**√**		**√**		**√**	**√**	**√**				**√**	**√**				
Da Costa et al	**2008**			**√**	**√**										**√**	**√**	**√**	**√**
Li, Kang, Lee	**2009**		**√**		**√**		**√**	**√**	**√**				**√**					
Havas, Schartinger, Weber	**2007, 2010**			**√**	**√**									**√**		**√**	**√**	**√**
Johnston, Smith	**2012**			**√**	**√**									**√**	**√**	**√**	**√**	**√**
Miles	2012	√	√	√	√	Dynamic Foresight Evaluation: Involvement of stakeholders (users)												
Piirainen, Gonzales, Bragge	2012	√	√	√	√	Input-Process-Output Evaluation Framework: 1-level:Application; 2-Level:Technical level; 3-Level.:Ethical level												
Steen, Twist	2012	√	√	√	√	Policy-Information-Organization												

The methods and frameworks are summerised as follows:

Foresight evaluation framework was first introduced in 1995 in two perspectives, process and time (pre evaluation, evaluation through project and ex-post evaluation) (Martin, 1995).

The evaluation criteria of government led foresight evaluation is defined as (Georghiou & Keenan, 2006);

- Accountibility, implementing of foresight program in an efficient way and appropriate use of public funds,
- Justification and verification of foresight impact and continuity,
- Learning, examining how foresight could be applied in a better way.

(Destatte, 2007) defined foresight evaluation in process and result perspectives. Evaluation criteria are defined as effectiveness, efficiency, utility, relevance and appropriateness, sustainability, fairness, and behavioural additionality. Evaluation frameworks mostly based on these rationales, process and time perspectives, and evaluation criteria. Policy related functions of foresight are defined as informing, counselling, and facilitating.

Foresight evaluation criteria are (Georghiou & Keenan, 2008);

- Implementation Efficiency: Process evaluation, focuses on managerial issues.
- Impact and Effectiveness: It is in focus of policy makers and deals with output and results.
- Appropriateness: It is policy evaluation at national level.
- Behviroural Additionality: It is the skill of changing behaviours. BA was suggested to examine the foresight program's impact on innovation system, learning impact and cultural change.

(Alsan & Oner, 2004) developed an evaluation model consists of three elements as human, organisation and system, and with management perspective at three levels as normative, strategic and operational levels.

(Li, Kang, & Lee, 2009) framed foresight evaluation with 4 criteria at process and result perspectives which are effectiveness, efficiency, relevance and appropriateness, behavioral additionality.

Another framework is Input-Process-Output evaluation framework (Piirainen, Gonzalez, & Bragge, 2012) defines evaluation at three levels. The first level is the application level and it focuses on realization of objectives and customer satisfaction. The second level is the technical level and it is about technical quality of exercise, data quality, appropriateness of methods, and edaqucy and accuracy of reporting. The third level is the ethical level and focuses on acceptability of research and transperancy of activities.

Dynamic foresight evaluation (Miles, 2012) emphasises on importance of production of foresight results by different stakeholders taking place in the process

altogether. Especially focuses on importance of understanding the system to be affected, and how to involve stakeholders to the process and at what degree.
Foresight evaluation framework based on project management approach (Makarova & Sokolova, 2012; 2013). Evaluation purpose is analysis of project success, its impact, and development of recommendations for the follow-up projects. Criteria are efficiency, effectiveness, appropriateness, and relevance.

Foresight evaluation provides a medium by information exchange to externalize tacit knowledge, lessons-learned and to diffuse of knowledge in society. There are frameworks specifically developed for foresight impact assessment. Since context of this thesis is the impact assessment of Turkish technology foresight program, the frameworks devoted to technology foresight impact assessment are summarised under a separate heading.

2.3.2 Foresight impact assessment

Foresight policy functions, time of the impact realized and the intended and unintended impact are brought together in impact assessment model (Havas, Schartinger, & Weber, 2007). Policy functions of foresight are policy informing, policy advisory, and policy facilitating.

Policy informing is the creation of consolidated information about future opportunities, challenges, and dynamics of change. It provides input to policy makers. Policy advisory, counselling function is beyond providing information, it is about transforming information into new polices, by taking into consideration of strategic positions of policy making entities. Policy facilitating function is building joint vision towards plausible future, coordination of activities, application of policies, building new stakeholders networks and joint learning. Impact of foresight functions are assessed at different time periods which impact will be realized, short term (immediate), mid-term (intermediate), and long term (ultimate).

Foresight impact types are awareness raising, informing, enabling and influencing (Keenan et al., 2007; Havas et al., 2010; Johnston, 2012; Smith, 2012). Raising awareness is the increase of understanding of target stakeholders values, needs, foresight methods to be prepared for the future. Informing is providing conceptual and experimental input for more effective planing and decision making. Enabling is providing tools to facilitate management of uncertanity about future and enhancement of capacity. Influencing is shaping policies, strategies, investments, research and priorities. Impact areas are development of knowledge society, STI system, business, policy making, decision making processes and understanding of public science and knowledge (Sokolova & Makarova, 2013).

Another foresight impact assessment framework which has been introduced is based on interaction of Policy-Organization-Information trio (Steen & Twist, 2012). According to the framework, information directs policy and organization's decisions and applications, meantime organizations and policies direct the information which will be created. The assessment framework covers pre and ex-post phases of foresight program. Policy is defined as output of powergames, organization is defined as organization process and information is defined as data, information, and evidence of policy.

2.4 Challenges in Foresight Evaluation

Despite the increase in foresight activites and the importance of foresight as a key policy and decision making tool, evaluation of foresight is still under research. It is seen from the literature that it is difficult to develop one-size-fits-all evaluation approach (Georghiou & Keenan, 2006). Foresight is defined at three levels as output (epistemology), process, and developing theory about future. Foresight as an interdisciplinary field its theoretical base covers from epistemology to behavioral science, economics, and policy analysis. Foresight evaluation could be done at any phase of foresight-cycle. Therefore, there are challenges in foresight evaluations from theoretical, methodological and practical perspectives. Difficulty in foresight impact evaluation is developing logic model for the evaluation, if it is not explicitely defined, thus causing difficulty in tracing the cause-effect relationships. Other challenges in application of sound evaluation program are; Differences in understanding of foresight concept and benefits, and expectations from foresight exercise; Complexity and lack of ownership of foresight, and its goals; Benefits of foresight are not always tangible and therefore, it is difficult to assess the impact, lack of appropriate indicators; Attribution problem of impact of the foresight intervention. Methodological challenges are; there are a variety of foresight evaluation methods and frameworks in conceptual phase, difficulty in application of quantitative and counterfactual analysis methods; Quality, validity and accuracy problems of data, Need of long-term time lapse to be realized, involvement of large variety of participants from different background, and dispersed across a wide range of actors and systems (Barré & Keenan, 2006). Difficulty in evaluation of foresight activities makes it difficult to compare them as well. Much of the value-added of foresight will be misssed, when just a formal input-output comparison was done (Miles, 2012). An evaluation should be guided by foresight program objectives.

2.5 Remarks

Technology foresight is a dynamic field and still evolving. It is an interdisciplineary field and provides methods, tools to link S&T to social and economy together and to take the advantage of S&T as a resource and power to increase the wellfare. It focuses on the involvement of all stakeholders into the processes of shaping the future. It is a learning and culture development process and tool for individuals, institutions and nations to think systematicaly, out-of-the-box, future-oriented, briefly to become a knowledge society.

In this chapter, theoretical and historical background information is provided in the context of foresight, evaluation-assessment, and technology foresight impact assessment. It is seen from the literature review that there is no single foresight assessment framework widely accepted, in order to define outcomes and impact of technology foresight in general. In order to develop a technology foresight impact assessment scale and model, literature was reviewed deeply from a theoretical perspective covering foresight definitions, scope, varieties, goals and objectives, benefits, theories and methods, processes, generations, outcomes and impact, and CSFS of foresight. The goal is to understand the key attributes (codes) of foresight, and to benefit from them as impact variables in the study.

Before conducting foresight impact assessment, the literature review was conducted in the context of evaluation discipline. In order to understand and define foresight impact assessment, evaluation concepts, types, methods, tools and techniques were examined. In the applications and even in literature, evaluation and assessment words are used interchangibly and the distance between two gets blurry. Therefore, to understand and differentiate impact assessment from other similar wordings, a deep literature review was conducted on evaluation and assessment definitions, theories and techniques.

In the literature, Utilization Focused, Outcome Value Added Assessment, Case Study, Program Theory-Based evaluation, Mixed Methods are counted as the most applicable and useful program evaluation approaches. It was decided to apply Program Theory-Based Evaluation approach for the impact assessment of Vision 2023 Technology Foresight. With its strengths and positive features such as, in cases where counterfactual methods are not applicable, it focuses on contribution rather than attribution, and it provides more insights and information regarding the program, its impact, and success and failure. The qualitative approach and techniques were implemented in the assessment study beside quantitative techniques. Program Logic Model was not developed from the scratch it was based on the model of Vision 2023 DAS Technology Foresight.

The foresight evaluation programs were increased by 2000s. A variety of models and frameworks were developed for technology foresight evaluation. It is seen from the literature review that, there is no one-size-fits-for-all foresight evaluation approach. The foresight under evaluation needs to be considered in the development of foresight evaluation or impact assessment model. The foresight evaluation frameworks and models are; Integrated Foresight Model frames the evaluation with human-organisation-system elements with management perspectives at operational-strategic-normative levels; Systems Thinking approach frames the evaluation with systems, systems components, links as inputs-outputs and inner-outer context; Policy-Organisation-Information framework covers the throughout cycle of foresight (input-process-output).

Beside foresight evaluation frameworks, there are frameworks focused on specifically foresight impact assessment, ex-post (immediate-intermediate-ultimate) impact on policy functions to assess the (un)intended, (un)targeted, positive or negative impact and impact types of technology foresight program. A table is prepared to summarize the foresight evaluation and impact assessment frameworks covering historical, foresight evaluation phases, and impact criteria perspectives. In the thesis, the technology foresight impact assessment framework developed by Johnston and Smith in 2012 was adopted as baseline, since it was focused on specifically policy impact functions and applied at least in one technology foresight program (Canada).

CHAPTER 3

TECHNOLOGY FORESIGHT AND IMPACT ASSESSMENT PROGRAMS AROUND THE WORLD

3.1 Technology Foresight Impact Assessment Programs around the World

A list of technology foresight evaluation programs around the world is given in Table 5.

Table 5 Foresight evaluation studies around the world

Country	Foresight Program	Evaluation Studies
Austria	Delphi Austria, 1999	Internal impact assessment, by Science Ministry
Canada	Renewal Project, 2005	Assessment carried by National Research Council, 2009
Colombia	CTFP 2005-2008	2007/2008 and 2010 panel evaluation: Process and impact assessment by national- international committees.
Denmark	2001-2004 National Tech Foresight	-
France	FuturIS, 2003-2005	International evaluation committee, 2005
Finland	R&D investments, Foresight programs	Evaluation by TEKES
Germany	Delfi-98, FUTUR, 2001-2005	Delfi 98: Evaluation questionnaire Evaluation of FUTUR:2002-2003 and 2004-2005.
Holland	NRLO Foresight Program, 1995-1999	OCV Self evaluation. Ms, PhD studies, AWT (ST Counseling Committee) evaluation , 2003
Hungary	TEP, 1997-2001	2003/ 2004 panel evaluation: Process and impact.
Japan	1-9th foresight programs (1971-2010)	Evaluation of STA forecast realization for 15-20 by NISTEP. Foresight evaluation on regular base.
Malta, Cyprus, Estonia	eForesee	“Light” expert evaluation of eForeSEE Project. Examining achievements of EU funded projects.
Sweden	Number of foresight programs, 1999-2001	Continous process evaluation by Evaluation Committee
UK	1.Cycle 2.Cycle 3.Cycle	1.Cycle: ad-hoc studies (Parliament, PhD studies). 2.Cycle: OSI evaluation, 3.Cycle: Full evaluation (PREST, 2006)

Author elobration based on (Georghiou, Keenan, 2008).

Foresight studies had been discussed in literature since 1990s and these exercises have been focused more on design and execution of the foresight programs. Evaluation studies increased with year 2000. The technology foresight and evaluation programmes of USA, Japan, Korea, UK, Germany, Hungary, Colombia and Turkey are summarized below. Evaluation exercises cover process, ex-post evaluations, and immediate-intermediate-ultimate impact of the foresight interventions.

3.1.1 USA technology foresight evaluation

In the USA, The Congressional Office of Technology Assessment (OTA) started its operations in 1972 to execute TAs to inform national policy studies, and to provide technical counsel to the Congress. Exercises to identify critical technologies are conducted since 1990s. Critical Technologies means identifying the essential technologies for the long-term national security and economic prosperitiy of the country (Wagner & Popper, 2003). In USA, Critical technologies processes were conducted with experts from government, universities and industry, and public involvement was not persuaded. Technology foresight studies done by Department of Energy (DOE), Defense and Environmental Protection Agency (EPA), and Department of Defense (DoD) are limited with their missions, not encompassing the broad range of national goals and leadership. Some organizations and private sector firms employed foresight method for strategic planning and long-term technology investments.

TA and foresight similiar activities in USA have played important roles in evolution of technology foresight methods and tools. Scenario planning, technology roadmapping, technology assessment, economic analysis, technology intelligence, impact assessment, and Delphi methods could be listed as examples.

Delphi technique is designed by USA RAND Corp in 1940 and spreaded in 1950s among policy, industry and academia. The most two important element of Delphi method are to provide unity between cycles and feedback. The first national Delphi application was used in USA in 1960s. Japan is the champion of Delphi method and employs the method since 1971 for ST policies successfully. 1990s Delphi method was common application by EU countries and used together with scenario, bibliometric and other survey methods.

Key outcomes of the TAs in the USA are the changes in research investments of federal science agencies and of government investments in research infrastructure (Bissell, 2011).

3.1.2 Japan technology foresight evaluation

Japan in the way of becoming economic superpower, starting from post-War, its industrial success relied heavily on its technology base and government-industry cooperation. Its success in global market was attributed to industry dominated R&D base in manufacturing competencies.

Japan has well established foresight culture, and public and private organizations are mostly involved in forward-looking activities. Technology foresight studies are carried out since 1971. Delphi method is used every five year and it is in the 9th iteration. Towards the end of 1980s, Japan has decided to become scientific frontier, than follower to sustain its competetiveness. In 1995, “Basic Law on Science and Technology” was launched and since 1996, national S&T policies are done according to Basic S&T Plan and renewed every 5 year. In the early years, foresight programs focused on S&T. In the 8th Delphi survey, technological realization and social realization of the topics were included as new approach. 3rd Basic Plan covered social and economic needs. The 9th S&T foresight is novel with focus on social and most urgent challenges for Japan. Delphi survey, scenario writing and capability of local regions for green innovation are used. The link between technology foresight and S&T policy had evolved with each Delphi aplications (Urashima, Yokoo, & Nagano, 2012).

Since 1996 Delphi statements were evaluated regularly and become part of foresight system. NISTEP is responsible for the evaluation of the accuracy of Delphi forecast. In evaluations, realization status of foresights in the expected time frame and adequacy of Delphi clauses are measured. NISTEP evalutions focused on accuracy of foresight, and examined the realization rates. Predictions of 1-5th Delphi survey were assessed by experts in the 9th and reported that %70 of topics were successfully realized. Topics were expected to be implemented in earlier stages had higher realization scores. Reasons for not achievements were listed as cost, technical difficulty, low needs, social problems and advent of alternative technologies (Yokoo, 2011). Perceptions of scientists and engineers with regard to foresight impact on policies are measured. Perception patterns of experts for foresight impact on policy making depend on age, organization, involvement in foresight exercises, and culture of following the impact after foresight (Yoda, 2011). The impact of foresight is the creation of social-scientific expert networks; social learning developed by linking foresight with S&T policies beside technological achievements; foresight processes provided a reality check role to extend the utility of other policy inputs (Urashima et al., 2012).

3.1.3 Korea technology foresight evaluation

The first technology foresight of Korea was implemented in 1993 by National Science and Technology Policy Institute (STEPI) with a time horizon of 20 years from 1995-2015. Three iterations of Delphi was run on future technology issues without considering social impact. Second technology foresight conducted in 1998-1999, time horizon extended to 25 years from 2000 to 2025.

In 2001, “S&T Framework Act” was set as a major development in technology foresight program. It merged several S&T related legislations and ruled carrying out technology foresight exercises on regular base and implementation of the results into S&T policies. Korea Institute of Science and Technology Evaluation and Planning (KISTEP) was designed as managing organization. Technology foresight has become a key process of defining S&T policies. The S&T Basic Plans were based on technology foresights. It is top level policy document and defines national strategic technologies and S&T related policies.

The third technology foresight program was run in 2003-2004. The first time, the relationship between technology and society was set and policy makers and social scientists were involved in addition to S&T experts. Two round Delphi surveys and scenario writing method are used to build the picture of future social systems. First, social trends were identified, and then future technologies defined as based on them. In 2007, the 3rd technology foresight revised and directly reflected into the second S&T Basic Plan.

In 2008, Korean technology foresight was designed to shape national S&T policies for the following ten years. Beside Delphi, bibliometrics, scenarios, SWOT, seminer/conferences, and expert panel methodologies were used. The first phase of technology foresight was the analysis of future challenges that country would face in the future. The second phase was future issues and needs identified by analysis of national and international foresight outputs. The third phase is technology capability assessment performed, and finally overall outlook of technological development. Time horizon for future technologies was extended to 40 years from 2010 to 2050.

The forth technology foresight was conducted in 2010-2012 with time horizon up to 2035, and reflected to 3rd S&T Basic Plan. It had 3 stages; the first was future of Korean society and future needs; the second was the identification of future technologies through Delphi surveys; the third stage was the illustration of future world changed by these future technologies. In the 4th technology foresight, the first time negative impact of future technologies was drawn by scenarios.

The realization of the first technology foresight predictions about future technologies and obstacles of realization were evaluated. The accuracy rate was 72,2%. In addition to technology foresight, Technology Level Evaluation and Technology Assessment exercises are conducted on a regular base in Korea. Technology Level Evaluation is conducted every 2 years and technological levels of strategic technologies targeted in S&T Basic Plan are compared with other country’s technology levels. Technology Assessment is conducted annualy and targets the evaluation of positive and negative impact of new S&T on economy, society, environment, culture and ethics. Results are reflected into research plans and S&T Basic Plans (Choi & Choi, 2015).

With more than 15 years of experience in technology foresight in Korea, some improvements were recommended to be more systematic and efficient. These recommendations are foresight methodologies should be refined, and technology intelligence and scanning system should be included to detect weak signals of change. Past Korean technology foresight exercises needs to be evaluated. To get the benefit of technology foresight exercises as mutual learning process, through networking of stakeholders, and more participatory policies are needed (Hwang, Kim, Son, & Han, 2011; Choi, & Yang, 2014;).

3.1.4 UK technology foresight evaluation

In UK foresight programmes are conducted since 1993 by Office of Science and Technology (OST). The program is in its third cycle. In 1993, OST launched the report titled as 'Realizing Our Potential'. Focus of the white paper was to launch National Foresight Programme (NFP). The rational of NFP was being means of gaining early notice of emerging key technologies, and process forging new partnership and interaction between scientists and businessman. Sector panels were retained as hubs of implementation of follow up activities until 1999. The first technology foresight was done in 1994-1995. The objective was to identify the future S-T areas, building cooperation among scientist and businessman, informing the directing decisions of public S-T funds. Delphi technique was used in the foresight program. Many institutions before starting their own foresight activities, referenced first UK technology foresight for benchmarking (Georghiou, 1996). The second technology foresight was launched by OST in 1999-2002. Objective of foresight was set as sustainable development. It was aimed to provide more visionary and more integrated outputs, involvement of wider variety of participants, and emphasis on quality of life issues. Both first and second cycle foresights had 5 years of period with a 1-2 year consultation phase and 3-4 year implementation phase. Third cycle was carried in 2002-2008 period as outcome of review of second cycle foresight. First 2 foresight cycles were about wealth creation, the third cycle focused on science based discrete projects of government departments to improve policy making ability about S&T issues. Objective was to increase the benefit obtained from science capacity of the country.

UK has a good history of foresight evaluation efforts. During the 2^{nd} cycle foresight, an indicator-driven evaluation framework was developed. Items of the evaluation framework focused on the impact of foresight, increase of foresight awareness and industry interest in foresight culture; commitment of participants, consulting and cross-panel communication; influence on government spendings on foresight and S&T expenditures; influence on formation of new industry-science networks, contribution to quality of life. Chief Scientist Review was conducted and superseded the evaluation framework, and led to abandon the second cycle.

Evaluation of the third cycle foresight conducted in 2005 and based on a formal framework. The objectives of the evaluation were the analysis of impact of foresight programme as a whole and the seperate projects, cost effectiveness of the foresight programme, foresight process, and to develop recommendations for improvements. Evaluation criteria are objectives of the foresight; immediate, intermediate, and ultimate effects; BA; value-for money; resources (financial, human-power, time). Semi-structured interviews, documentary analysis and benchmarking methods were implemented. Foresight had direct informing impact on national policies and programmes. Immediate effects were the increased recognition of the topic area, emerging new networks of experts and stakeholders, success in integrating natural and social sciences. Intermediate effects were articulation of shared vision of future, formulation of recommendations for action, formation of action networks. Influence on senior policy to engage with science and scientists. The biggest benefit was the building the ‘whole picture’ of the topic area in a sound framework. Ultimate effects were influence on research agendas of public and industry; policy counselling and policy implementation; development of foresight culture. Self-sustaining networks needed to be built. Value-for money was high, learning curve for building networks had shortened timescale. Foresight programme staff needed to be managed from the knowledge management perspective. Projects could benefit from public participation before their completion. UK innovation system was not addressed directly with a holistic view by the third cycle foresight (Georghiou & Keenan, 2006; Cameron, Georghiou, Keenan, Miles, & Saritas, 2006; Havas et al., 2007; Cassingena Harper, 2013; Sokolova & Makarova, 2013).

3.1.5 Germany technology foresight evaluation

Germany foresight studies have started by 1990s. Unification of Germany brought up challenging economic and social problems. Necessity for having a rational process to set priorities, allocation of financial resources accordingly, and strategic orientation of R&D field became increasingly important and challenging. It was imperative to execute the foresight exercise at national level taking into consideration economy, society and environmental impact along with S&T.

History of foresight in Germany, started with the foresight activity called 'Technology at the Beginning of 21st Century' in 1992. In 1993, the first Delphi study was exercised in cooperation with Japan NISTEP and Science and Technology Agency (STA). The rationale was to discover future S&T and their time horizon. Delphi method had become a new tool to start a communication process about future. Before the second Delphi which was exercised in 1998, a mini Delphi study conducted to gain more detailed data and technical solutions for most important and emerging problems. The second Delphi exercise started at the request of industry and to provide more information about future to the actors like small companies, institudes, etc that they could not run such a program. Focused on developing new concepts for effectiveness and innovative leap 1999, more comprehensive foresight exercise was executed involving greater variety of participants in addition to experts, and internet was used in this process as discussion platform.

"FUTUR-The German Reseach Dialogue" foresight program started in 2001 and ended in 2005 phase by phase. FUTUR was started by Germany Federal Education and Research Ministry in order to identify the direction of science and technological developments, identification and inclusion of societal needs into future research agendas, to identify the priority areas of R&D funds, priority setting for future oriented resarch policies. Directive visions "Lead Vision Papers" were the major outcomes. Reports included examined topics explaning importance for society and economy, scenarios, and future research priority lists. FUTUR program was supposed to promote awareness-raising and future oriented thinking in society as well. Evaluation of FUTUR was carried out in 2002, and based on hypothesis of foresight exercises. It focused on foresight process rather than outcomes, since time lapse was not long enough to observe the outcomes. Evaluation criteria were the rationality and achievements of objectives; appropriatenesss of process; effectiveness and efficiency of applied instruments and methods, process principles, participants selecting methods and activities. Evaluation was conducted by an international expert panel. It was independent from the sponsors. Surveys, interviews, focus groups evaluation methods were used. The first evaluation data collected through surveys and interviews with foresight specialists. The findings of evaluation were grouped as participation, process of priority-setting, and implementation. FUTUR met its objectives, had broad participation and delivered Lead Visions document, its objectives were increasingly valid for economic and social purposes. Programmes emerged from participative process of FUTUR had significant support. Improvement areas for participation perspective: Difficulty in finding and nomination of sufficient expertise, under-representation of SMEs, concerns about the impact of self-interested lobbies. Improvement areas for priority-setting process perspective: Consensus-oriented process wil not produce radical results, to generate disruptive ideas, foresight should be supplemented with different acitivities. The process was complex and lack of transparency. It could reach a wider public. Improvement areas for implementing perspective: A dedicated budget for the implementation of lead visions would increase the impact of FUTUR (Cuhls & Georghiou, 2004; Harper, 2013b; Sokolova & Makarova, 2013).

3.1.6 Hungarian technology foresight evaluation

Hungarian Technology Foresight Programme (TEP) was launched in 1997 by the Hungarian National Committee for Technological Development. When TEP was designed, the country went through a fundamental economic and social change. It was the first foresight program conducted in Central and Eastern European Country (CEEC). It was driven by a broad socio-economic needs and problems. The main objective of the program was to identify R&D priorities, improve quality of life, and enhance international competitiveness. TEP was evaluated in 2001-2002 by an international panel to analyse the degree of achievements of programme’s objectives and to consult decision making regarding the following foresight activities.

Evaluation criteria are appropriateness of objectives, efficiency and effectiveness of foresight process. Appropriateness and effectiveness of methods applied. Focus was on the justification of foresight programme in terms of value for money and obstacles of implementing TEP. An international panel was commissioned. Questionnaires, interviews, documentation analysis methods were implemented for evaluation. Highest impact was on the area of cultural change in long-term thinking and interdisciplinarity. It was seen a success from the methodological point of view, but TEP has not had a substantial and immediate impact. Questionnaire respondents were negative on the impact of TEP on research directions of public sector or industry. TEP had an informing impact on public policy system in a non-linear way and through personnel networks of participants (Georghiou & Keenan, 2006, 2008; Havas & Keenan, 2008; Sokolova & Makarova, 2013).

3.1.7 Colombian technology foresight evaluation

Colombia has a strong tradition in foresight and reference in Latin America region. The first cycle Colombian Technology Foresight Programme (CTFP) was conducted in 2003 (2003-2004), managed by government, contracted to Univalle university for overall management and had a wide sponsor groups. It consisted of sectoral, sector-teritorial, and thematic 8 projects. End of 2004, early assessment was conducted by Manchester University. Documentary analysis, interviews, and workshops were conducted. Major objectives of the workshop were to share lessons learned of UK foresight cycles and jointly to define success strategies of future Colombian foresight programmes. CTFP had impact to build foresight culture in universities, research institutions and government organizations in Colombia.

The second cycle CTFP was conducted in 2005 (2005-2008) and it was built on the lessons derived from the first cycle. Objectives of the 2nd cycle CTFP were transforming Colombia into knowledge-based economy, to conduct foresight exercises, and to build foresight capacity. It was an independent and international evaluation. Evaluation of the second cycle CTFP was conducted in Aug 2007- Nov 2008 and focused on immediate and ultimate impact of the programme. The evaluation process had four stages which were scoping, understanding, evaluating and learning. Main objectives of evaluation were defined in the scoping phase (first phase), which were impact assessment of programme and projects, cost-effectiveness of programme, and identifying lessons and recommendations for the improvement of foresight and horizon scanning efforts. In the understanding phase (second phase) methods to be used were defined as interviews, online surveys, documentary analysis, structural analysis, statistical analysis and case study analysis. The third phase covered evaluation of findings, bencmarking and learning with international foresight programmes. The fourth phase was the reporting, validation of finding with sponsors, and learning. Critical factors affecting foresight programmes were summarized as innovation and learning capabilities of users and practioners, productivity of foresight process, pertinence of foresight programmes, quality of foresight reflections (Popper & Medina, 2008). European Foresight evaluation criteria were used for CTFP evaluation which are appropriateness and degree of achievements of objectives; performance of management and funding mechanisms; value for money (justification of foresight programme); effectiveness and efficiency of organizational structure, approaches and methods, and implementation; level of commitment of participatants, level of foresight capacity and achievement of foresight culture; level of impact and novelty; level of national, sub-national and international presence. The result of this fully-fledged evaluation is substantial achievements. Appropriateness and achievement of CTFP objectives were validated. CTFP contributed to the development of vision and strategies for knowledge-based economy, foresight capacity was built. Excellent value for money captured and CTFP has become a flagship for Latin America foresight programmes. Combination of foresight, horizon scanning and productive chain was a novel future of CTFP. CTFP had impact on STI system. Foresight capacity and culture were satisfactory achieved. CSTF did not have an “aftercare strategy” to hold sponsors responsible for the implementation of foresight and follow-up programs as in UK 3rd foresight programs. This case would increase the ability to inform STI policies and shape research priorities, and consolidate institutional alliences. Recommendations include more foresight process management issues to encourage general public participation to projects and courses, increase of industry involvement, and inclusion of verifiable objectives in the future works (Popper, R., Georghiou, L, Miles, I. and Keenan, 2010; Sokolova & Makarova, 2013).

3.2 Turkey Vision 2023 Technology Foresight evaluation Studies

Turkey Vision 2023 project was initiated by Scientific and Technological Council of Turkey (TUBITAK) to build a vision for science and technological developments by 2023. Technology foresight program was the backbone of the Visison 2023 project. Strategic technology fields were identified, and prioritised, and technology rodmaps were developed.

A comprehensive evaluation study for the long-term impact of Vision 2023 Technology Foresight program was not conducted or published yet. There are foresight evaluation studies done as part of Ms, PhD studies and working papers. Mostly they are focused on the process, methodologies, and outputs of Vision 2023 Technology Foresight. The inferred evaluations and recomemndations are summarised as (Dursun, 2005; Daim, Basoglu, Dursun, Saritas, & Gerdsri, 2009):

- Training: Inadequate training of panelists on technology foresights and methods; Confusion of concepts of technology activity and technology fields was listed as weaknessess. Recommendations cover to provide training of panelists on foresight studies and methodologies.
- The diversity and balance of participation: High participation of the university and inbalance in representation of public, private, university and NGOs, low level of SME participation. Recommendations are to provide balance in participation from all stakeholders, and encourage of SMEs participation,
- Weakness of communication between thematic and sectoral panels. Recommendation is to design foresight to provide information flow from thematic to sectoral panels.
- Technology-Market-Economy Balance: Provide balance in technology-push and market-pull, and emphise on economic aspects in panel studies.
- Simplification of the "Delphi" survey.

The foresight study was evaluated as a good tool to look forward, long-term future of science, technology, and to identify emerging technologies and beneficial for following foresight studies.

Vision 2023 technology foresight was evaluated and bencmarked as part of some international scientific researches. It was shown as an obvious example of ‘Type A’ foresight in a study conducted by Havas (2011). ‘Type A’ foresight is about forecast of technology and technological developments, extrapolation of percieved trends. Aim of Type A foresight program is to identify S&T priorities. Rationale is to excell on S&T, to increase national prestige, socio-economic benefit by following linear model innovation (Havas, 2011). This is not a full evaluation of the Turkish foresight but this categorization indicates that academy-industry relation and techno-economy issues were not in the focus of the foresight program.

A research was conducted in member countries of OECD and ERA to assess the impact of national foresight studies on the performance of national innovation systems by Meissner in 2012. Vision 2023 Technology Foresight was included in this study. In the research, qualitative techniques were used for assessment. Total 8 criteria were used for assessing the national foresight studies which are value added of foresight implementation, motivation of foresight / meaning / position of foresight, involvement of stakeholders, resources assigned, experience level, instruments and methods applied, foresight context, and degree of dependency of responsible institutions. The criteria were weighted equally and rated on a scale of 5 points. Highest score was 1 after weighting and normalization. Regarding assessment of national foresight study of Turkey, only assessment score is avaliable and no explanatory statements are provided about the impact on policy and decision making, and national innovation system. Overall assesment score of Vision 2023 Technology Foresight program is 0,52 out of 1 (Meissner, 2012). As a result of the research, countries having more experience in foresight studies (Japan and Korea) and countries have strong international cooperations had higher scores than others. It was concluded that foresight done rarely or without full commitment are unsuccesful in creating the plausible results. In exchange, foresight results are more accepted by countries having a consistent and coherent approach towards foresight planning, application and commitment to actualize the following activities. This acceptance and ownership (commitment) are vital for the successful execution of the defined measures. Main success factor is defined as the believe in process and having support of all actors of the innovation system (Meissner, 2012).

3.3 Remarks

The outstanding examples of foresight programmes and evaluation exercises around the world are summarized in this chapter. Although there are many country examples on foresight programs, evaluation exercises are limited. Some of the countries such as UK, Germany, Japan, Korea and Colombia have good history record in conducting foresight programmes. USA does not carry foresight at national level but technology assessments in federal level or instutional level. UK, Germany, Colombia have good examples of foresight evaluations by applying systematic, methodologic frameworks. Japan implements foresight methods uninterruptedly since 1971 and links foresight outputs to policy making processes. In Japan, technological achievements and reasons of obstacles are assessed in regular base as well. Korea evaluates the technological level and benchmarks with other countries by Technology Level Evaluation, and Technology Assessment on regular base and links the result of these evaluations to foresight and policy making processes. Evaluation process is part of their policy planning processes. UK, Germany, Colombia have a high foresight capacity and as in Japan and Korea, the result of foresight and evaluations are linked to S&T policy planning processes. These evaluation frameworks cover recommendations for improvements of technology foresight. The existence of an enforcing law to conduct foresight activities and linking to S&T policies is essential for conducting successful foresight programmes, reflecting outputs to S&T policies and for the coordination of related policy organisations. Having institutions dedicated to foresight activities is another important factor capturing the notice.

The general evaluation objectives derived from the examples and literature review are impact assessment of the programme and projects, cost-effectiveness of the programme, and development of lessons-learned and recommendations for the improvement of foresight follow-up acitivities. Country specific objectives are added to general evaluation objectives. The mostly used methods for evaluation and assessment are Delphi surveys, interviews, workshops, focus groups, documentary analysis. In the country examples, European Foresight criteria taken as reference for evaluation programmes are appropriateness and degree of achievements of objectives; performance of management and funding mechanisms; value for money (justification of foresight programme); effectiveness and efficiency of organizational structure, approaches and methods, and implementation; level of commitment of participants, level of foresight capacity and achievement of foresight culture; BA, level of impact and novelty; level of national, sub-national and international presence.

As a result, it is always recommended to evaluate the foresight programmes. Elobration of foresight process, management, more clearly design of processes, increase of stakeholder involvement, participation of industry and decision makers, building new networks are inferred as recommendations. Developing verifiable objectives are also part of recommendations. User involvement to evaluations is recommended to increase the learning impact. Independency of evaluator is an important factor. International structure of the evaluation team is counted as beneficial tool for learning and benchmarking.

It is concluded from a variety of evaluation programmes that, foresight evaluation capability level is different for each country. It depends on maturity of the country in long-term, participatory, exploratory, and evidence-based planning culture. There is no one common evaluation framework accepted and applied, rather, each country designs evaluation programmes based on their needs and knowledge accumulation. Foresight evaluation capacity of the countries evolve by their own and shared experiences. Involvement of international structures in the foresight evaluation organisations helps to disseminate, share knowledge, and increase learning. The above findings provide valuable insights for the development of technology foresight assessment model and recommendations.

CHAPTER 4

SCIENCE AND TECHNOLOGY POLICIES IN TURKEY

Turkey started to plan its S&T policies in 1963 with the Five Year National Development Plans. One of the most important outputs of the first plan was the establishment of The Scientific and Technical Research Council (TUBITAK) in 1963 to direct basic and applied research, set research priorities and to align research activities with the targets of national development plans. These initiatives are the remarking milestones of Turkey in transition to S&T policy era. Until the early years of 1980s S&T policies and decisions were made by TUBİTAK as internal processes.

20 years later, The Supreme Council for Science and Technology (SCST) was established in 1983 as the highest S&T policy making body of the country to set long term goals, define R&D policies, direct and coordinate applications in S&T. The first S&T policy document approved by SCST in 1983 titled 'Turkish Science Policy: 1983-2003' defining the prioritized technology areas aligned with economic-social development goals. It was the first time S&T policy prepared with the contribution of a high number of experts. 10 years later in 1993, the second S&T policy document titled 'Turkish Science and Technology Policy: 1993-2003' was approved by SCST. It was another milestone in Turkey's S&T policy trends as being innovation oriented national S&T policies.

All these S&T policies had problems and difficulties in implementation and meeting the objectives due to number of reasons which can be summarized as insufficient long-term and strategic approach to S&T issues, insufficient ownership of R&D agendas by stakeholders, lack of political support, isolation and fragmentation.

4.1 National Development Plans as Science and Technology Policy Documents

1st 5-year Development Plan (1963-1967): This development plan is the first operational science policy document of the country (Türkcan, 2009). The most important outcome of this development plan is to establish 'The Scientific and Technological Research Council of Turkey, TUBITAK' to prepare and implement the plan measures. It was also planned to establish an Economic and Social Research Institute (TİSAK), which will give priority to the research that is necessary especially for long-term state planning. The creation of the necessary environment for research, the education of research staff by benefiting from international scholarships, the establishment of libraries with basic scientific publications and the translation of publications into Turkish are some of the other policies that are prominent (SPO, 1962; Türkcan, 2009).

2nd 5-year Development Plan (1968-1972): The S&T policies of the plan focused on applied research by prioritizing the developmental researches directed to applications and practical problems to obtain results in a shorter term. The first time, TUBITAK was assigned with a strategic task to develop national R&D programs targeting economic and social goals of the national development plans, to plan and monitor of project based national R&D allocations and expenditures in systematic structure, to support of university researches, to encourage of universities to cooperate with TUBITAK, and to establish industrial research division in TUBITAK. The S&T policies covered the changes in education programs to develop the research capacities of students starting from elementary schools. The established TUBITAK Documentary Center was one of the measures of the plan. One of the prominent policies of the first and second development plans was the establishment of TISAK, which can be considered as TUBITAK's twin in the field of social sciences. However, the establishment of TISAK did not take place in subsequent development plans (SPO, 1967; Türkcan, 2009).

3rd 5-year Development Plan (1973-1977): The new approaches of the plan regarding S&T policies are syncronisation with other policies, technology transfer,

and selection of technologies. Industry needs have been considered for the first time in determining basic and applied researches and development of national goals.
In summary, the new science policies of the plan are; Conduct of basic and applied researches in the forefront of TUBITAK; Cooperation of universities with public institutions and private institutions; Preparation of long-term research programs and notification to SPO and TUBITAK; Design and audit of public institutions' research and development allocations as separate accounts in their budgets; To participate in European cooperation networks in the field of scientific research.

The comments made on the predecessor plan periods were not being successful in establishment of complementary relations between technological developments and national development goals and objectives, social and cultural structure, and international relations and national resources.

4th 5-year Development Plan (1979-1983): ‘Technology Policy’ term started to be used instead of science policy. The policies and measures of the plan were focused on technology transfer, importance of quality, and patent and license regulations to support national technological developments. Despite not being in the 4th development plan, in 1983 the 'Turkish Science Policy 1983-2003' document was prepared. This is the first official science policy document after pilot project design. This study appears to be the beginning of change in Turkish science policies. In 1983, SCST was established to transform the science policies, which were fragmented under different sections of the plans into a holistic and systematic structure (SPO, 1979; Türkcan, 2009).

5th 5-year Development Plan (1985-1989): The most important decision of the 5th plan on S&T is the preparation of a new science policy. This new policy study was referenced from the previous 'Turkish Science Policy 1983-2003' document.
Other prominent scientific and technological policies include the increase of resources allocated to scientific research and development according to the infrastructure of research institutions, specialization of the universities in certain areas where they are strong, and promotion of university - industry cooperation (SPO, 1985; Türkcan, 2009).

6th 5-year Development Plan (1990-1994): The S&T objectives of this plan period are;

- Double the number of 33,000 researchers,
- Increase the number of research personnel per 10 thousand persons to 15 persons,
- Increase the number of academic staff allocated to universities to twofold,
- Increase the GDP ratio of R&D spending to 1%.

The S&T policies of the plan could be summarised as operationalisation of SCST, encouragement of technoparks to cooperate with universites and industries, establishment of semi-autonomous patent institution, establishement of R&D fund, and support of R&D studies of defense needs. In addition, priority areas of technology (biotechnology, information technology, microelectronics, telecommunications, satellite technology, nuclear technology, new materials, etc.) have been pointed out. During this plan period, targets and policies related to Information Technologies were also included. The policies were the repeat of SCST first meeting resolutions. Starting with this plan, national S&T policies were taken out of national development plans (SPO, 1990; Türkcan, 2009).

7th 5-year Development Plan (1996-2000): The S&T objectives of the plan period are:

- Increase the GDP share of R&D activities to 1.5% at the beginning of 2000s,
- Increase the number of researchers per 10.000 working people to 15,
- Support the increase of R&D expenditure share of private sector.

The lack of achievement of S&T objectives, and reasons behind are assessed as:

- Inconsistency between 'S&T Policies' and industry policies,
- Development plans could not be made the main axis of 'S&T Policies',
- Lack of integration between education-training system and technology needs.

The 'Science and Technology Progress Project' of the 7th Plan is based on the 'Turkish Science and Technology Policy 1993-2003', and 'Progress in Science and Technology Project' prepared in 1993.

The S&T policies are: The establishment of a national R&D network covering the public sector R&D institutions, universities and the private sector; Development of international scientific and technological cooperation, mainly with EU, Japan and the USA; Initiatives aimed at improving the national defense industry; Taking into account the purpose of upgrading science, technology and industry competence in state procurement policies; To provide venture capital support to enable entrepreneurs to transform R&D activities into products (SPO, 1996; Türkcan, 2009).

8th 5-year Development Plan (2001-2005): The S&T objectives of this plan period are:

- Increase the share allocated to R&D activities in GDP to 1.5 percent in 2005,
- Increase the number of Full Time Equivalent (FTE) researchers to 20 per 10.000 working people.

SCST's decisions were included under the headings of ‘Development of Science and Technology Capability’ and ‘Information and Communication Technologies’ in the plan.

New S&T policies of this plan are: Activation of the National Innovation System; Development of risk capital applications; Preparation of action plans for transition to knowledge-based society; Legal and institutional arrangements for Technopark and Technology Development Regions; The Turkish Metrology Institute, the National Aerospace Organization, and the establishment of the Biotechnology High Council have been planned. The ‘Long Term Development Strategy (2023)’ document was approved as an annex to this plan (SPO, 2001; Türkcan, 2009).

9th 5-year Development Plan (2007-2013): The word ‘innovation’ first time used in the development plans. The policies and objectives were prepared under the framework of the ‘Long-Term Development Strategy (2023)’, which is an Annex to the 8th Development Plan (SPO, 2006). S&T policies have been listed under the titles of ‘Development of R&D and Innovation’ and ‘Widespreade Utilization of Information and Communication Technologies’. R&D objectives for 2013 are:

- Share of R&D expenditures in GDP is 2%

- Share of private sector R&D expenditures in total R&D expenditures is 60%
- Number of FTE researchers is 80,000.

It was planned that R&D activities will be directed towards marketing, which will increase the efficiency and competitiveness. Therefore, it was aimed to increase the share of private sector R&D expenditures in GDP. Establishment of technology centers by private sector in priority technology fields; increasing the awareness and culture of society in STI; Increasing the quality and quantity of researchers; reversing the brain migration and employment of foreign researchers in areas of need; to increase cooperation between institutions.

Making arrangements for independent monitoring and evaluation of policies, programs and projects, in the field of S&T; the specialization of the 'Technology Development Zones' to bring the private sector and universities together in priority areas; Intensification of R&D activities in priority areas of technology (nanotechnology, biotechnology, next-generation nuclear technologies and hydrogen and fuel cell technologies); Medical research aimed at raising the quality of life (vaccine and anti-serum in particular); Supporting information, communication, defense and space technologies as priority areas; establishment of Technology Transfer Centers; regulation of the public procurement system to support the development of in-country technology; cooperation activities for information and technology transfer with competent countries, mainly with EU were planned (SPO, 2006).

10th 5-year Development Plan (2014-2018): The plan is based on 'Long Term Strategy Document' which is annex of 8th Plan, as the 9th Development Plan. In order to provide the effective implementation of the plan, it was taken as the basis for the preparation of Medium Term Plans (MTP), annual programs, institutional strategic plans, and regional development and sector strategies. In addition, the priority transformation programs to be implemented by policies and strategies are defined. The S&T objectives and policies were defined under the heading 'Science and Technology' and 'Information and Communication Technologies' and 'Commercialization Programs in Priority Technology Areas' and 'Technology

Development and Local Production Programs Through Public Procurements'. R&D and innovation objectives for year 2018 are:

- Ratio of R&D expenditures in GDP is 1,80%
- Private Sector's Share in R&D Expenditures 60%
- Number of FTE R&D personnel 220,000
- Number of FTE researchers. 176,000
- Private sector share of total R&D personnel is 60%

The S&T Policies are: Cooperation between the research centers of university-public institutions and the private sector; The implementation of R&D and innovation programs to generate new sectors, products and brands with high added value at international level; promoting entrepreneurship for innovation; Review of R&D support programs through impact analysis; Consideration of priority technology areas and commercialization targets in support of R&D activities; Supporting R&D and innovation activities for the development of high value-added green products and clean technologies; regulation of technology development zones legislation to promote, university and industry cooperation and joint R&D and innovative entrepreneurship; Focus of research centers, incubation centers, technology transfer and innovation centers and technology development zones on specific areas; Arrangements to improve university and private sector cooperation, restructuring of higher education, encouraging academicians and students to R&D and entrepreneurship; Increasing employment of researchers in the private sector; Increasing the number and quality of researchers and the number of research done in basic and social sciences; Modification of public procurement system to promote innovation, localization, technology transfer and entrepreneurship; R&D cooperation between public and private institutions, and increasing the ability to transform into products; Development of regional and global collaborations in terms of R&D activities, research infrastructures and researcher human power.

Commercialization Program in Priority Technology Areas: Energy, health, aviation and space, automotive, rail systems, and defense were identified as priority sectors, and commercialization programs were planned in these areas to provide products and benefits. In this framework, program objectives and performance indicators were defined.

Technology Development and Local Production Program through Public Procurement: With the new regulations in public procurement, it was aimed to increase innovation, localization, technology transfer, entrepreneurship and direct investments. Program objectives and performance indicators were set (MoD, 2013).

4.2 Medium-Term Plans as Science and Technology Policy Documents

The main goal of Medium-Term Plans (MTP) is to become competent in STI and to transform this competence into economic and social benefits. The goal of enhancing the innovation ability of the private sector took place in 2007-2009 and the following MTPs. The S&T policies of MTPs are briefly summarized as;

- MTP 2006-2008: Establishing a national innovation system that promotes inter-organizational cooperation and the effectiveness of the private sector within the system, to increase private sector R&D capacity and demand, to develop university and industry cooperation, orientation of university R&D activities according to market demand, elimination of problems and needs in public institutions through R&D, increasing the R&D support to reduce the defense industry's dependency on abroad and transferring the technologies developed for the defense industry to other sectors, universities, research institutions and SMEs, increasing cooperation with countries and international organizations, especially with the EU, which are competent in research and development, it is aimed to increase social awareness in the fields of STI, especially in primary and secondary education institutions. The additional policies of the following MTPs are as follows;
- 2007-2009 MTP: Establishment of technology transfer centers,
- 2008-2010 MTP: Establishment of a system for the monitoring and evaluation of policies and support mechanisms in the field of S&T,
- 2010-2012 MTP: Support of establishment of research centers and central laboratories with the aim of strengthening R&D based production capacity,

- 2012-2014 and 2013-2014 MTP: The goal of the S&T policies was changed and stated as, to increase the innovation ability of the private sector and its scientific and technological competence and to transform these capacities into economic and social benefits.

The S&T policies of the MTP were the repeat of National STI system 2011-2016 strategic framework: Target-oriented planning in areas where R&D and innovation capacity are strong; need-oriented planning in areas that need to be accelerated; decrease of foreign dependency by fostering creativity in the other areas and provide support for the development and commercialization of domestic technological capabilities.

4.3 National Science and Technology Policy Documents

National S&T policies were started to be planned in 1963 with the Five Year National Development Plans. The list of S&T documents and plans are given in Table 6. Until the early years of 1980s S&T policies and decisions were made by TUBITAK as internal processes. Early 1980s were the years of structural change of national science policy processes. In 1983, SCST was established as the highest S&T policy making body of the country to set long term goals, define R&D policies, direct and coordinate applications in S&T.

These initiatives are the remarking milestones of Turkey in transition to S&T policy era in the country. The first S&T policy document approved by SCST is “Turkish Science Policy: 1983-2003” developed with a holistic approach to define prioritized technology areas aligned with economic-social development goals. It was the first time S&T policy prepared out of national develeopment plans and with the contribution of a high number of experts. 10 years later in 1993, the second S&T policy document “Turkish Science and Technology Policy: 1993-2003” was approved by SCST. It is another milestone in Turkey’s S&T policy trends as innovation oriented national S&T policy. The third national S&T policy document “National Science and Technology Policies: 2003-2023 Strategy Document” was developed in 2001-2003. The goals and polices are outlined below.

Table 6 Turkey S&T policy documents

Year	Policy Document
1960	Pilot Teams Project on Science and Economic Development
1965	In order to determine the research potential of the country, the first "Research Staff and Research Institutions Inventory"
1965	In 1965 the "Programming of Research in the Construction Sector" seminar was organized. This seminar was evaluated as the beginning of the activities in the field of 'science policy'
1981	• Evaluation Report of the Scientific and Technical Research Council of Turkey, • Prime Ministry Atomic Energy Commission Status Assessment Report, • Nuclear Program Summary, • Energy in the World and Turkey (Nuclear Energy, Nuclear Technology and AEC) • Research and Development in the World and Turkey, • Establishment of SCST (structure and tasks) • Navigation in the Straits
1981	"Problems and Suggestions in the Science and Technology System" Report
1983	Research and Development Policy
1983	Energy related R&D studies
1983	Marine Science Research Master Plan
1983	Turkish Science Policy: 1983-2003 Objectives: To be among the first 20 industrialized countries as the first target for the year 2003. The 92 development goals and research areas given by the SPO the necessary technological developments were identified and energy, microelectronics, material researches and agricultural researches took place at the beginning of the priority profile.
1993	Turkish Science Policy: 1993-2003 Turkish Science Policy Designed based on 1983-2003.
1995	Science and Technology Progress Project (Basic Structural Change Projects to be addressed first in the 7th Plan period) 7 concrete progress areas have been defined. The defense industry is defined as one of these areas (monitoring the development strategy based on the push of field and product selection). - Turkish Science and Technology Policy: Reference to 1993-2003 (p.19)
1997	Science and Technology Policy of Turkey
1997 1998	National Innovation System
2003	"National Science and Technology Policies:2003-2023 Strategy Document" Vision 2023 Project: 1.Technology Foresight Project, 2.National Technology Inventory Project, 3. Turkish Researchers Inventory Project, 4. National R&D Infrastructure Project.
2005	-2005-2010 period 5-year Implementation Plan: National Science and Technology Policy Implementation Plan -National Innovation Strategy (2008-2010), -International Science and Technology Innovation Strategy (2007-2010).
2011	2011-2016 National Science, Technology and Innovation Strategy 2013 Action Plan

4.3.1 Turkish Science Policy: 1983-2003

'Turkish Science Policy 1983-2003' document is the first document prepared in line with OECD norms. The policy document was prepared in approximately two years with the participation of approximately 300 scientists and experts.

Scientific long-term goals, priorities in science and research, and national R&D indicators (researcher human power and R&D expenditures) have been identified. Energy, microelectronics, material researches and agricultural researches have taken place at the forefront of the prioritized technology fields identified from the list of 92 development targets and research areas (TUBITAK, 2001). The policy document had an overall hierarchical structure from top to bottom (Türkcan, 2009). As a result of this work, SCST was established in 1983 with the Decree Law No. 77 for the establishment and application of S&T policies. Goals for R&D spendings;

- Increase R & D spending by 15% per year,
- Distributing research funds according to priorities,
- Increase the GDP share of R&D spendings to 1% in 1993 and to 2% in 2003.

Human power related targets in R&D;

- Raising the number and quality, competency of researchers,
- To plan researcher human power,
- To increase the number of FTE researchers in the workforce of 10.000 to 15 in ten years and to 30 in 20 years.

Objectives related to contributing to world science literature:

- To rank Turkey, among the first 30 countries in 10 years, and in the first 20 countries in 2003.
- One of the 5 identified objectives is, R&D activities to strengthen the Defense Industry (Özdaş, 2000).

For a sound research system, the additional policy recommendations;

- Establishment of the S&T Commission in the The Grand National Assembly of Turkey (TBMM), (the activities of the Energy, Science and Technology Commission in the TBMM started in 2011),

- Providing research coordination in ministries,
- Establishment of new R&D industries (biotechnology, metrology, etc.).

4.3.2 Turkish Science and Technology Policy: 1993-2003

The aim is to bring Turkey to the level of developed countries in S&T fields. The 2003 targets were down graded of the previous science policy targets. The goals were:

- To increase the number of full-time equivalent researchers from 7 per 10,000 population to 15,
- To increase the share of R&D spending in GDP to 1%,
- To raise the Turkey's scientific contribution rank to 30th,
- To increase the share of private sector R&D spending to 30%.

The policies are grouped under four main headings;

- Financial resource;
    - Competition and demand creation in domestic market through public procurement,
    - Support of public R&D projects by TUBITAK,
    - To use indirect offset of large investments made with foreign partnership as financial resources through TUBITAK,
    - Transfer ofresources from Development and Support Fund to conduct international mega projects,
    - Selection of technology to be transferred from abroad by "Technology Evaluation Center" where the TUBITAK has active role,
- Human power;
    - Centralization of international doctoral programs conducted by different institutions,
    - Encouraging orientation towards science branches at the undergraduate level,
    - Increase of schooling and quality in secondary education and higher education,
    - Continuation of the program of bringing scientists from the former Soviet Union, initiated by TUBITAK in 1992.

- Increasing the share of private organizations in R&D spending,
    - Funding for R&D activities of private institutions,
    - Encouraging small and medium-sized enterprises to R&D,
    - Encouraging multinational companies to establish R&D units in Türkiye,
    - Establishment of the risk capital market,
    - Coordination of technopark activities with TUBITAK,
    - Encouragement of transition from licensed production to original design,
    - Update of patent and intellectual property legislation
- Increasing Turkey’s contribution to S&T in the world;
    - Establishment of university-based centers of excellence,
    - Establishment of Turkish Academy of Sciences (TUBA)
    - Promotion of scientific publishing activities at international level.

4.3.3 Science and Technology Progress Project

The Science and Technology Progress Project was prepared in 1995. It was one of the 20 projects in the 7th development plan to be addressed primarily, and prepared by the study committees within the scope of the basic structural change projects. It has provided input to the 7th development plan under the title of S&T policies.

It was proposed to make progress in seven areas with the progress project in S&T:

- Establishment of National Information Network, Establishment of Telematic Services Network,
- Adapting the country's industry to flexible production and flexible automation technologies to strengthen international competitiveness,
- Renewal of railway system with high-speed train technologies and extension of railway systems in urban transport,
- In space, aerospace and defense industries, the implementation of technology-driven investment strategy,
- Focus on R&D, in genetic engineering and biotechnology,
- Focus on environmentally friendly and energy-saving technologies and expand the scope of implementation across the country,

- R&D investments in advanced material technologies to support other progress areas.

In addition, the following proposals were made in the document for S&T management and political committment:

- Establishment of a ministry on S&T, making SCST operative,
- Incorporation of TÜBA and Technology Development Foundation of Turkey (TTGV) into SCST,
- Constitution of a permanent commission in the Parliament, for the support of the political authority and for the continuity of support,
- Extension of TUBITAK's job definition to include social sciences, until the establishment of an institution related to social sciences,
- Transformation of informatics services into autonomous structures,
- To convert Turkish Atomic Energy Authority (TAEK) to a structure similar to TUBITAK,
- The autonomy or unification of the research units of the institutions,
- Reorganization of SPO's role in S&T management.

4.3.4 National Science and Technology Policies: 2003-2023, and National STI System

Development of a new S&T policy started by SCST in 2000 with the decision of SCST (2000/1), and titled ‘Vision 2023: Science and Technology Strategies’ to create an innovative economy and society in 2023 and use S&T in this transition process.

The goal of the strategy document is to realize the “Vision 2023” vision. S&T was seen as the most effective tool to reach the goal. The defined strategies are; Focusing on technology fields prioritised at technology foresight project by prioritizing the allocation of public funds to these strategic technology fields; Developing cooperation networks on focused strategic technology fields to transform research outputs to socio-economic benefits; Management of focusing process in a systematic and holistic way, and in a framework to provide coherence between the agents, monitoring, evaluation and update of all activities and policies from education to tax, to industrial investment policies. Therefore, creating a knowledge-based economy and to provide the sustainability of the knowledge based economy by improving the national innovation system.

The approaches and strategies are; ownership of the joint vision, NIS and strategies by governments; focusing and supporting scientific research areas, allocating funds for R&D, developing required humanpower, creating public awereness.

The measures to realize the Vision 2023 goals are:

- Declaration of will for political ownership,
- Determination of those responsible for Vision 2023 applications,
- Constant monitoring and evaluation system setup and, to initiate monitoring and evaluation
- Use of public procurement as a policy to increase technological competence, making legal arrangements,
- Preparation of national implementation plans, allocation of financial resources.

It is planned to monitor and evaluate the STI indicators in order to determine the success of the strategy to be implemented.

The defined strategic technology fields are ICT, biotechnologies and gen technologies, nanotechnology, mechatronic, production process and technologies, material technologies, energy and environment technologies, design technologies. The technology roadmaps were prepared, milestones and objectives were defined. The policy tools to enable focusing on technology fields are; Acquisition of public and defense needs with R&D; Developing national R&D funds - national research programs; Developing guided R&D projects.

The STI indicators were defined to monitor and evaluate the performance of the strategies, and 5 Year Implementation Plan (2005-2010) was prepared. Wit this plan TUBITAK was assigned as the coordinator and responsible agent for the execution of the strategies, monitoring and evaluation of the process and to evaluate to what degree the R&D efforts transformed to socio-economic benefit.

The goal of the year 2023 is to be one of the top 10 EU countries. The 2023 R&D targets approved by SCST in of 2011 (decision no: 2011/101) are;

- Increasing R&D intensity to 3%
- Increasing business R&D expenditure ratio to 2% of GDP
- Increasing number of FTE researchers to 300,000
- Increasing number of private sector researchers to 180,000

The STI Strategy 20011-2016 was prepared with the decision of 21st Meeting of SCST in 2010 (decision no: 2009/201) and approved in 2010 by SCST (decision no 2010/201).

The plan was prepared in light of National Science and Technology Policies, 2003-2023 Strategy Document, national development plans and yearly plans. A series of workshops were conducted with the participations from university, government and industry. TUBITAK was assigned as the the coordinator and responsible agent for the execution of the strategies, monitoring and evaluation the progress. The automotive, ICT, machinery manufacturing, defense, space, water, energy, food sectors are the prioritised strategic sectors. Health sector was included as prioritised sector to the STI strategy in 2013 (SCST decision 2013/106).

Vertical pillars of the National STI Strategy (2011-2016) are; Mission-oriented approaches in areas with strong R&D and innovation capacity (automotive, ICT and machinery manufacturing); Need-oriented approaches in areas with demand for gaining acceleration (defense, space, health, water, energy, food); Bottom-up approaches in basic, applied and frontier research.

The horizontal layers are; Development of human resources for STI; Transform of research outputs into products and services; Enhancing multi-actor and multi-disciplinary R&D culture; Strengthen role of SMEs in STI system; Increasing contribution of R&D infrastructure to TARAL's knowledge production; Increase of international STI cooperations.

Science, Technology and Humanpower Strategy (2011-2016), National Energy R&D and Innovation Strategy, National Water R&D and Innovation Strategy, and National Food R&D and Innovation Strategy were approved in 2011, by 23rd Meeting of SCST. There is a remarkable shift in STI plan from horizontal to vertical focus and from research to innovation to transform research outputs into products and services (Erdil & Çetin, 2013, 2014).

As part of national STI system, Impact Evaluation division was established in mid 2014 under MoSIT to provide necessary information and knowledge to policy and decision-makers to design efficient policies, to decide on to support the programs. Number of impact evaluation exercises are very limited and conducted by researchers, academicians or public organizations. Although, huge budgets were allocated to R&D and innovation programs, no mechanisms were set for the systematic evalution (ex-ante, intermediary or ex-post) of R&D policies or foresight exercises yet (Erdil, Pamukçu, & Çiftçi, 2016).

4.4 Failure or Success Reasons of Science and Technology Policies in Turkey

'Turkish Science Policy: 1983-2003' and 'Turkish Science and Technology Policy: 1993-2003' were used as source in various studies. In the country, the necessary competence to prepare science policy has been achieved. Findings in policy studies have been confirmed (Özdaş, 2000). However, the implementation of S&T policies has failed (Göker, 2005).

The fundamental deficiency of S&T policies is defined as the inability to implement it within a systematic integrity, continuity and political ownership (Özdaş, 2000). Comparisions of S&T objectives of development plans and S&T policy documents are given in Table 7 and Table 8.

Table 7 **Comparison of S&T objectives of national development plans**

Indicators	**1983 Realization**	**6th DP 1990-1994**	**7th DP 1996-2000**	**8th DP 2001-2005**	**9th DP 2009-2013**	**10th DP 2014-2018**
R&D/GDP	0,3%	1%	1,5%	1,5%	2%	1,8%
Private Sector R&D /Total R&D Expenditure					60%	60%
Number of FTE R&D Personnel		66.000*				220,000
Number of FTE Researhers/10.000 employee	4,2	15**	15	20	80.000	176.000 ***

(*) No "FTE" classification
(**) No "working citizen" classification
(***) No "per 10.000 working citizen" classification

Table 8 Comparison of national S&T policy objectives

		S&T Policies:1983-2003		**S&T Policies: 1993-2003**	**S&T Policies: 2003-2023**	
Indicators	**1983 Realization**	**1993 Targets**	**2003 Targets**	**2003 Targets**	**2013 Targets**	**2023 Targets**
R&D / GDP	0,3%	1,0%	2,0%	1,0%	2,0%	3%
R&D Expenditure of Private Sector /Total Country R&D Expenditure				30%	65%	65%
Number of FTE Researchers per 10.000 working citizen	4,2	15	30	15	60	300.000*
FTE Researcher of Private sector /Total					50%	60% (180.000)
Rank of contribution to world science	41	30	20	30		

(*) No "10.000 working citizen" classification

As a result, S&T policies have been repeated from the First Development Plan to the 10th Development Plan. As seen from the tables, some R&D targets of development plans and S&T policy documents set back from previous plans due to low realizations. It reflects the disconnection between national development plans and S&T policies, and lack of coordination.

With regard to the reasons for failure of S&T policies and their deficiencies in implementation, the insights and findings derived from the reports (1995) of TUBITAK "Science and Technology Progress Project" Working Committee and from other sources (Bermek, 2001; Erdil et al., 2016; Göker, 2013; Özdaş, 2000; Saritas, Taymaz, & Tumer, 2006; TUBITAK, 2004; Tümer, 2004) are as follows:

- The 1980s were defined as the years in which S&T policies were laid back (Göker, 2015).
- Non-execution of SCST Meetings: The first meeting of the SCST was held in 1989, six years after its establishment. During this 6 year period, the necessary support was not given to the 'Turkish Science Policy: 1983-2003' document,
- Lack of political and public ownership and support,
- Lack of holistic approach and linking S&T policies to social and sectoral policies and to national innovation system,
- Lack of integration between national policies with research operations made by public and private sector organisations, lack of focus to achieve the integration and to concentrate resources on determined areas,
- Lack of legal-structural-financial mechanisms to provide communication and interaction between research, technology development and economical- social benefit,
- Insufficient understanding and knowledge,
- Failure to convert state policies to social projects, built on a vision which was not shared by all related parties,
- Change of staff: the result of a change in the management of TUBITAK, the absence of authorized persons to deal with this issue, and the deterrence effect of initiative use,
- Interruption in information flow due to staff change in organisations,
- Lack of demand and pressure of industrial sectors on S&T policy due to their structural reasons,
- Culturel effect: Lack of long-term planning culture and strategic planning discipline in institutions,
- Organization's failure to become a learning organization: The inability of organizations to return to learning organizations due to the lack of expertise and desire to operate the long-term planning, implementation, monitoring and evaluation process,
- Lack of specialised personnel: In organizations, to act with political populist approaches, instead of merit in personnel employment and promotion,

- Lack of co-operation between TUBITAK and SPO: The lack of co-operation between these two institutions responsible for making, implementing and coordinating national S&T policies,
- The absence of a Ministry of S&T: Though the implementation and coordination of science policies require authority and responsibility at the ministry level, responsibility was given to a board (SCST) on this matter,
- Lack of social awareness on S&T.

Some of the deficiencies listed above were cleared but in general they are still valid. 2003-2023 S&T policy document had the same fate with the prior S&T policy documents. Policy recommendations or proposals of the S&T policy document were not implemented and supported by TUBITAK administration and the governments of early 2000s.

4.5 Vision 2023 Technology Foresight

"Vision 2023" project was started in 2000 to develop the national S&T policies. The project had four main sub-projects as Technology Foresight Project, National Technology Inventory Project, Turkish Researchers Inventory Project, and National R&D Infrastructure Project. In Vision 2023 project, foresight exercise is used as an instrument in order to overcome the problems of formulation, implementation and realization of S&T policy documents. Therefore the backbone of 'Vision 2023' project was the 'Vision 2023 Technology Foresight' sub-project and it was the first national foresight exercise of Turkey. In this sub-project socio-economic goals which will realize Vision 2023, priority activity areas and their common ground technology fields to reach these goals were defined. TUBITAK was assigned as the responsible organization. The Vision 2023 Technology Foresight study was directed by a senior committee of 65 people. This committee consists of representatives of public institutions and organizations, Non-Governmental Organizations (NGOs), professional chambers, private sector companies and universities. The technology foresight study led by a high level executive board representing TUBITAK, SPO, SSM and TTGV, and was carried out by a team of TUBITAK staff and consultants.

Vision 2023 Technology Foresight subproject was based on foresight panels, Delphi, and scenario methods. Panel work was the basis of the technology foresight study. Two thematic and 12 sectoral panels were created. ‘Defense, Aviation and Space Industry’ panel was one of these socio-economic areas and may be one of the most mature sectors to carry out and adapt this exercise. Approximately 250 people who are experts in their fields have participated in the panels, from public, university and private sector. Total of 192 panel meetings and 36 extended panel meetings with outside experts were held. In the study, a two-stage Delphi interrogation technique with broad participation was used. Approximately 7.000 specialists were reached with Delphi survey, and 34% responded.

Strategic Technology Groups have identified policies to ensure the achievement of goals in the direction of technology priorities, technology areas with strategic priorities, and competency targets set out in the panels. During the course of the work, 140 members took part in this group.

‘National Science and Technology Policy 2003-2023 Strategy Document’ covering the strategies to be followed until 2023 was prepared by using the results of all the studies made by a Strategic Group of eight people consisting of TUBITAK staff and consultants (Göker, 2005).

The aim of Vision 2023 Technology Foresight (Daim et al., 2009; Saritas et al., 2006; TUBITAK, 2004) is defined as:

- To create the S&T vision of Turkey,
- To identify strategic technologies and R&D priorities,
- To shape the S&T policies of the country for the next 20 years,
- In this process, to ensure in the broad spectrum partners and gain their support,
- To raise public awareness of the importance of S&T for socio-economic development.

Benefiting from the foresight project in the design of the country’s S&T policies, and to increase the benefits from it (broad participation, long-term thinking, focus on future, coordination, and social ownership).

4.6 Vision 2023 DAS technology foresight

The Defense Aerospace Industry panel is one of the 12 panels created within the scope of the Vision 2023 Technology Foresight project. In the panel, there are total of 21 members including 7 members from TAF, 6 members from industry, 4 members from university and 4 members from public office. In the panel study, two-stage Delphi was conducted. 793 people attended the Delphi exercises. The distribution of participants are; 36% public, 34,1% industry and 29,9% universities (Çakır, 2015). The purpose of this panel is, to determine national technologies that can be used for dual purposes, which will contribute to the goals of Vision 2023 through military-civilian viewpoint and work, "*not to create an alternative to the studies of determining long-term national defense and security needs and technology development targets conducted by MoND-TAF".*

As a result of the study, national defense and aerospace industry vision and, sectoral and socio-economic targets were determined. Technological activities and technology fields that are critical to achieving the vision and objectives are defined.

Prioritization has been done in two stages: In the first stage, the vision of the sector, the long-term technological needs determined by TAF and the critical technologies of the future in this direction has been determined. The Critical Technology Tree, consisting of about 600 technology areas, was created. As a result of the work carried out according to the first stage priority criterias, 109 of the 600 technology fields were identified as critical technology areas. These 109 technology areas are grouped under 11 different activity headings. In the first stage prioritization, the LISTSEL weighting and prioritization model developed by the General Staff BİLKARDEM and the PAIRSEL model were used.

In the second stage, a short list was created by the panel covering 38 technology areas, which are the top priority in the list of 109 technology areas. Technology areas have been transformed into Delphi expressions. Each Delphi expression has been questioned by experts. Expressions as a result of the delphic questioning, were prioritized by calculating the second stage prioritization criteria and weight points of these criteria. As a result of the second stage evaluation, 6 main Technology Activity Areas were determined (TUBITAK, 2003).

Technological Objectives:

a) To achieve high quality information services at all levels from the integrated system to the individual user in the fields of information communication and information management for military and civil purposes; in the fields of information and communication security, to have national technologies and products that meet the military and civil needs and have international competitiveness.

b) Having advanced sensor and system technologies used to provide physical and biological safety at system and user level,

c) Having the technologies that increase system-user interaction and system usage efficiency,

d) To have unmanned systems and robotic technologies with platforms that can be used for civil and military purpose,

e) To have satellite technology for civil and military purposes and to have technological knowledge and facilities that can send rockets to space,

f) To have critical weapons, counter-weapons and protection technologies in terms of national defense.

Technology Activity Areas:

1. Informatics Technologies,
2. Sensor, Electronics and Communication Technologies,
3. Navigation, Guidence, Control and Microelectromechanical System Technologies,
4. Propulsion, Power and Energy Technologies,
5. Land, Sea, Submarine and Air Platform Technologies,
6. Space Technologies,
7. Extraordinary Systems, Production Technologies and Nanotechnology
8. Strategic Material Technologies
9. Biotechnology, Biomedical and Medical Technologies
10. Weapons and Ammunition Technologies
11. Modeling / Simulation / Analysis and Training Technologies

A total of 38 critical technology fields were defined under 11 technological activity headings.

In the field of Defense and Aerospace, the S&T Policy Roadmap was prepared, and policy and implementation recommendations have been developed for the achievement of science, technology and socio-economic goals. Policy recommendations are detailed in the fields of industry, procurement, legal regulations, institutional infrastructure, resource management and training.

Products of Vision 2023 DAS Technology Foresight are: Defense and Aerospace Sector Analysis, Evaluation Reports; Critical Technologies Tree; Science Technology and Innovation Road Map; Science Technology and Innovation Policy Road Maps / Turkish Defense Industry Policy and Strategies; Technology Taxonomy; Technology Prioritisation (Critical Technology Prioritisation Activities, Delphi Survey Results and Evaluation).

4.7 Laws, Regulations and Institutions Related with National Defense R&D

4.7.1 STI system of defense sector

The agents and policies governing STI mechanisim of defense sector is outlined in Figure 3 and Table 9. A highly flexible mechanism was established to construct a modern defence industry and to modernize TAF. The Defense Industry Executive Committee (DIEC) which makes critical decisions related to defence industry and major defence procurement projects, Undersecretariat for Defence Industries (SSM), and the Defence Industry Support Fund are the main pillars of the mechanism. The defense sector conducts long-term brainstorm and workshops in an increasing trend toward developing long-term planning culture.

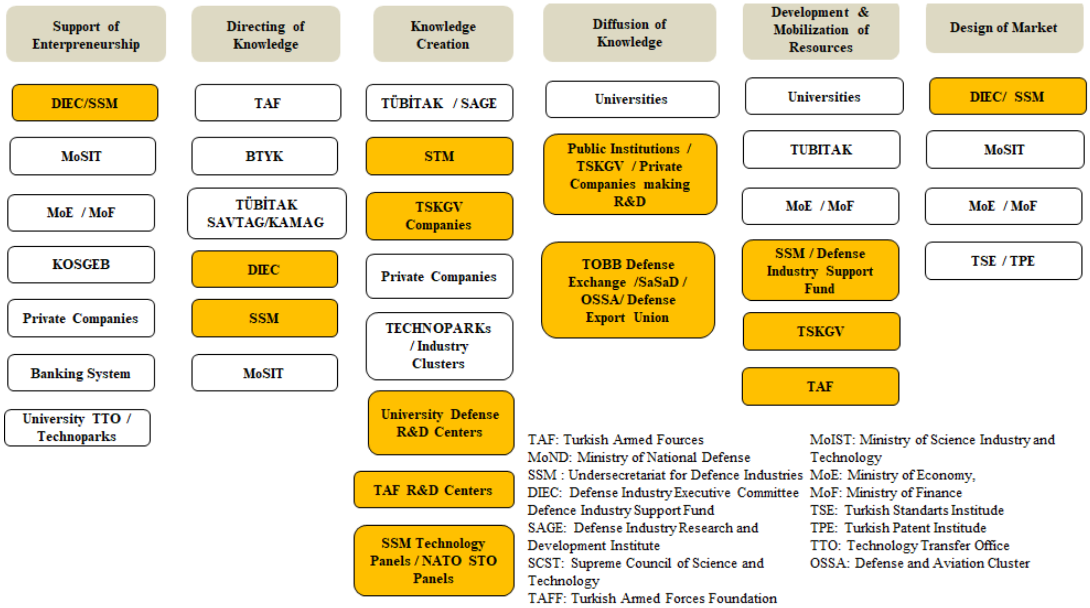


Figure 3 Reflection of national STI sytem on defense sector

Table 9 Defense related organisations & policy documents

Year	Public Institutions / Policy Documents
1972 1983 1988	Establishment of SAGE and name changes: • Guided Vehicles Technology and Measurement Center (GATÖM) • Ballistic Research Institute (BAE) • Defense Industry Research and Development Institute (SAGE)
1985	Establishment of SSM (Law 3238), 13/11/1985, No: 18927)
1985	Defense Industry Executive Committee (Law No. 3238)
1998	Turkish Defense Industry Policy and Strategy Principles
2001	Establishment of Technology Zones (Defense Cluster in METU technopark)
2003	Offset Implementation in Defense Procurement Directive-2003
2004	Defense Industry R&D Working Group (TÜBİTAK)
2005	TUBITAK, Public Institutions Research and Development Projects Support Program (1007 Program) • KAMAG - Executive Research Support Group • SAVTAG - Research Support Group for Defense and Security Technologies
2007	Industrial Participation / Offset Implementation Directives
2007	SSM Strategic Plan 2007-2011
2009	SSM 2009-2016 Defense Industry Sectoral Strategy Document
2011	Industry Participation / Offset Guide (2011)
2011	SSM Technology Management Strategy 2011-2016
2012	SSM Strategic Plan 2012-2016
2015	SSM, Technology Readiness Guide for the Defense Industry
2017	SSM Strategic Plan 2017-2021

Defense Industry Research and Development Institute (SAGE): SAGE was established in 1972 with the name of Guided Vehicles Technology and Measurement Center (GATOM) and then changed to Ballistic Research Institute (BAE) in 1983 and in 1988 it was named as Defense Industry Research and Development Institute (SAGE). The mission of the institude is to carry out research and development activities, including engineering and prototype production, starting from the basic research and conceptual design of defense systems.

Undersecretariat for Defence Industries (SSM): SSM was established in 1985 with the law 3238 to construct a modern defence industry and to modernize the TAF, by generating long term defence policies and principles, and supplementing financial resources. Its major tasks are; To reorganize Turkish industry in line with the needs of defence industry; To conduct research, development and production of modern arms and equipment; To coordinate export and offset trade issues in this scope. SSM enacts the decisons of DIEC. SSM put a series of policy documents into implementation to improve in defense related technologies. These documents are Industrial Participation / Offset Implementation Directives, Strategic Plan documents, Technology Management Strategy documents, and other guiding documents.

Turkish Defense Industry Policy and Strategy Principles: The policy document entered into force in 1998. The aim of the policy document is to identify the objectives regarding to what extend the arms, weapons, and ammunitions needs of TAF are met with the Turkish defense industry capabilities and capacity, and to identify short-mid-long term development planning principles of Turkish defense industry to meet these objectives; and to identify the export principles.

SSM Plans and Guiding Principles and Documents: Strategic plans, technology management plans are prepared to develop a competent defense technology base focused on TAF needs. Offset and local content guides are prepared to identify the principles of the applications to leverage defense industry and increase the value for money from the defense related development or procurement projects. Technology Readiness Guide for the Defense Industry in order to increase awereness of defense industry companies on Technology Readiness Level (TRL) and to provide a common ground for communication and evaluation in development of new Technologies. Performance indicators are defined for the evaluation of the progress and realization of the goals and objectives.

MoND/SSM R&D Divisions and Technology Panels: R&D and technology management division was established in SSM to conduct and support the R&D projects which are prioritised through the designed system-component-technology infrastructure roadmaps in regard to acquire the needs of TAF. SSM has defined strategic technology fields as TNoE.

The R&D division and technology panels of MoND were merged with SSM's R&D division in 2016. The technology panels were setup on, weapon and platform technologies, sensors and electronics technologies, vehicle technologies, information systems technologies, modelling and simulation technologies, material technologies and energy materials, human factors and military health technologies, technology management, and CBRN. These panels are formed in parallel to NATO Science and Technology Organization (STO) panels. The panels were formed to enable cooperation and to exchange information between stakeholders (military, government institutions, university, and industry).

Defense Technologies as Focus Area: The socio-economic objectives and to realize these objectives focus of S&T in the selected Technology Activity Areas and Technology Fields strategies were identified in "Vision 2023 Technology Foresight". "2005/4: National Prioritised Science and Technology Fields" decision of SCST (11th meeting) was based on "Vision 2023 Technology Foresight". In the decision the defense technologies (Gaining Competence to Develop Space and Defense Technologies) was listed at the third row of the Prioritized Technology Activity Areas. The sub-technology activity areas are; Designing satellites and to gain competence to launch satillites; Developing critical weapons and ammunition protection technologies; Development and production of NBC (Nuclear, Biological, Chemical) detection systems.

SAVTAG-KAMAG: National Defense Research Program (SAVTAG) was established in 2005 with the decision of SCST (decision number: 2005/8). The aim is to conduct R&D projects in the field of defense by allocating the necessary resources. National Public Research Programs Preparatory Studies (KAMAG) was established in 2005 with the decision of SCST (decision number: 2005/5). The aim is to meet the needs of public institutions based on R&D and to create research programs related to the needs to create R&D demands at the social level.

Support Programs for Defense and Aerospace R&D Projects: In order to carry out Defense and Space R&D Projects according to "TUBITAK, Support Program for Public Institutions Research and Development Projects" numbered 1007, these regulations have been amended to "Regulation on Support Program for Public Institutions Research and Development Projects" (Official Gazette date 13.07.2005 and number 25874). With the support of TUBITAK, TAF Defense and Space R&D Projects Cooperation Protocol was signed (11.07.2005), between TUBITAK, SSM and MoND Undersecretariat.

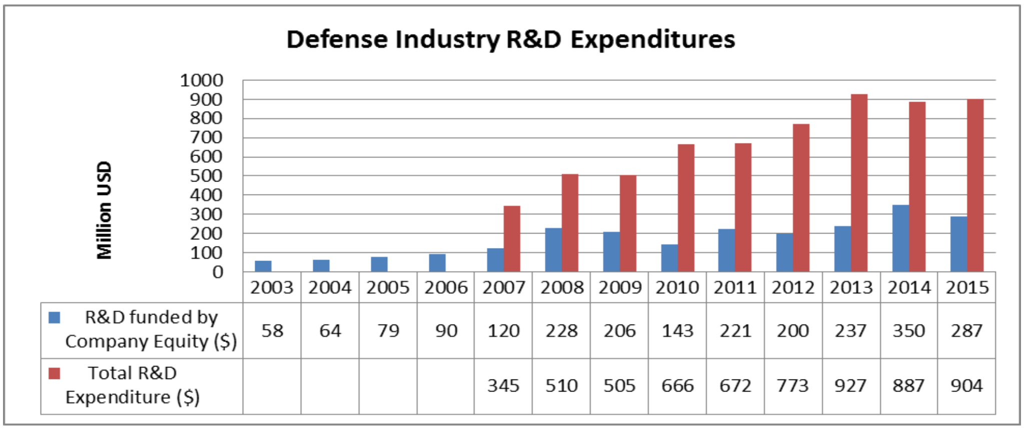
TAF R&D Centers: There are R&D centers established in the TAF and TAF-University joint R&D centers. The goal of these centers to do research in S&T fields and develop prototypes in line with TAF operational needs. The outputs of the centers are operationalized in the related forces. There are cases that the outputs are commercialized through transferring knowledge or technology to industry. Patrol and Anti-Submarine Warfare Ship (MILGEM- National Ship) Project, METU-TAF Modelling & Simulation R&D Center are examples of knowledge / technology transfer applications.

Technoparks: The efforts to establish technoparks started in 1980s. The legal frameworks of technoparks was regulated by Technology Development Zones (TDZ) Law No. 4691 (year 2001), and TDZ application regulations (years 2002 and 2016). The aim of TDZ is to create technological knowledge, commercilisation of knowledge, to increase the quality of the product and production processes, to ease SMEs to reach technology, to increase the competitiveness of industry by increasing the employment of researchers, and the foreign capital for technological investments. Technoparks are the tools to enhance technology transfer through government, university and industry cooperation.

METU technopark was established in 2001 as the first one and has the biggest defense cluster in technoparks. 55 technology zones are active out of 69. As of 2016, the total number of patents (national/international) received by the technopark companies is 640. Only 3% of companies located in these technpoarks are defense companies, and 54% are ICT and SW companies. The cooperation level of defense industry companies located in METU Technopark and Bilkent Cyberpark for technology transfer was low (Kılıç & Ayvaz, 2011).

4.7.2 R&D Expenditures of Turkish DAS Industry

R&D expenditure of DAS industry is given in Figure 4. Total R&D expenditure has recorded an increase between the years of 2007-2015. Meantime R&D expenditures funded by company equities increased significantly in 2008-2015 compared to previous years (SaSaD, 2013), (SaSaD, 2017). The gap is R&D projects funded by customers (TAF, MoND/SSM) and government incentives. Number of SSM's TUBITAK funded R&D projects started in 2005 and afterwards increased significantly. The breakdown of total R&D expenditure is needed to make analysis regarding the economic impact and contribution of Vision 2023 DAS technology foresight to this change.

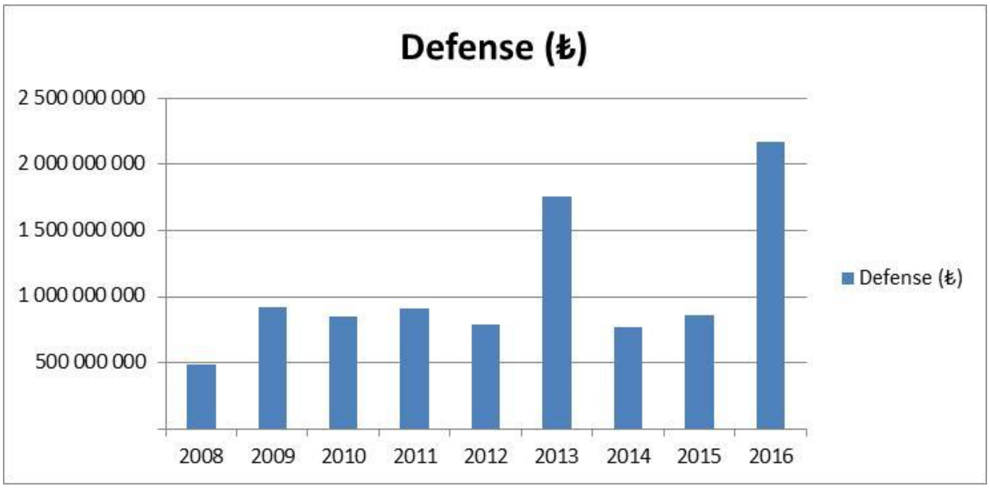


	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
R&D funded by Company Equity ($)	58	64	79	90	120	228	206	143	221	200	237	350	287
Total R&D Expenditure ($)					345	510	505	666	672	773	927	887	904

Source: SaSaD, 2013, 2017

Figure 4 DAS industry R&D expenditures

Central government budget appropriations and outlays on R&D by socio-economic objectives (TUIK, 2016) is given in Figure 5.



Source:TUIK, 2016

Figure 5 Central government budget appropriations on defense R&D

Data prior to 2008 is not available therefore no comment could be done regarding the relation between Vision 2023 DAS Technology Foresight and Central government budget appropriations on defense R&D except it was increased significantly in 2013 and 2016.

4.7 Remarks

Turkey entered a planned era with the first national development plan. Mid-term plans followed the development plans. S&T policy documents prepared as separate documents to plan the future of S&T investments and benefit from S&T as resource and power to increase the welfare and competitiveness of the country in the world. The focus of the development plans shifted from research to innovation by change in policies from science research to applied research, taking industry needs into consideration, and using technology policy term and innovation term through 2nd - 9th plans.

When S&T policies of development plans are compared it is seen that they are repeated due to low realization of the objectives. Similar case is seen in the S&T policy objectives, in some plan terms S&T targets drew back of the previous period targets. The S&T 2003-2023 Strategy Document differs from the predecessors with its processes and methods. In this strategy document, policies are more specificly defined, technology fields are prioritized and roadmaps are developed. STI system is stimulated, strategic sectors are identified. Defense was defined as strategic sector in the S&T policy sections of the development plans, starting from the 4^{th} development plan and national STI system. STI indicators based on EU are identified. Beside all these positive and promising progress, systematic evaluations on R&D programs are not conducted or published yet.

Sustainability of monitoring and evaluation requires a cultural base. Deciding on STI indicators, obtaining data, sustainability, validity and reliability of data, analysis of data, and feed back of analysis results to policy design processes and policy makers require the commitment, acountability and transparency. It was a big gain to develop a shared vision and S&T policies, and to develop related policies from tax to industry, and to stimulate NIS to foster the research and innovation capacity in the country. Number of impact evaluation exercises is very limited. Although, huge budgets were allocated to R&D and innovation programs, no mechanisms were set for the systematic evalution (ex-ante, intermediary or ex-post) of R&D policies or foresight exercises yet.

Defense sector has a more flexible structure and made big progress in long-term planning, R&D and technology management. The evaluation of S&T policies or the technological developments are not conducted or published yet. Performance evaluations are made through annual reports and by internal teams.

CHAPTER 5

RESEARCH METHODOLOGIES AND TECHNIQUES

In this chapter, the methodologies, techniques and tools applied in the research are explained in detail. The goals of the thesis are the assessment of long-term impact of Vision 2023 Technology Foresight in defense sector and the development of an impact assessment model. In order to assess the impact an assessment scale needs to be developed. In order to achieve the goals of the thesis, the process and research methods were implemented as outlined in Figure 6.

In the research, in-depth face-to-face interview, focus group, document analysis, and survey methods were applied to extract knowledge through gathering and analysing of data, information, insights from different sources.

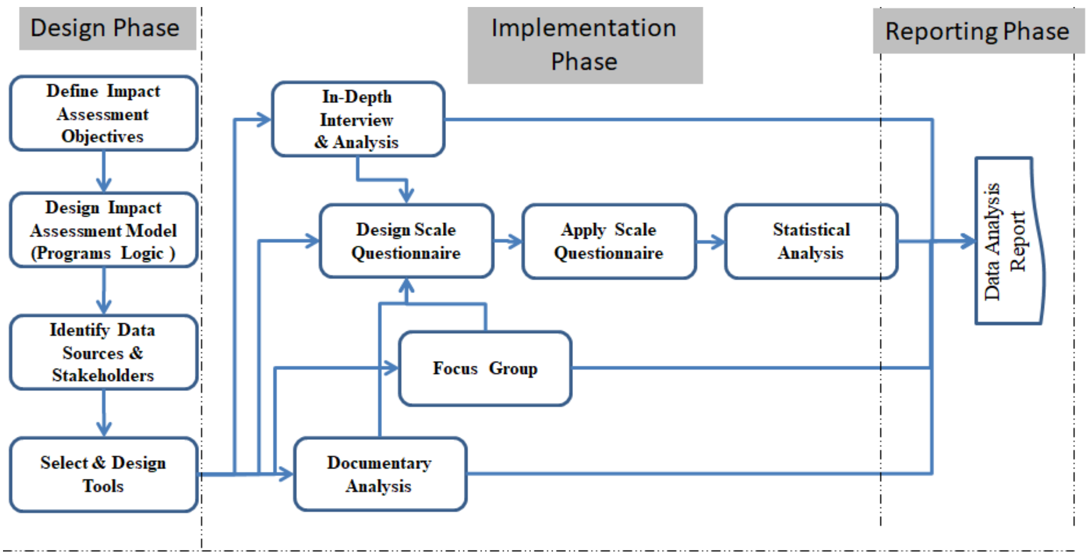


Figure 6 Assessment process

Data sources of the research are:

- Panelists of Vision 2023 Technology Foresight
- Participants of Delphi exercises
- Representatives from army, institutions (MoND, SSM, TUBITAK, etc.,), defense industry companies, Non-Governmental Organisations, and universities.
- Outputs of Vision 2023 Technology Foresight
- Resolutions of SCST and documents of national STI System
- EC ERAWATCH and OECD reports and statistics on STI systems of nations
- National long term (5 years) and mid term development plans.
- Documentary of industry stakeholders
- Higher Education Council (YOK) theses database
- Turkish Statistical Institude (TUIK) statistics

The research is based on Program Theory-Based evaluation approach. It generates information about the program, how the outcomes are generated, the contribution of the program on the outcomes, and helps to draw causality relations, and directs improvements of the program. Program logic model used for the assessment is given in Figure 7.

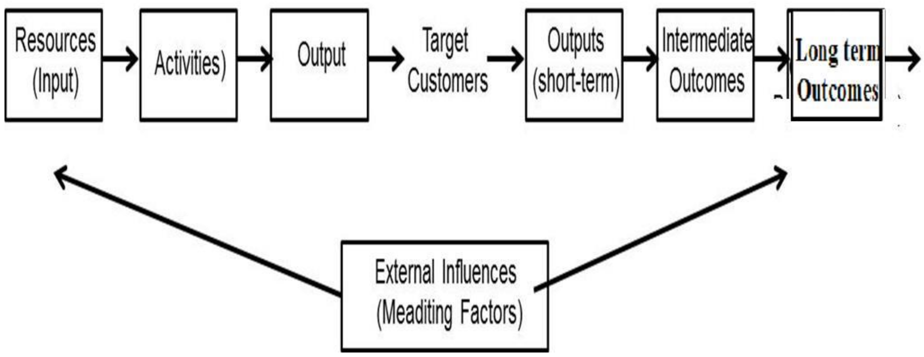


Figure 7 Program-Theory approach (Program's Logic Model)

At the beginning of the research, insights of a group of experts are obtained about the impact of Vision 2023 Technology Foresight in defense sector in order to identify impact, impact variables, and hyphoteses. This pre-interview activity was helpful especially developing a baseline for impact and impact areas. In this phase 14 experts were interviewed. A sub-group of them were contacted throughout this research as advisory group on a voluntary basis. This advisory group consists of 7 experts from government institutions, universities and industries. 5 of them were committee members or panelists in the Vision 2023 Technology Foresight program and 2 were not. The output of this process is used as the input to program logic to define the ex-post ultimate impact of the technology foresight. The program logic model is based on program-theory approach, roadmaps of Vision 2023 DAS Technology Foresight, and insights of experts as given in Table 10. The database of informants and sampling of population to be contacted throughout the research is developed as given in Figure 8.

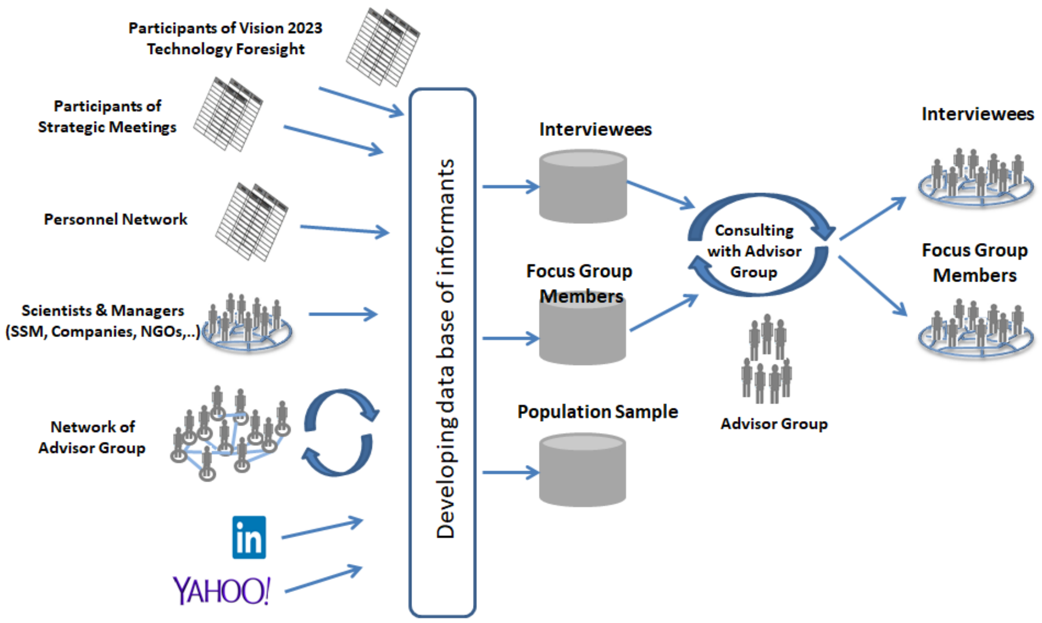


Figure 8 Building informants database and choosing interviewees & focus group participants

The committee and panelist lists of Vision 2023 Technology Foresight, attendees list of long-term planning activities of TUBİTAK, SSM, SaSaD, TOBB, and decision makers, managers of defense institutions and defense industry companies were reviewed. An informants database was developed to select interviewees, focus group members and sample size of the population to conduct the survey. Interviewees and focus group members were chosen by consulting with this advisory group. Network of core advisory group and their snow-ball effect helped in reaching the informants.

Social media platforms were effective in reaching to right individuals and receiving their feedbacks.

In the interviews and survey, a variety of questions about the impact of the technology foresight were directed to interviewees and survey respondants to collect their insights and the impact perceptions. Perceptions could be different from reality and biased. Perception is defined as process of attention and selection, organization, interpretation, retrieval, and response of people to information from the environment, world around them (Schermerhorn, Osborn, Uhl-Bien, & Hunt, 2011). The use of data/method triangulation prevents bias and complements each other. At the end, the individuals consisting research population are from the defense sector or other sectors in interaction with defense sector are influenced by the policies and decisions directly or indirectly. Therefore, their perceptions are essential to measure and assess the impact of the Vision 2023 DAS Technology Foresight.

Triangulation of data reduces bias and provides confluence of evidence which breeds credibility by convergence and corroboration of findings generated through multiple methods (Bowen, 2009).

5.1 In-Depth Interviews

In order to identify impact factors and variables, long-term impact, reasons of low or high impact, Critical success Factors (CSFs) of Vision 2023 technology foresight and to obtain insights about solution recommendations, face-to-face in-depth interviews were conducted with experts. Results of the in-depth interview analysis will be used in the design of technology impact assessment scale and development of assessment model and recommendations.

The in-depth face-to-face interview technique was preferred, since it was aimed to get insights, personnel evaluations, views, and feelings of the participants. Open ended, exploratory focused questions were asked in interviews. During the interviews additional stimulating questions were raised in order to get more insights.

Table 10 Vision 2023 DAS technology foresight program logic model

INPUTS	PROCESS	OUTPUTS		EX-POST ULTIMATE IMPACTS
•TAF Prioritized Tech Fields (TF) •Sectoral Insights •Financial Resources •HR •Infrastructure (IT, Facilities) •Time •Consultancy	**-Building Shared Technology Vision** **Distributing/Feedback** **-Delphi Exercise** •Defining technology clauses •Defining questionnaire •Defining experts •Application & Evaluation of Delphi questionnaire -Defining **Socio-economic Goals** •Prioritize TAA &TF •Development of Technology Roadmap •Policy suggestions -**Reporting**	-**Reports** •Shared Technology Vision •Socio-economic Goals •2023 Technology Roadmaps •Policy & Strategy Roadmaps •Vision 2023 SHU Panel Report •National S&T Strategy -**Process** •Broad Participation •Networks •Focusing future •Learning •…..	Short & Mid Term Outcomes	•Awareness Raising (STI, Tech Management, Mod & Sim, R&D Personnel,) •Policy Informing •Enabling (tool effect) •STI policies •Define & Prioritize Technologic Areas •Foresight culture, •Competent R&D Personnel •R&D, Innovation Demand •Government-Industry-University (KUSI) Coop •Technology Transfer Mechanisms *(The above impact list was created by literature review, Vision 2023 TF Goals & Experts Insights)*

Interviewees were chosen by consulting with advisory group and with their snow-ball networking. Since it has been more than 10 years after technology foresight was conducted, contact info of foresight participants have changed or participants have lost their interest in the subject. In order to avoid bias and to get the insights of all stakeholder categories, selection of experts was designed to include;

- Scientists, professionals, business woman/man,
- Experts both participated and not participated in Vision 2023 technology foresight project,
- Experts from government, university, and industry (TAF, MoND, SSM, universities, TUBITAK, TTGV, TAFF companies, private companies, SMEs),
- Senior policy makers, decision makers
- Experts from defense, commercial electronics, ICT, mechanical industries,
- Experts ivolved in national or sectoral long-term planning activities.

The list of interviewees was finalized by consulting with the core group. 20 experts were planned and 17 were interviewed. 9 out of 17 interviewed experts were participated and 8 were not participated in Vision 2023 technology foresight project. Distrubition of experts to organizations and foresight program participation status are given in Table 11. Each interview has lasted nearly one and half hours, were voice recorded where applicable.

Table 11 Distribution of experts interviewed

	V2023 Participated	V2023 Not Participated
TUBITAK/ University	1	1
TAF	2	
SSM	1	3
TSKGV/ Company	2	3
Private Capital Defense Company		1
ICT-Electronics-Machine Private Capital Companies	3	
	9 Expert	8 Expert
		Total =17

Questions were e-mailed to experts one week in advance, and 17 questions were asked in total. Interview questions are grouped as given in Table 12 and provided in Appendix A. In interviews with experts who are not much knowledgeable about defense sector (who are from other sectors-commercial electronics and ICT), insights more focused on cooperation and spillover effects between the sectors.

Table 12 In-depth interview questions

Questions Groups
Reasons & Goals of Technology Foresight
Impacts of Technology Foresight
Critical Success Factors of Technology Foresight
Structures of Organisation(s) Responsible for Technology Foresight
TF Process Benefit/Quality
TF Outputs Quality

Interview voice records were transformed to text data (Microsoft Word text). Content analysis technique was used in the analysis of interview text data. Content analysis is the identification of themes, conceptual codes and the relations in the data which are not visiable, and it requires deep analysis. It is the derivation of messages embedded in the texts. The in-depth interview data analysis process is shown in Figure 9. This process consists of coding of data, finding themes, arrangement of data according to codes and themes, and identification and interpretation phases. In this study data-driven approach was implemented and codes created from the data.

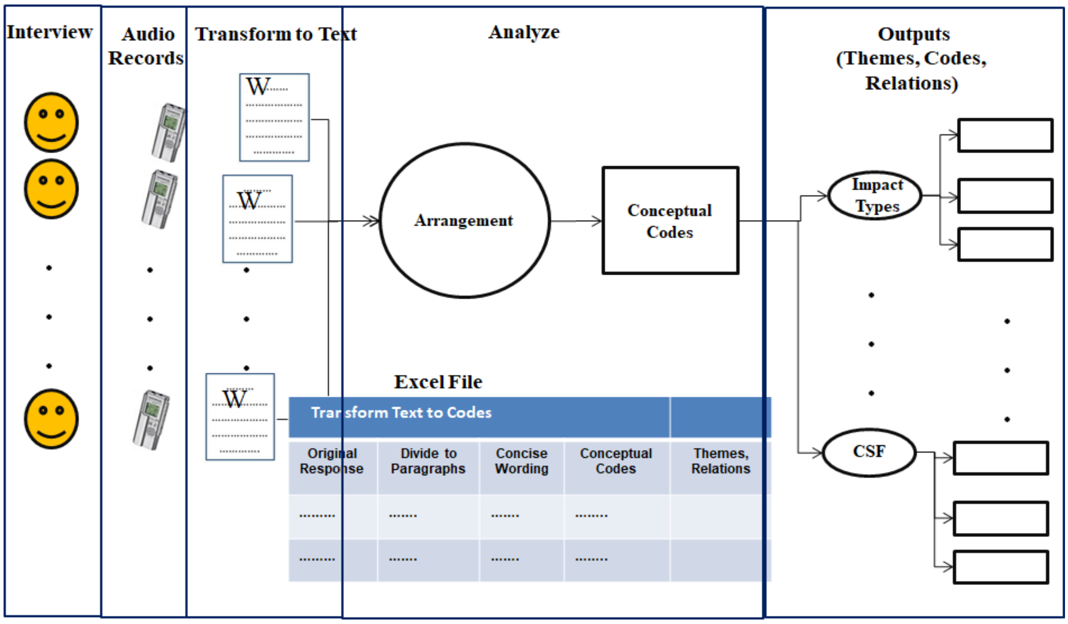


Figure 9 Analysis process of in-depth interview data

In-depth interview analysis is a qualitative analysis method. Validity of the analysis was done by implementing data/information triangulation and informant's feedbacks. Some of the expert interviewees (5 out of 17), had sent their replies in a written format prior and/or after the interviews.

There are several software programs in the market for content analysis as NVIVO etc. However, the content analysis of the whole interview data was done with Microsoft Excel Office software program. The program was used as a database and with wizard tool dynamic reports (tables) were generated. It was tried to extract the meaning and relations, from what was said. A data table was prepared to ease the analysis of data collected from different interviewees. Columns of the table are named as to highlight the criteria used to select the interviewees (Table 13). The columns of the data table are name of the interviewee, ID Code of the interviewee, institution name, institution code, the code of participation to Vision 2023 Technology Foresight program, and the question number.

Table 13 Data table of in-depth interviews

Name	ID Code	Institution Name	Institution Codes	Participation Status to Vision 2023 Technology Foresight Codes	Interview Question Codes
Full Name	Mixed of letters & numbers	Full Name	Abbreaviation	Letters	Numbers
			TAF	Y: Yes, participated	Question Number
			Government Organisation	N: No, not participated	
			University		
			Public Company		
			Private Company		
			TUBITAK		
			TTGV		

These participant attributes are the basis of the identifying key categories, and to sort and retrieve data. The categories of the attributes are labeled with tags represented by the letters, numbers and combination of both.

Data Coding: In the first phase of the analysis process, the text data was divided into meaningful paragraphs. Text data moved to excel cells paragraph by paragraph. It was important to keep the integrity of the meaning.. Answers given to each question filtered several times in the same way and tried to reach the conceptual codes (word or word groups) representing the view in the best way. Code is the label to tag concepts, ideas explicit or implicit in the text. Similiar views of different participant were tagged with the same codes.

Finding Themes: This phase covers the finding of themes that the conceptual codes categorized under. It is an upper level coding, and searching relations among codes. Codes identified in the previous phase were gathered under these themes. In defining themes and creating theme-codes, interview questions and question groups are used. Expert views were categorized under each question and sub-questions. Therefore themes and theme-codes were created by starting from the interview question categories as priori codes. A code book was prepared to be used as reference for the coding of themes. The code book was structured with 3 components as theme-code label, full definition and example (Table 14).

Table 14 First-tier codebook of in-depth interviews

	Theme-Code Labels	Full Definitions	Example
1	Goals	Main and sub-goals of the technology foresight program	*To design and shape technological future of Turkey,*
2	Impact	Realized (in)tended, (un)intended, positive or negative lon-term impact or contributions of the technology foresight program on identification of strategic techgnology fields, STI policies, plans, R&D projects, investments, personnel, organisations, GUIC, and culture in defense sector	*The projects conducted in defense sector are still related with Vision 2023.* *It could not go beyond creating awareness*
3	Critical Success Factor	Factor to actualize the long-term intended impact of the technology foresight	*Governmet ownership, setting milestones, renewal and evaluation of results as "succeeded or not succeeded".*
4	Policy Makers' Commitment	Commitment of policy makers to implement outputs of the technology foresight program	*There is no impression regarding the ownership of this document neither by changed TUBITAK management nor other government instutitions.*
5	Industry Committment	Commitment of policy makers to implement the outputs of the technology foresight program	*Real sector needs to behold responsible for application phase. The document was not in the agenda of defense sector in application period.*
6	Improvement of Impact	Increase the impact level and extend the impact area of the technology foresight	*In order to increase the impact, impact should have been managed*
7	Renewal of Foresight	Renewal phase of technology foresight in a regular, systematic base	*Definitely, it is needed today!*
8	Responsible Structures & Functions	Structure, responsibilities and functions of institutions / organisations responsible from technology foresight cycle	*Owner (responsible) institution is the one will execute the activities.*
9	Expectations	Expectations from technology foresight program	*Increase of synchronisation in long- term plans of instutions*
10	Knowledge Creation Platforms	Platforms to generate knowledge regarding STI intelligence, needs and R&D projects in a continuously structure	*New organizations are required to keep the documents updated with continouity of knowledge*
11	Process Quality	Quality of technology foresight program process, its execution, and management	*It was a good practice. Required factors were brought together. Steering committee, executive committee, core team were brought together by getting support of all stakeholders*
12	Output Quality	Quality of technology foresight outputs	*It is one of the rare technology foresights around the world encompassing military perspective*

Words and phrases were used to label the codes. In the creation of sub-theme and conceptual-codes, frequency analysis technique and in-vivo codes defined by the participants were used.

The sub-theme-codes and conceptual-codes were elobrated and refined through repeated examination of the raw data, and by comparing the text data and tagged codes. Code book and codes were developed through this iterative process.

Arrangement of data according to codes and themes: In this phase, data was arranged in a systematic structure to show relations, and links between codes and themes. Result of the analysis is the coding schema which is generated by dynamic reports of Ms Ofis Excel Wizard illustrating the theme-codes, sub_theme-codes, conceptual-codes, excerpted statements, and the nodes among them.

In order to avoid the bias and to provide validity data/informant triangulation techniques were implemented. The selection of interviewees was decided by consulting with core group. The raw data collected through in-depth interviews was analysed with content analysis method. Codes were created with data-driven method.

Reliability of codes were provided with agreement of 2 coders (Campbell, Quincy, Osserman, & Pedersen, 2013). Coders who have background knowledge in the subject matters of the interviews gained through the professional background in defense sector. Firstly, the codes were created by the author of this thesis and reviewed by the second professional. Final review and agreement was done by the author. Coding was practiced until reaching to agreement.

Foresight impact and impact types obtained from the analysis of in-depth interview data were benefited as input for the development of impact scale to assess the impact of Vision 2023 technology foresight in defense sector.

5.2 Document Analysis

Document analysis is a quantitative and qualitative research method, and systematic process to evaluate documents in all formats (printed or electronic) to gain understanding of the matter, and to develop empirical knowledge. Document analysis process covers the searching and finding document sources, selecting sources and documents, appraising and sythesising the data in the documents. Document analysis incorporates data into themes and categories by coding through content analysis.

Main goal of the document analysis is defined, document resources are identified and documents were selected, content analysis method was applied by linking codes with data contained in the documents. Data triangulation method was applied by analyzing data from different sources. A data table was prepared to list the selected documents and the data analysed (Table 15). Authenticity, acuracy, credibility, and quality of the selected document and evidence they contain were provided by acquiring the documents from the official sources.

Table 15 Selected documents, and data analysed

Selected Documents	Analysed Data
MSB Technology Panels web site	Impact of Vision 2023 Technology Foresight to policies, decisions and R&D projects
SSM Strategic Plans, SSM Technology Management Plans, SSM Export Plans, SSM Industry Plans	Impact of Vision 2023 Technology Foresight (policies, decisions, R&D projects, GUI cooperation,..)
SSM Annual Reports	Impact of Vision 2023 Technology Foresight, list of R&D projects supported by TUBITAK
SSM Presentations	Impact of Vision 2023 Technology Foresight
SSM Technology Network of Excellence web site	List of Technology Fields influenced
Annual reports of defense companies	Impact of Vision 2023 Technology Foresight
Reports and web site of SaSaD	Impact of Vision 2023 Technology Foresight
Annual report of TOBB Defense Commerce Exchange	Impact of Vision 2023 Technology Foresight
Magazines of SSM, defense companies, sectoral magazines	Impact of Vision 2023 Technology Foresight
Agendas of sectoral seminars, semposiums, etc	Impact of Vision 2023 Technology Foresight
YOK Theses Center (web site)	Impact of Vision 2023 Technology Foresight on post graduate theses
Report on Technoperks	Impact of Vision 2023 Technology Foresight

The plans, annual reports, presentations, web pages, magazines of Udersecretariat for Defense Sector (SSM), Ministry of National Defense (MoND), Turkish Armed Forces (TAF), The Union of Chambers and Commodity Exchanges of Turkey (TOBB) Defense Industry Council, Defense and Aerospace Industry Manufacturers Association (SaSaD), Turkish Armed Forces Foundation (TAFF), and TAFF and private companies were analysed with content analysis methods. The documents were downloded from the official web sites of the subject organisations. Some of the documents which were not uploaded to web sites were asked permission to reach these documents. The objective of the analysis is to trace and detect the information related to Vision 2023 Technology Foresight in the documents of TAF, SSM, MoND, SaSaD, TOBB Defense Indsutry Council, TAFF and companies. Therefore to detect and infer Vision 2023 technology foresight impact types. 'Vision 2023' and 'technology foresight' word groups are choosen as the analysis units.

The findings are the evidence of the impact of the technology foresight program and were reported with the source documents. As a result, document analysis was used in combination with in-depth interview and focus group research methods as complementary, and to provide method triangulation.

5.3 Focus Group

The purpose of conducting a focus group is to listen and to gather information from a small number of experts, to obtain valuable insights, and to diverse perspectives and opinions from the interaction of the participants. In the selecting focus group members, it is essential to keep balance between homogeneity and diversity. Focus group is a special type of group with its goal, composition, process and size. There is no certain rule for the number and the size of the groups. Group size with 5-10 participants is widely used (Krueger & Casey, 2009). The goal of conducting a focus group was to synthesis different views, ideas, insights and experiences in a sound discussion platform to build a new S&T vision for the defense sector, and to define the weights of impact types.

The focus group was done with a team of professionals, business woman / man, and scientists for their knowledge, experience and insights about Vision 2023 technology foresight, national R&D activities, policies, and issues of defense industry. Focus group members were selected by consulting with the core group and with their networks. 15 experts were invited, 10 were confirmed but 6 attended to the focus group. Distribution of participants is 2 scientists from university, 2 businessmen / businesswoman from industry, 1 businessmen from industry & TTGV, 1 businessman / expert from industry and technopolis. Focus group was conducted by a moderater and assistant. The moderator had the mediator role to bring out the insights. The purpose, scope and the program of the workshop were e-mailed to focus group members in advance (Table 16).

Table 16 Focus grup workshop program

Program
Opening Remarks
Brief Presentation about Vision 2023 Technology Foresight and DAS Technology Foresight
A Short Review of Interviews: Impact of Vision 2023 DAS Technology Foresight in Defense Industry.
Building a new S&T Vision for Defense Industry
Weight & Prioritision of Impact Factors of Technology Foresight
Recommendations to Increase the Impact of Technology Foresight (policies, mechanisms, indicators, etc.,)
Closing Remarks&Thanks

Focused group workshop was conducted for a half day at TTGV KIVILCIM Center on 13 January 2017.

5.3.1 Development of S&T Vision

The process was conducted as follows: Participants were asked to write the most important 5 conceptual codes to post-its and stick them to A4 papers. Redundancy of conceptual codes was eliminated by cycling the papers between participants. At the end of the process, the list of codes for the vision was obtained. In order to categorise the codes, participants were asked to explain the context of the codes.

Contexts and definitions of the codes were debated in the group. The codes were categorized and listed under these categories on flipcharts to be seen by everbody. Following the categorisation, participants were asked to select 5 codes listed on flipchart. Thus, the key codes were identified and selected for the vision statement. Key code groups were listed starting from the highest point in descending order. The key code groups with the highest points were selected to be in the vision statement (Table 17).

Table 17 Key conceptual codes & code groups with highest points

CONCEPTUAL CODES and POINTS					
7	6	5	5	5	5
COMPETENT	FOCUSED	CORE COMPETENCE	COMPETETIVE SAME LEVEL WITH COMPETITORS	MULTIPORPUSE USAGE RELEVANT WITH OTHER SECTORS	GENUINE
*DIVERSIONARY POWER	MEETS THE NEEDS	CORE RESOURCE BASED		NON MILITARY TECHNOLOGY / HR TRANSFER	INNOVATIVE
RADICAL TECHNOLOGIC SUPERIORITY		SELF IMPROVING NATIONAL TECHNOLOGIC INDEPENDENCE		EASY ADAPTING	CREATIVE
					IMPROVING
FAST		SELF SUFFICIENT		COOPERATION	
AGILE		MANUFACTURING TECHNOLOGIES NATIONAL TECHNOLOGIC INDEPENDENCE		RELEVANT TECHNOLOGIES	

Next step was the transformation of codes into vision statement. This activity was also executed by the comments and remarks of all participants. At the end of the process, the S&T vision statement was formulated.

5.3.2 Weighting and prioritization of impact types

Instead of assigning the same weights to impact types, the participants were asked to weight the impact types. A presentation was done about how the impact types were derived. Impact types and statements grouped under them were handed to participants for weighting. Each participant assigned points from 1 to 10 for each impact type, and 10 was the highest score. Aritmethic mean was calculated for each impact type and normalized to 100. Impact types and weights are given in Table 18.

Impact types are grouped in four categories. The first group has the highest score (16) and the impact types are ‘Impact on Design and Application of STI Policies’, and ‘Impact on Technological Goals, Identification of R&D Projects and Prioritision’.

Table 18 Impact factors & weights

Technology Foresight Impact Factors	Weighting Points
Impact on Design & Application of STI Policies	16
Impact on Technologic Goals, Defining R&D Projects and Prioritization	16
Informing Impact to STI Policies	12
Impact on R&D and Innovation Demand	11
Impact on Awareness Raising	9
Tool Impact (Use of Foresight as a Tool)	9
Impact on Government-Industry-University Cooperation (GUIC)	8
Impact on Competent R&D Personnel	8
Impact on Development of Technology Transfer Mechanisms	6
Impact on Foresight Culture	5
TOTAL	100

The second group (scores 12-11) impact types are ‘Informing Impact to STI Policies’ and ‘Impact on R&D and Innovation Demand’. The third group impact types are ‘Impact on Awareness Raising’, ‘Tool Impact’, ‘Impact on Government-University-Industry Cooperation’, and ‘Impact on R&D Personnell’. ‘Impact on Development of Transfer Mechanisms’ and ‘Impact on Foresight Culture’ impact types set the fourth group with lowest scores. These impact type scores were applied to the result of statistical analysis to calculate the impact levels.

5.4 Development of Technology Foresight Impact Scale

In order to measure the impact of Vision 2023 Technology Foresight in defense sector quantitative research method and survey technique were applied.

5.4.1 Research Population and sampling size

In order to reach an edaquate sample size of the research population, size and structure of the population needs to be defined. Research population is composed of people who participated in or has information about Vision 2023 Technology Foresight, or who has interest in S&T issues in national defense context. In total 793 experts involved in the technology foresight exercise through panels and Delphi exercises of Vision 2023 DAS technology foresight program (Çakır, 2015). People who have not participated in foresight activity, but informed later are also fall in the research population. There is no data available regarding the total number of the population. Except panelists (20 people), the communication data of the population was not available in the foresight documentation. However, people who participated in DAS panel and Delphi survey are the employees, managers, experts working in defense industry or experts and scientist who has interest in this sector. This means that, research population are the employees and scientists of defense companies, government organisations (MoND, SSM, TUBITAK), TAF, universities and NGOs mostly located in Ankara. R&D, technology, strategy, marketing, HR managers and employees, senior level managers, policy-makers, TAF personnel, and scientists are part of this research population. Therefore, it was planned to apply survey in this population.

Research population and sampling data were given in Table 19. In order to reach the research population, the survey was published at turdefind@yahoo (communication platform for defense sector) and "Science Technology and Innovation" platform on "Linkedin" social media. Unfortunately, the participation to survey, through these platforms was very limited.

Table 19 Research population and sampling size

	Total
Population	793
Sampling Size	236
Participants checking "I do not Know" option	40
Participation to Survey	**196**
Sampling Ratio	**%24,7**

The number of survey participants was increased by e-mailing the URL link of survey to people who are from defense sector or has interest in defense related issues.

5.4.2 Impact scale development

The goal is to develop impact assessment scale to assess the ex-post (ultimate) impact Vision 2023 technology foresight in defense sector. At the beginning of the study, literature review was conducted, and foresight goals, impact types and a variety of impact (intended, unintended, direct, indrect, positive, negative) were examined. Furthermore, intended and targeted goals of Vision 2023 technology foresight were analysed and covered in the draft impact assessment scale as observed or latent impact variables. Expected impact was questioned through pre-interviews with experts at the beginning of the thesis research. Moreover, technology foresight impact codes derived from in-depth interview analysis were added to the scale. The draft technology foresight impact types and the comparison with impact types framework developed by Johnston (2012) are given in Table 20.

Table 20 Vision 2023 technology foresight impact categories framework

	Impact Types of Draft Scale	Impact Types of Technology Foresight Impact Framework
1	Design & Application of STI Policies	Influencing
2	Identify & Prioritization of Technology Fields, R&D Projects	Influencing
3	Informing STI Policies	Informing
4	R&D and Innovation Demand	Influencing
5	Awereness Raising	Awereness Raising
6	Tool Impact	Enabling
7	Government-University-Industry Cooperation (GUIC)	Influencing
8	Competent R&D Personnel	Influencing
9	Technology Transfer Mechanisms	Influencing
10	Foresight Culture	Influencing

Technology foresight impact types are defined as awareness raising, policy informing, enabling, and influencing (Johnston, 2012). The draft scale is more detailed and breakdown of the foresight impact framework taken as baseline in the research.

5.4.3 Content validity

Content validity is the degree of scale items which relevant and represent the attribute to be measured (Haynes, Richard, & Kubany, 1995). Content validity is measured with Content Validity Ratio (CVR). In order to test CVR of the developed scale, the scale questionnaire was e-mailed to 15 experts and asked to assess how accurately the scale questionnaire items represent the variables. Experts were selected based on their experience or knowledge in strategic management, technology management, technology foresight, and specifically from defense sector. In total 8 expert replied the request (5 scientists, 3 engineers). The evaluations and comments on scale items were;

- Evaluation of scale items to what extend they represent the variables (1-2: the item does not measure the object attribution, 3: the item is related with the attribution that wanted to be measured but not necessary; 4-5: the item measures the object attribution).
- Suggestions regarding some scale items to be listed under other impact types,
- Suggestions regarding descriptive information about participants,
- Not necessary but valuable to provide additional information for assessment.

The minimum CVR=0,78 for 8 expert and minimum CVR=0,99 for 7 experts (α=0,05 significance level), (Lawshe, 1975). CVR was calculated for each item. CVR value, required minimum CVR and status information (item was deleted or left) for each item of the scale questionnaire is calculated. After CVR, draft scale was composed of 10 factors and 74 items. The draft scale survey was e-mailed to 20 experts for pre-test before applying in the sampling group. Pre-test phase was completed by making minor changes on draft scale questionnaire.

5.4.4 Application of impact assessment scale survey

Survey consists of 2 parts. The first part had questions to collect data on the socio-demographic properties of the participants: Information level on Vision 2023 technology foresight, age, institution (public institutions, army, university, and industry), company type (public company including TAFF companies or private companies). Institutional categories are based on Frascati Manual (2002).

Participants who did not have information about technology foresight were prevented to fill out the survey by directing to the end of the survey. There were additional questions as the source of their information and their responsibilities in the institution. The second part had questions for technology foresight impact. Additional questions were included as to collect more specific and suplementary data. Survey had 5-likert options as: 1-Completely Disagree; 2-Disagree; 3-Partially Agree; 4-Agree; 5-Completely Agree. The draft scale survey was transferred to SurveyMonkey software on internet for online acccess. Survey data was transferred from SurveyMonkey program to SPSS Statistics program.

In total 236 participants replied the survey but sampling size was 196 since 40 participants did not have any information about Vision 2023 technology foresight. Missing value analysis and randomness was conducted on data. Table 21 includes a brief description of variables used in the statistical analysis. Distribution of information level, institution, age and company type categories are given in Figure 10, Figure 11, Figure 12, and Figure 13.

Table 21 Variables and descriptions

Variable Name	Variable Type	Variable Description
TOTAL_IMPACT	Dependent Variable	Total impact level contributed by Vision 2023 Technology Foresight
SUB_IMP_FACTOR1	Dependent Variable	Impact level of sub-impact factor 1 (Influencing)
SUB_IMP_FACTOR2	Dependent Variable	Impact level of sub-impact factor 2 (Awareness Raising & Informing)
SUB_IMP_FACTOR3	Dependent Variable	Impact level of sub-impact factor 3 (Influencing & Enabling)
SUB_IMP_FACTOR4	Dependent Variable	Impact level of sub-impact factor 4 (GUIC)
SUB_IMP_FACTOR5	Dependent Variable	Impact level of sub-impact factor 5 (Foresight Culture)
INFORMTN_LEVEL	Descriptive Variable	Information level of participants on Vision 2023 Technology Foresight
AGE	Descriptive Variable	Age category of participants
INSTITUTION_TYPE	Descriptive Variable	Institution category of participants
CMPNY_TYPE	Descriptive Variable	Company category of participants

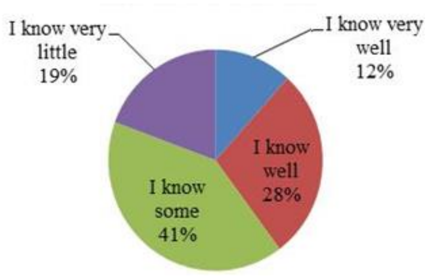


Figure 10 Participants Information Level

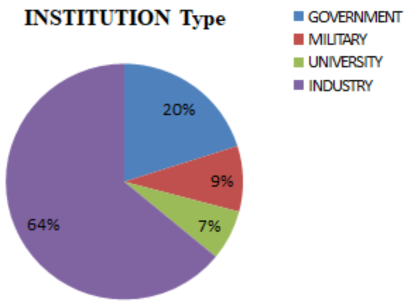


Figure 11 Institutional Category

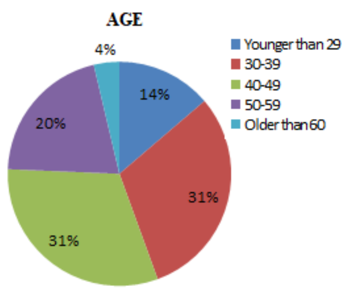


Figure 12 Age Category

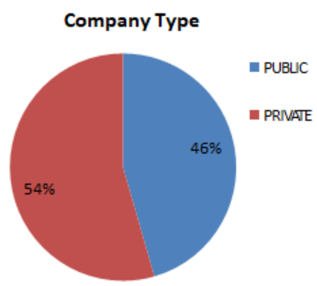


Figure 13 Company Category

40% (sum of “I Know Very Well” and “I Know Well”) of participants are quite knowledgeble on the Vision 2023 Technology Foresight, and 19% of participnts have limited information.

5.4.5 Exploratory factor analysis

EFA test was applied to test construct validity of the scale. Construct validity indicates if the items measure the subject variable of the scale. In order to test the construct validity of the scale Principle Component and Varimax axis rotation techniques are used. Varimax is an orthogonal rotation technique. Orthogonal rotation is used in cases where factors are uncorrolated with each other. Factor rotation loads items in the related factors with the highest load factors and in the unrelated factors with the lowest load factors. It provides a set of items (observable variables) to be represented by a less number of variables (factors) which are defined due to common information of items. In the research, it is planned to develop a scale that its factors are not correlated with each other, and represented with less number of items.

In order to run EFA, sampling size should be minnimum three times the scale item number or preferably 10 times. Sampling size changes by the factor load (q) value to add or delete items. Factor load (q) is a cofficient indicating its relation with the factor. Sampling size of 150-200 was seen as adequate for factor load value q>0,5. Another technique used to test sampling adequacy is Kaiser-Meyer Olkin Measure (KMO) test. KMO index higher than 0,6 indicates the adequacy of sampling for factor analysis. The factor analysis was conducted by exluding cases listwise. KMO index = 0,926 (>0,6), indicates the adequacy of sampling for factor analysis. Bartlett Test of Sphericity [$X^2_{(1378)}$=7275,553 Sig=0,000] indicates the appropriateness of correlation between items for factor analysis.

In this research, it was targeted to build scale factors with powerful items as much as possible. Factor load value was taken higher than 0,5 (q≥0,5). In order to prevent cross factor loading, differences between load factors of the subject item was taken higher than 0,1.

A structure with 8 factors with eigenvalues >1 was obtained. Factor loads, cross loading and factors explaining variances were taken into consideration. Items with factor load less than 0,4 and cross-loading factors were removed from the scale. Factors have less than 3 items were removed from the scale as well. All items are removed one by one and each time EFA was re-run. At the end of the EFA, the Technology Foresight Impact Assessment Scale was constructed with 53 items grouped under 5 factors and explains 75,23 % of total variance and with load factors (q) ≥ 0,5. After EFA test, factors were named by taking into consideration the items loaded under factors. EFA of Technology Foresight Impact Assessment Scale is given in Appendix B.

The impact scale factors are:

1. Influencing: The factor consists of 21 items and explains 57,55 % of total variance.

2. Raising Awareness and Informing: Factor consists of 11 items and explains 9,06 % of total variance.
3. Inflence and Tool Impact: Factor has 10 items and explains 3,96 % of total variance.
4. GUIC: Factor consists of 5 items and explains 3,07 % of total varience.
5. Foresight Culture: Factor has 6 items and explains 2,36 % of total variance.

The first two factors explaines the 66,61% of the total varience, therefore it could be decided that the scale is constructed by 2 factors. But having said that, all 5 factors with eingenvalues higher than 1 are kept and explain 75,23 % of the total variance.

5.4.6 Reliability tests

The reliability test was run to check if the developed scale makes a consistent measurement and consistency among scale items. In this analysis, internal consistency reliability method was used. Reliability coefficient of each factor was calculated by Cronbach Alpha (α) technique:

1. Influencing, α=0.975
2. Raising Awareness and Informing, α=0.952
3. Influencing and Enabling, α=0.960
4. GUIC, α=0.948
5. Foresight Culture α=0.963

Reliability coefficient of Total_Impact (α=0.985) and each factor is higher than > 0.70, and indicate consistency of the scale.

5.4.7 Technology Foresight Impact Scale and Impact Types

The developed technology foresight cunstructs of 5 impact factors. The weights of the new impact factors were recalculated by using the weights of draft impact factors derived by focus group. The impact types and weights of Vision 2023 Technology Foresight were categorized as given
Table 22.

Table 22 Developed impact types, weights, and comparison

	Impact Types of Vision 2023 Technology Foresight	Weights	Impact Types (*)
1	Influencing (STI policies, GUIC, R&D personnel, TTM, Demand for R&D and Innovation, Identifiction & Prioritisation of Technology Fields, R&D Projects)	65	Influencing
2	Awareness Raising & Informing	12	Awareness Raising Informing
3	Influencing & Enabling	10	Enabling
4	GUIC	8	Influencing
5	Foresight Culture	5	Influencing

(*) The technology foresight impact types developed by Johnston and Smith (2012)

'Influencing' impact type has the highest weight. It contains other factors and items related with R&D personnel and their competency, GUIC items specific to cooperation in defense projects, technology transfer mechanisms, and demand for R&D and innovation, beside STI policies.

'Awareness Raising and Informing' impact type covers the awareness raising items and some of the informing items specific to be used as resource or reference in STI policies. 'Influencing and Enabling' impact covers the items related with use of technology foresight as a tool in developing long-term STI policies and plans, and some of the items related with design of STI policies.

'GUIC' impact type covers only the GUIC items. 'Foresight Culture' impact type covers items of the development of foresight culture. The developed impact scale is a breakdown of "facilitating" impact type of the framework developed by Johnston and Smith (2012). GUIC and culture impact are derived as separate impact types.

The developed framework indicates that the impact types and their weights could differ by the technology foresight program under assessment. Assessment needs to be conducted by taking into consideration the subject foresight intervention. Final version of Vision 2023 Technology Foresight Impact Assessment Scale Questionnaire is provided in Appendix C.

The items/questions not covered by the developed impact assessment scale are more related with ‘reliance on plans’ and consistency between the institutional plans. These scale items can be included by taking factor load value less than 0.5. These are the (un)intended and (in)direct impact of technology foresight inferred from literature. Therefore, these items will be kept as part of the impact scale although they are not structured by EFA test of Vision 2023 technology foresight impact assessment scale

CHAPTER 6

IMPACT OF VISION 2023 TECHNOLOGY FORESIGHT IN DEFENSE SECTOR: FINDINGS AND INTERPRETATIONS

This chapter covers the identification and interpretation of the findings obtained from in-depth interviews, focus group, document analysis and survey data analysis.

6.1 In-Depth Interviews

Goals and Objectives of technology foresight program: The goals and objectives of foresight concluded from the analysis cover the formal objective statements of technology foresight as well as tacit objectives and goals. The inferred conceptual codes defining the goals and objectives of Vision 2023 Technology Foresight are given in Table 23.

Table 23 Codes of goals and objectives theme

Codes for Goals & Objectives Theme	
Defining S&T Goals	Defining Technology Roadmaps
Defining Joint Direction	Government-University-Industry Cooperation
Prioritising Technologies	Develop Technology Foresight Culture
Revealing Existing Knowledge	EU Membership
Analysing S&T Situation	Increase of Global Visibility of the Country
Define, Design and Application of STI Policies	Technology Foresight as a Need
Need for Resource Planning	

The goals are to define STI goals, policies, strategies, and to build joint direction, to prioritise technology fields, to develop national technology roadmaps, to increase the cooperation between government, university and industry, to develop foresight culture, to analyse status of the industry and to extract the existing knowledge. It is clear that, the planning of resources inline with national vision was an important need. The increase of global visibility of the country, and EU membership are also the goals of Vision 2023 technology foresight. These codes indicate that the expectations of defense industry were high from the technology foresight program. It was seen as a promising tool to reach the goals and objectives.

Impact of DAS Technology Foresight: The impact themes and codes of Vision 2023 technology foresight is given in Table 24.

Table 24 Codes of impact theme

1st-tier Codes	2st-tier Codes
Tool	Facilitating as Tool and Use of Foresight Methods
Technology Fields and R&D	Prioritising Technology Fields
	Realisation of Projects
	Increase of R&D Expenses
	Use of Technology Taxonomy
	Use of Technology Roadmaps
Policy Informing	Informing policies
STI	Design & Application of STI Policies
	Design & Applİcation of STI Policy Tools
	Establishment of Technology Management Organisations
Awareness	Awareness Increase
Decision-makers	Commitment of Politicians, Decision makers
	Getting into their agenda
Goals Realization	Goals Realization
	Technological Development
Technopolices	Establishment of Technopolices
GUIC	Increase of Government-University-Industry Cooperation
Foresight Culture	Developing Technology Foresight Culture
Other Factors	Leadership of SSM
	Vision 2023 Technology Foresight not in the Agenda

Impact codes spesific to national defense sector have been generated as a result of the interview analysis. The codes were used in the development of impact types of the scale. The tool impact type is the use of foresight and foresight methodologies in institutions or companies. Impact on technology fields and R&D is the prioritization of technology fields, the achievement of R&D projects, the increase of R&D funds, and the use of technology taxonomy and technology roadmaps by instutions and companies. Policy informing impact is the use of foresight outputs as input to policies, and policy making processes. Impact on STI is the design and application of STI policies, tools, and establishment of new organisations for technology management. Awareness impact is the increase of awareness of S&T and technology management. Impact on politicians and decision makers is the getting into their agenda, and their commitment to foresight results. Impact on goals realization is the development in prioritized technology areas. GUIC impact is the increase of cooperation between government, university, and industry. Culture impact is the development of long-term, participative thinking, and planning culture. Beside these, new factors appeared that, the impact was increased or achieved by SSM, and Vision 2023 technology foresight is not in the agenda.

The companies benefitted from foresight program are large scale companies more mature in long-term planning and established the technology management committees and applied Delphi surveys.

The insights and perceptions of interviewees on realized impact levels were not the same, and varied from no-to-high impact. Meanwhile, no negative impact was voiced throughout the interviews. The knowledge level of interviwees changes by the involvement degree in the Vision 2023 technology foresight program. There were views that impact would not happen without the leadership of SSM, and that the same policies would be designed and applied without the technology foresight.
The renewal of technology foresight and conduct of foresight programs in systematic and continuous cycles came out as a necessity. It was concluded that it is the high time to renew the technology foresight. The update of technology foresight every 2-3 years and renewal every 5 years were defined as requirements and needs.

Critical Success Factors: CSFs inferred from the interviews were compared with the CSF defined by Calof and Smith (2010) for government-led foresights. New CSFs, specific to Vision 2023 technology foresight were obtained, beside the generic CSFs as given in Table 25.

Table 25 Generic & specific CSFs of Vision 2023 DAS technology foresight

Generic CSFs (Calof, Smith, 2010)	Expert Views on CSFs of Vision 2023 Technology Foresight
1.Significant and clearly identified client	Assign responsibilities to ministers, senior level policy makers, managers, agents. Ownership of industry, government org (TÜBİTAK, SSM, Industry, TAF)
2.Link to current policy agenda	Integration with government policies, integration with company strategic plans, plannig of procurement projects as to cover technology development plans, integration with TAF needs and projects
3.Link to high level policy makers	Role of SSM. Involvement of ministers, undersecretary and management ranks
4.Public-Private Cooperation	Involvement of clients, acquisition divisions, industry, and universities.
5.Stakeholder Integration	Broad-breadth of participation of stakeholders, common wisdom, organisational and individual participation of people from various sectors
6.Communication Strategy	Dissemination and announcement of technology foresight outputs. Vision and objectives should be simple, and easy to map in minds. Active involvement of industry in SCS&T. Public Awareness.
7.Academic receptors	Development of tehnology foresight based new programs in universities
8.Novel Methodologies	Methodology, management by expert team, managing as a project,
No additional factors are defined	Technology-Product structure. Creating market
	Update and Renewal of technology foresight
	Setting SMART objectives. Monitoring & Evaluation. Monitoring with KPIs.
	Evidence based, independant, holistic view, trust, accountability, prioritising.
	Allocation of funds, continuity, sustainability/consistency of S&T policies, and decisions.
	The continuouity of technology foresight project team.

Renewal of technology foresight, and to conduct foresight programs in systematic and continuous cycles were come out as a necessity. Update of the technology foresight every 2-3 years and renewall of every 5 years were defined as requirements and needs. CSFs derived as unique to Turkish program are the continuity of foresight cycle, monitoring and evaluation of foresight cycle, monitoring with KIs, accountibiliy, trust, funds allocation, holistic view, and consistency of STI policies. The continuity of the technology foresight team with the balance in old and new staff to provide the sustainability of knowledge creation and to develop foresight capacity was counted as CSF.

Quality of Technology Foresight Process and Output: The competency of participants, quality of stakeholders' involvement, the management of technology foresight program methods, and techniques implemented in the program were assessed as good by interviwees (Table 26).

Table 26 Codes for technology foresight process and product quality

Process Quality	Output Quality
Participant competency was high (right, knowledgeble people)	Understandable goals & targets
Common sense obtained	Detailed road map
Interaction between panels: (good for DAS-Electronics)	Uncertainty in goals (not SMART; missing mid-term targets,)
Stakeholder participation (industry:weak)	Genuine for national requirements
Connection to policy makers (good in TAF)	Management like project (business, market approach is missing)
Technology foresight was a need	As a reference and source
Technology foresight project management quality was high	Technology fields classification (good)
Technology foresight guiding quality was high	Technology Activity Areas and Technology Fields terms are confusing
Technology foresight methods,tTechniques (good)	Technological focus (prioritisation:not enough)
	Technology foresight accuracy (projects realised)

Insights regarding the certainity of technology foresight goals, targets, technological focus (prioritisation) differentiated by participant institution (army, government, industry).

Committment to foresight by goverment instutions and industry: Conceptual codes regarding commitment and ownership technology foresight by stakeholders contains negative findings beside positive ones as given in Table 27.

Conceptual codes to reverse the negative cases are also derived from the interviews. These are CSFs and recommendations to increase the value of technology foresight investment: Giving more responsibility to industy in foresight program and realisation of goals and objectives; Actively participation of senior policy makers (ministers, undersecretaries, managers, commanders, directing managers etc.,) into foresight process; Active involvement of industry in SCST; Continuity of program teams; Follow-up actions; Transform of foresight outputs to projects; Link to incentive mechanisms; Long-term planning culture; Monitoring and evaluation;

Setting SMART goals are outstanding codes to increase the commitment and success of foresight intervention.

Table 27 Codes of commitment theme

Committment of Industry	Committment of Government Institutions
Commitment of Industry (real sector was not demanding)	Weak internalisation by SCST and institutions
Support of seminars and semposiums	Not adopted by Government institutions
Internalisation of TF Tools	Accountability for R&D funds
R&D culture is enabler for TF implementation	Supported by SCST
Limitation of knowledge share due to military classifications	Fund source of TAF projects
Flow of R&D project proposals from industry to TAF/SSM up to 2005	MoND, SSM role to execute technology foresight
Government Leadership	Simple, memorable technology foresight
Trust in transform of technology foresight output into projects	Concrete, SMART Goals
Fund allocation for technology foresight projects	Implemented by TAF
Coordination among Institutions	Not adopted by TUBITAK following admin
Technology Panels (MoND, NATO STO) usefull for information sharing	Perception of TUBITAK as sole responsible for technology foresight
Common Wisdom	Committment of SCST (for a short time)
Responsibility of industry in technology foresight and implementation phase	Negative impact of change of technology foresight project team
SSM Effect on industry	
SSM-TUBITAK Competition (negative impact)	
Setting Local Content/Offset departments in other government Institutions	
Investment capacity of ministries is driving force for success of technology foresight	
Links with incentive mechanisms	
Technology foresight is not known	
International technology networks	
Implementation, follow-up programs	
Long term planning culture of industry (not mature enough)	

Renewal and Expectations from Technology Foresight Program: One of the important findings of the analysis is the need to renew the technology foresight program for defense sector (Table 28).

Table 28 Codes for expectations and renewal themes

Expectations & Renewal of Technology Foresight
It is the time for renewal of technology foresight
Integration with Public Policies
Common wisdom
Trust, Share Building
Monitoring, Evaluation (evaluation per 5 years)
Monitoring with KPI
Technology Foresight Update-Renewal (per 2-3 years)
Active Representation of the Real Sector in SCST
Real Sector Take the Responsibility
Committment
Current Situation Analysis of S&T in Defense Industry
Preparation of DAS Strategy Paper
Clear Focus on Technology Areas
Setting SMART Goals
Use of Technology Management Tools
Become Competent
Integration with TAF Needs and Projects
Participation of all Stakeholders
Transition to Practice
Market driven Vision
Development of New Policies and Mechanisms for Prototype Development
Management of technology foresight process with Software

One of the codes is the message to conduct a new technology foresight program. The impact / integration of foresight on STI policies is the outstanding code. The preperation of DAS strategy paper, the development of new policies and mechanisims to facilitate prototype development, the transition of foresight outputs to practice, and the real sector taking the responsibility of foresight are the expectations from the renewal of technology foresight program. Trust, monitoring & evaluation, common wisdom, committment, renewal of technology foresight every 2-3 years to 5 years are prominent codes of the analysis. The same codes defined as CSFs for the success of technology foresight.

S&T Knowledge Creation Platforms: The technology panels were defined as necessary platforms during the interviews. The developments in S&T and the future scenarios can be discussed, and military and non-military personnel can work together at these technology panels as in NATO Research and Technology Organisation (RTO) structure. It was derived that these platforms needs to be managed in more otonomous structure and to trigger national defense R&D investments, not to meet the needs of system procurement programs.

Organisations responsible from technology foresight: Recommendations were derived from the interviews regarding the structure, functions, pros and cons of the organisation which will be responsible for foresight cycle. Specific to defense sector, establishment of a committe similiar to DIEC as sponsor of the foresight is the inferred code. SSM and TUBITAK are the responsible institutions for the foresight program. Having funds, authority and accountibility are the driving elements. Another element is the role of SSM in defense sector defined by laws and regulations. Assessment and evaluation needs to be conducted by independent structure assigned by sponsor of the foresight.

6.2 Focus Group

6.2.1 S&T vision for defense sector

The jointly developed S&T vision statement is: “In defense area, by using resources effectively and efficiently, developing multipurpose novel technologies and innovative products focused to country needs and in close co-operation with other sectors, being an internationally competitive, competent, agile, and self-sufficient S&T platform”.

When the new S&T vision statement and the Vision 2023 DAS Technology Foresigh vision statement are compared, the term ‘agile’ is emerged as the new concept.

When this new S&T vision statement and the vision statement of Vision 2023 DAS Technology Foresight are compared, it is appeared that the term “agile” is emerged as new conceptual code. The concept ‘agile’ underlies how important it is to empower the STI system to be enacted on time. In order to have an agile STI system, data needs to be managed with the “big data” approach.

6.2.2 Impact assessment factors and weights

The output of focus group indicates that the relative importance of impact factors could be different for each foresight application based on the goals and expectations. The weighting in this study is specific to Vision 2023 DAS Technology Foresight. The impact factors are ranked in four categories. The impact factors of the first group with the highest score are ‘Impact on Design and Application of STI Policies’, and ‘Impact on Technological Goals, Identification of R&D Projects and Prioritision’. The second group impact factors are ‘Informing Impact to STI Policies’ and ‘Impact on R&D and Innovation Demand’. The third group impact factors are ‘Impact on Awareness Raising’, ‘Tool Impact’, ‘Impact on Government-University-Industry Cooperation’, and ‘Impact on R&D Personnell’. The fourth group impact factors are ‘Impact on Development of Transfer Mechanisms’ and ‘Impact on Foresight Culture’ with the lowest scores.

6.2.3 Insights on how to increase foresight impact

The recommendations to increase the impact of technology foresight are concluded as: The data produced through STI system needs to be managed with ‘Big Data’ approach; the quality and reliability of data needs to be provided by MoSIT; Renewal of technology foresight every 4-5 years; The conducting impact analysis before the next cycle of foresight and to inform the stakeholders; the conducting foresight programs with process and system design approach; Production of standard data during the processes.

6.3 Documentary Analysis

In the documentary analysis, policies, plans, reports, presentations, web pages, magazines of Udersecretariat for Defense Sector (SSM), Ministry of National Defense (MoND), Turkish Armed Forces (TAF), The Union of Chambers and

Commodity Exchanges of Turkey (TOBB) Defense Industry Council, Defense and Aerospace Industry Manufacturers Association (SaSaD), Turkish Armed Forces Foundation (TAFF), and TAFF companies and private companies were analysed with content analysis methods. The impact of technology foresight is given in Table 29.

Table 29 Impact of Vision 2023 technology foresight on SSM policies and documents

Document Name	Impact of Vision 2023 DAS Technology Foresight
SSM Strategic Plan 2007-2011	Informing impact: Vision 2023 Technology Fields and methodologies were benefited during external environment analysis
SSM Technology Management Strategy 2011-2016	Informing impact: “Vision 2023 Technology Foresight” is cited as the base policies and programs taken as reference.
SSM Technology Road Map and R&D Incentives, 2008	Impact on R&D Projects decision: list of R&D projects approved if they were covered in the technology foresight documents
SSM Annual Reports	Impact on R&D Projects decision: list of R&D projects funded by TUBITAK SAVTAG
“Savunma Sanayii Göndemi” Magazine	In a few issues in 2008-2011, Vision 2023 Technology Foresight, S&T Strategies and Policies, Technology Management and Roadmaps were covered through interviews with senior decision makers of the industry:
No implications regarding to ‘Vision 2023 Technology Foresight’were detected in these documents:, SSM Defense Industry Sectoral Strategy Document 2009-2016, Industrial Participation/Offset Guidelines, Regulation and Directives (2003, 2007, 2011), SSM Annual Reports, SSM Performance Programs. SSM Strategic Plan 2017-2022	

SSM Policies and Plans: Technology foresight outputs had influenced on ‘SSM Strategic Plan 2007-2011’ and ‘SSM Technology Management Strategy 2011-2016’ as reference and guiding documents.

SSM Strategic Technology Fields: In the scope of SSM documents analysis, strategic technology fields of Vision 2023 DAS Technology Foresight were compared with SSM’s strategic technology fields and Technology Networks of Excellences (TNoE). It was concluded that there is a high correlation between technology foresight and SSM TNoEs. SSM TNoE and corresponding technology fields of Vision 2023 DAS Technology Foresight is given in Table 30.

Table 30 Comparison of Vision 2023 DAS technology foresight and SSM's TNoEs

SSM TNoE Technology Fields	Vision 2023 DAS Technology Foresight Technology Fields
• Sensor Technologies	• Sensors, Electronics & Communication Technologies
• Electronic Warfare Technologies	• Sensors, Electronics & Communication Technologies • Strategic Material Technologies • Electronic Material Technologies • Weapon & Ammunition Technologies • Directed Energy Technologies
• Energy & Missiles Technologies	• Missiles, Power & Energy Technologies
• Advanced Materials Technologies	• Strategic Material Technologies
• CBRN Technologies	• Weapon & Ammunition Technologies
• Command Control and Information Technologies	• Information & Communication Technologies
• Micro & Nano Technologies	• Conventional System, Production Technologies & Nanotechnology • Navigation, Guidance, Control & Microelectronic Mechanic System Technologies
• Modelling & Simulation Technologies	• Modelling Simulation Analysis & Training Technologies
• Warfare Technologies	• Sensors, Electtronics & Communication Technologies
• Autonomous Guidance & Management Systems	• Guidance, Control & Microelectronic Mechanic System Technologies
• Destruction Technologies	• Weapon & Ammunition Technologies
• Space Technologies	• Technologies of Space & Use of Space
*	• Biotechnologies, Biomedical and Healtcare

*Biotechnologies, Biomedical and Healthcare Technology Field was not among SSM TNoE

SSM R&D Projects: R&D projects of SSM conducted during 2005-2016 period was compiled from SSM presentations, SSM annual reports and listed by fund resources. The R&D projects were compared with TUBITAK SAVTAG (Defense Technologies Research Group), projects. R&D projects funded by TUBITAK were classified and monitored as TUBITAK resourced projects by SSM and TAF. Strategic technology areas taking place in Vision 2023 DAS Technology Foresight were the selection criteria of TUBITAK resourced SSM R&D projects (SSM, 2008).

Influence on STI policies and R&D projects are more visible in SSM plans and applications between the years of 2005-2011. The actualisation of military R&D projects was influenced by technology foresight, starting from collecting R&D

project proposals from the industry to the approval and funding of the projects. Technology foresight had influenced the selection and approval of SSM R&D projects.

Seminars, Semposiums: Seminars, semposiums, conferences are organised by the cooperation of TAF, MoND/SSM and universities. MODSIM was established by METU-SSM in 2003, SAVTEK by METU-TAF in 2002. USMOS was initiated by METU-TAF-SSM, 2005). There is no evidence to attribute starting of these platforms to Vision 2023 Technology Foresight, but the themes are correlated with strategic technology areas of Vision 2023 DAS Technology Foresight. Innovation, R&D, and Technology Management is one of the themes of SAVTEK since 2002. The goal is to stimulate and increase S&T R&D, encorage discussion and diffuse of technology related information by presenting scientific papers at the platforms. These platforms facilitate creation of Community of Practice (CoP), networks and cooperation among stakeholders. The committees of these organisations are formulated to include scientists, business people, armed forces officers, and officres from public institutions.

The technology management and R&D management subjects entered into the agenda of seminars and semposiums (SAVTEK, USMOS). Technology fields of these organisations have corrolated with the technology fields of the Vision 2023 DAS Technology Foresight.

Defense industry Sector Magazines: The reflection of Vision 2023 Technology Foresight on defense sector magazines was analysed. The foresight intervention was in the agenda of SSM magazine during the years 2008-2011. This time frame is the period of SSM long-term planning process and strategic plans. The technology foresight program was in the agenda of only a few issues of ‘Defense and Aerospace’ magazine in years of 2003-2004. However, it did not take place in the agenda of the existing or new magazines published in the sector after year 2004. Technology foresight program had a short-term awareness increase impact on sector magazines.

Academic Studies: The post gradute theses were analysed for Vision 2023 Technology Foresight. Research covered theses after 2000 and archieved by YOK National Thesis Center. Search was done by checking 'Vision 2023' or 'technology foresight' word groups in the abstracts. Between 2000-2005 there were only one thesis per year about technology foresight, following Vision 2023 Technology Foresight project, it was increased (4 thesis in 2006) and afterwards it was decreased, but it was the subject of more theses compared to 2006 prior (Figure 14).

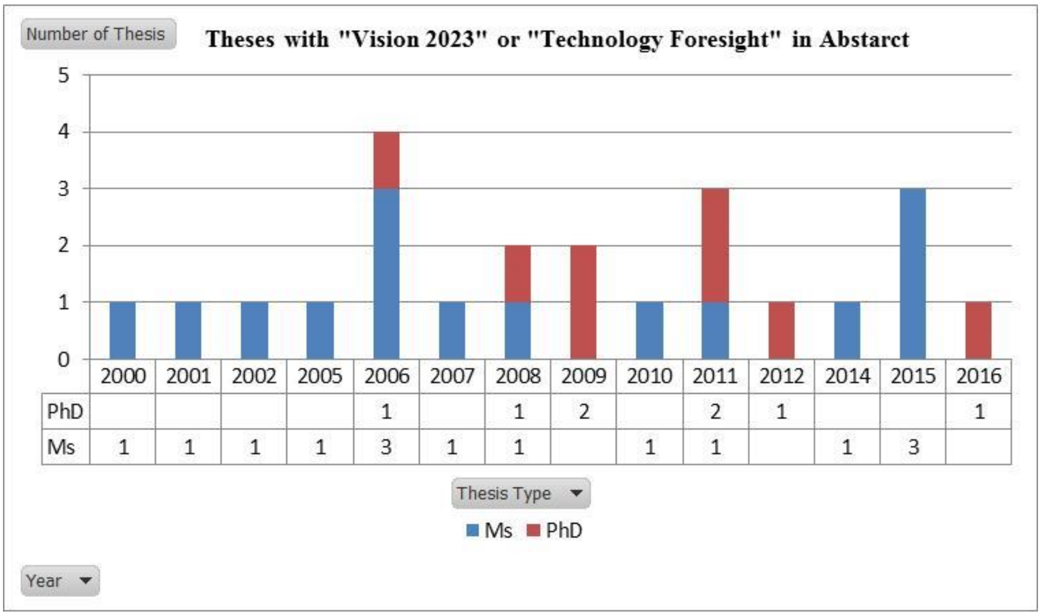


Figure 14 Post graduate theses on Vision 2023 technology foresight

The YOK thesis database was searched for "foresight", "technology management", "R&D management" in theses abstracts (Figure 15). Number of theses covering the key code words in abstracts increased upon completion of Vision 2023 technology foresight project and declined after 2010. However, it is higher compared to prior status of the technology foresight project.

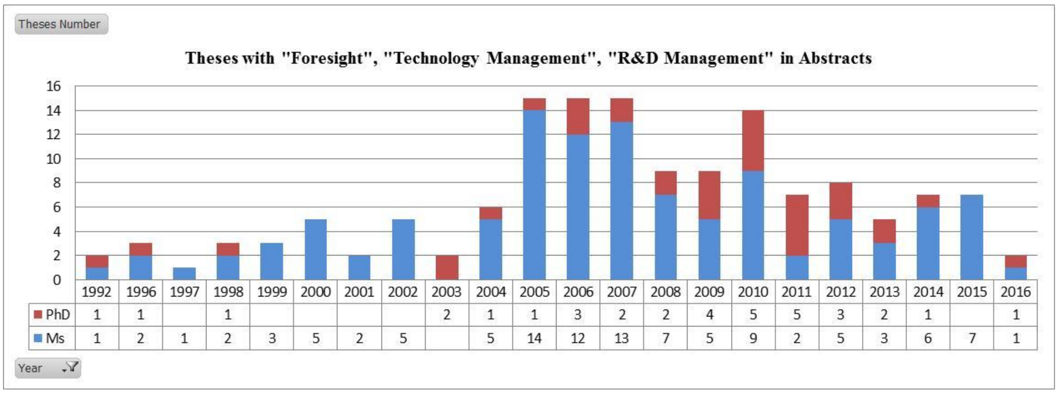


Figure 15 Theses on technology management

6.4 Impact and Impact Level of Vision 2023 Technology Foresight

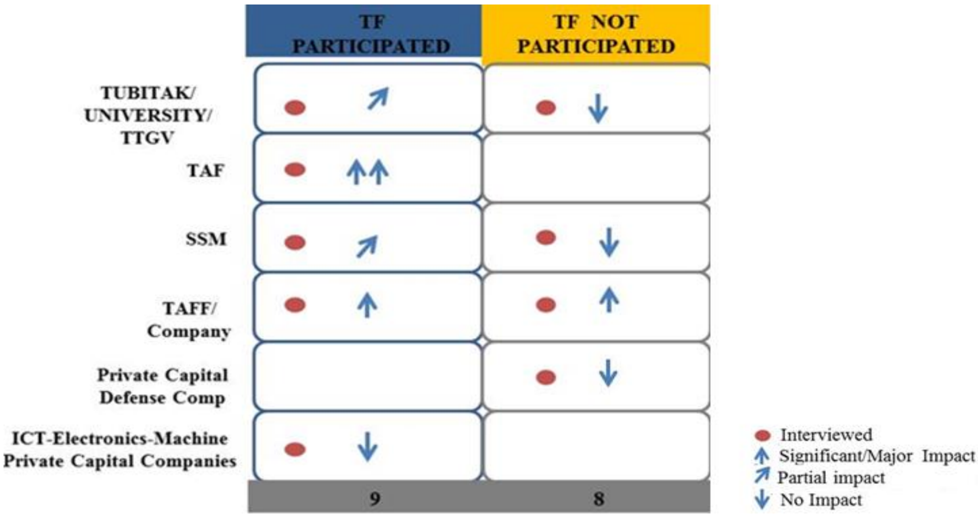
The research question 2 is “What are the ex-post impact and impact level of Vision 2023 Technology Foresight in defense sector?” The findings are of different methods are consolidated to answer the research question and interpreted.

6.4.1 Ex-Post Impact of Vision 2023 Technology Foresight

The insights and perceptions of interviewees on realized impact levels were not the same, and varied from high impact to minor-no impact. Knowledge level of interviwees changes by the involvement degree in the Vision 2023 / Vision 2023 DAS Technology Foresight program. Their impact perception were mapped on participation status and organisation codes with “major impact”, “partial impact” and “no impact” as given in Table 31. Meantime, no negative impact was voiced throughout the interviews. It is seen from the map that impact perception of the interviewees differs according to;

- Partipation status to Vision 2023 Technology Foresight,
- Maturity level of organizations to use the outputs of foresight program and need for them; awereness of foresight benefits and to see technology foresight as a tool to meet the needs.

Table 31 Experts views on impact of Vision 2023 technology foresight



	TF PARTICIPATED	TF NOT PARTICIPATED
TUBITAK/ UNIVERSITY/ TTGV	● ↗	● ↓
TAF	● ↑↑	
SSM	● ↗	● ↓
TAFF/ Company	● ↑	● ↑
Private Capital Defense Comp		● ↓
ICT-Electronics-Machine Private Capital Companies	● ↓	
	9	8

● Interviewed
↑ Significant/Major Impact
↗ Partial impact
↓ No Impact

Interviewees who did not participated in the technology foresight program were more negative on the contribution of the technology foresight to the observed or perceived impact. On the other hand, impact of technology foresight was expressed in a range from major impact to no impact. These finding led the analysis of impact according to the information level of participants in the survey.

Document analysis findings indicate that influence of technology foresight is more visible on STI policies and R&D projects in years of 2005-2011. The outputs of foresight were taken as reference in preparation of long-term plans which are SSM Strategy Plan 2007-2011 and SSM Technology Management Plan. Technology foresight had influenced selection and approval of SSM R&D projects. The foresight had influenced technology fields defined by SSM as the priority fields needs to be developed. The evidences of these influences are seen in the corrolation between Vision 2023 DAS Technology Foresight and SSM’s Networks of Technology Excellence. The realization of military R&D projects was influenced by technology foresight starting from collecting R&D project proposals from industry to approval and funding of the projects. Tool impact of foresight was limited with the large scale companies who have established S&T committees, technology management organisations and applied Delphi surveys. Defense technologies research group SAVTAG was set to boost R&D in defense sector. The foresight intervention had awereness impact through being agenda of sectoral magazines. The foresight intervention was in the agenda of SSM magazine during years 2008-2011. This time frame is the period of SSM long-term planning process and strategic plans. Vision 2023 Technology Foresight was in the agenda of the sector magazine (Defense & Aerospace) in years 2003-2004. The technology management and R&D management subjects entered into the agenda of seminars and semposiums organized by cooperation of TAF-MSB/SSM-University and industry (SAVTEK, USMOS) since 2002-2005 and afterwards in defense sector and technology fields of these organisations corrolates with the technology fields of the Vision 2023 DAS Technology Foresight. The foresight outputs were disseminated through the networks and transfer of personnel among instutitions as well.

Vision 2023 Technology Foresight has influenced academic studies by being the subject to post graduate theses. Number of theses on these subjects was increased by 2005 upon completion of the foresight intervention. It has declined afterwards but set at a higher level compared to pre-forseight phase. The renewal of thechnology foresight could avoid the decline and kept contributing to the development of foresight capacity in the sector and the country.

6.4.2 Impact levels of Vision 2023 technology foresight

In order to interprete the participants perceptions obtained from statistical analyses of impact survey, the impact means transformed to an interval. The scale options and transformed interval values are given in Table 32.

Table 32 Scale options, transformed values and value intervals

5 Likert	Options	Transformed Value	Value Interval
1	Completely Disagree	No Contribution	1.00-1.79
2	Disagree	Little Cntribution	1.80-2.59
3	Partially Agree	Some Contribution	2.60-3.39
4	Agree	Significant Contribution	3.40-4.19
5	Completely Agree	Major Contribution	4.20-5.00

Score of each sub_impact factors are calculated by arithmetic mean of variables grouped under the factor with SPSS (Table 33).

Table 33 Vision 2023 technology foresight impact levels

Impact Types	Mean Value	Impact Level
Total Impact of Vision 2023 DAS Technology Foresight Impact Level	2,92	Some Contribution
Impact Factors	**Mean Value**	**Level**
Influence *(STI policies, GUIC, TTM, R&D Personnel, Demand for R&D and Innovation, Identification & Prioritisation of Technology Fields, R&D)*	3,09	Some Contribution
Awareness Raising & Informing	3,05	Some Contribution
Influence & Enabling (Tool Impact)	2,82	Some Contribution
GUIC	2,92	Some Contribution
Foresight Culture	2,99	Some Contribution

Overall impact level of Vision 2023 Technology Foresight is 2,92 with ‘Some Contribution’. ‘Influence’ impact type and ‘Awareness Raising & Informing’ impact type have the highest impact levels as 3,09 and 3,05 respectively. The impact levels of total impact and impact types are recalculated with the weights obtained from focus group. The weighted impact level of Vision 2023 Technology Foresight increased from 2,92 to 3,04 (Some Contribution). The finding ‘Some Contribution’ is compatible with document analysis and interview analysis results that they provide evidences for the impact of technology foresight in defense sector.

6.4.3 Impact on Development in Technology Areas, Methods & Tools

Impact of technology foresight was analysed by means of the additional questions covered in Vision 2023 Technology Foresight Impact Assessment Scale survey. It is important to see the acceptance and use of technology foresight outputs, and impact on developments in strategic technology areas, innovation types, and use of technology foresight methodologies/techniques, technology management tools, technology maturity measurement tools at the organizations.

Impact Share of Technology Foresight Outputs: The most used outputs and their impact levels are presented in Figure 16. Sectoral Analysis Reports (51%), Critical Technology Tree documents (47%), STI Road Maps, and STI Policy and Strategy documents had medium impact (46%). STI Policy Roadmaps and STI Road Maps had major impact with 22% and 17% respectively.

Impact on Use of Technology Management Tools: Impact of Vision 2023 Technology Foresight on use of technology management tools is given in Figure 17. The highest impact is on use of technology roadmap tools. The impact level is medium.

Impact on Use of Technology Maturity Measurement Tools: Impact of Vision 2023 Technology Foresight on use of technology maturity measurement tools is given in Figure 18. Foresight had medium level impact on use of Technology Readiness Level (TRL) tools which are TRL-HW (41%), TRL-System (40%), TRL-SW (37%).

Impact on Use of Foresight Techniques: The most used foresight methods/techniques are brainstorming (53%), road maps (48,8%), SWOT analysis (48%), workshops (44,2%), critical technologies (38,8%) as given in Figure 19.

Impact on Developments in Strategic Technology Areas: Foresight had medium level impact on developments in “Sensor, Electronics and Communication Technologies” (50%), “Information Technologies” (44%), “Air/Land/Sea Platform Technologies” (44%), “Modelling & Simulation Technologies” (43%) as given in Figure 20.

Impact on Innovation Types: Foresight had medium level impact on product innovation (40%) and process innovation (38%) as given in Figure 21.

Impact on Policy Areas: Impact of Vision 2023 Technology Foresight on organisations policy areas is given in Figure 22. Foresight had medium level impact on technology management (47%), technology-product development (40%), technology acquisition (38%), and R&D Innovation policy and strategies (38%).

The technology foresight had increased use of foresight, technology management tools and techniques, contributed technological developments in identified strategic technology fields. Additionally, these impact variables could be used as indicators, even as KIs to monitor the improvements and impact. The indicators turn intangible impact into observable variables.

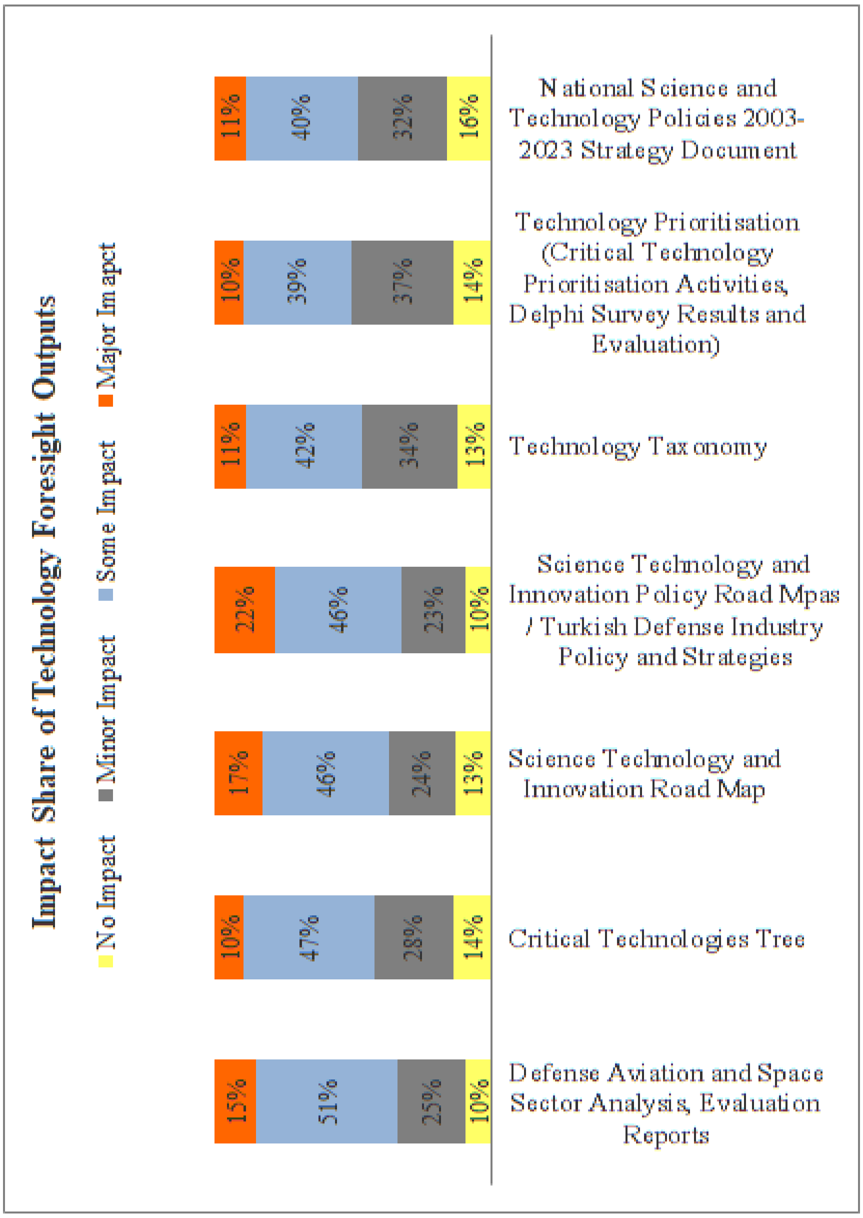


Figure 16 Use and impact of Vision 2023 technology foresight outputs

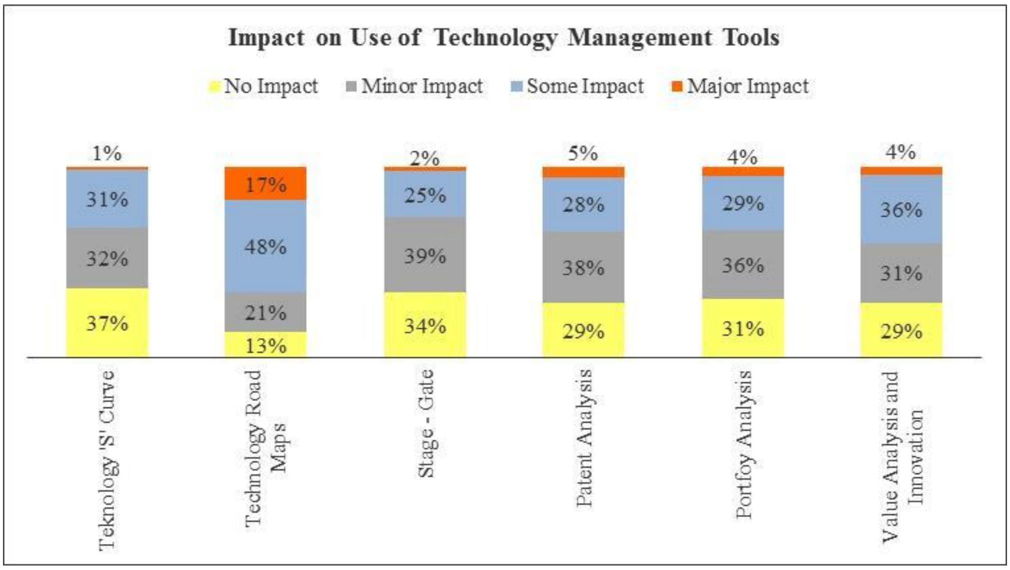


Figure 17 Impact on use of technology management tools

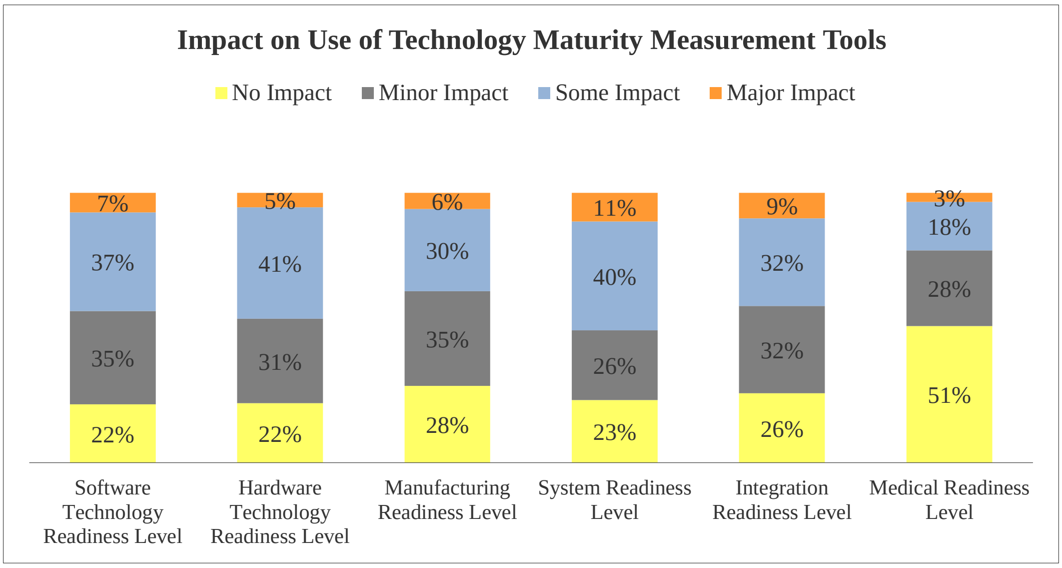


Figure 18 Impact on use of technology maturity measurement tools

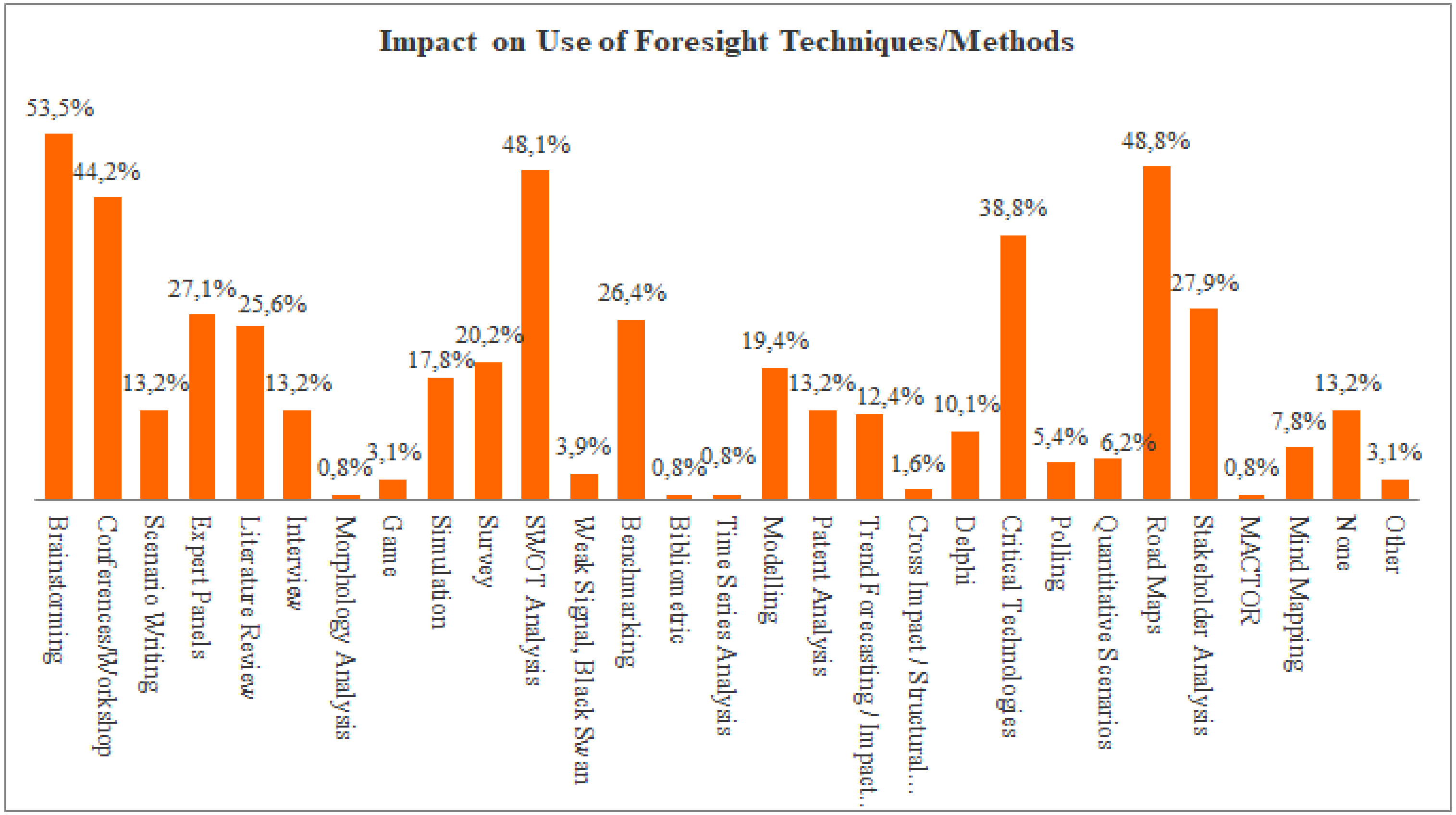


Figure 19 Impact on use of foresight techniques / methods

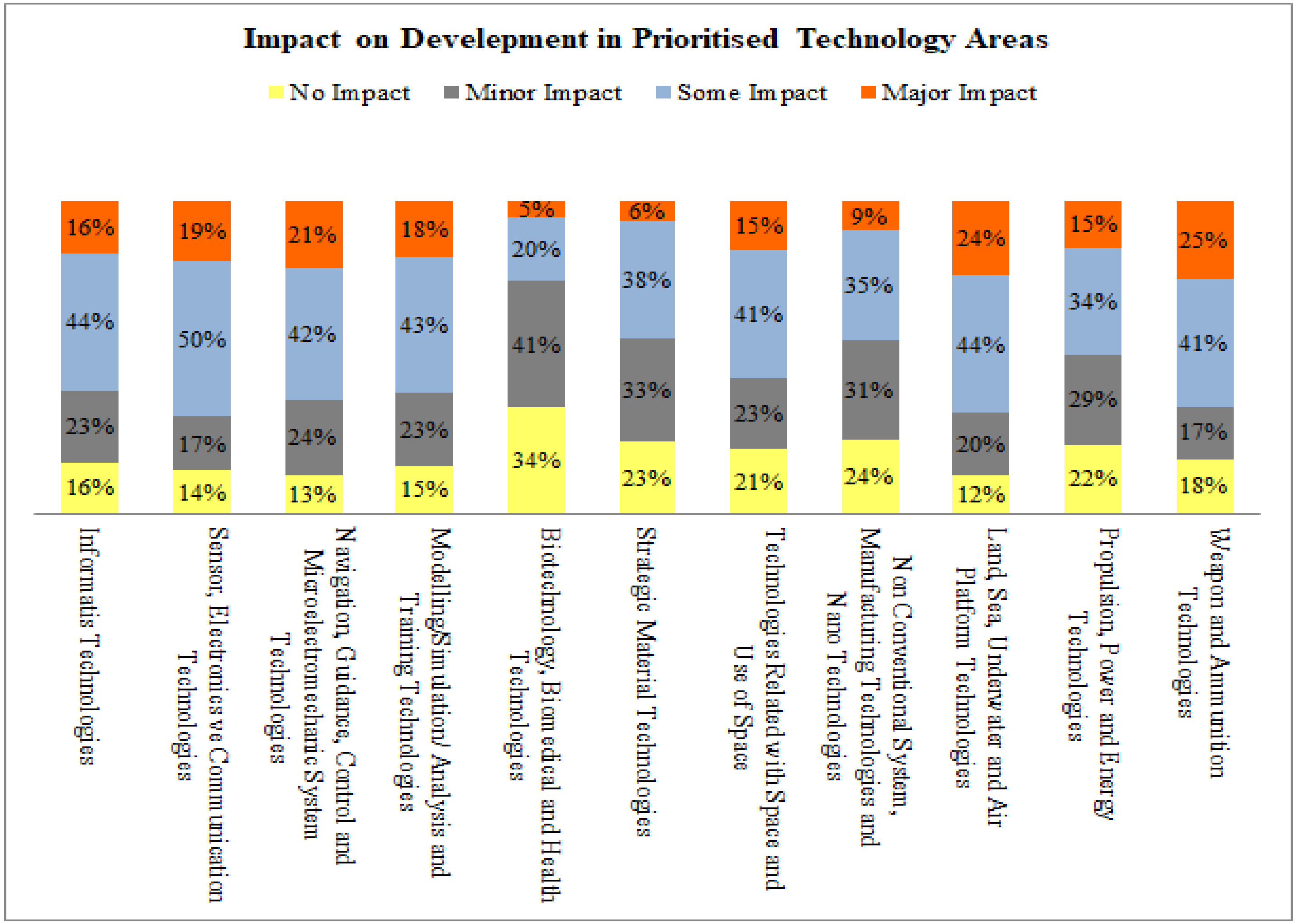


Figure 20 Impact on developments in strategic technology fields

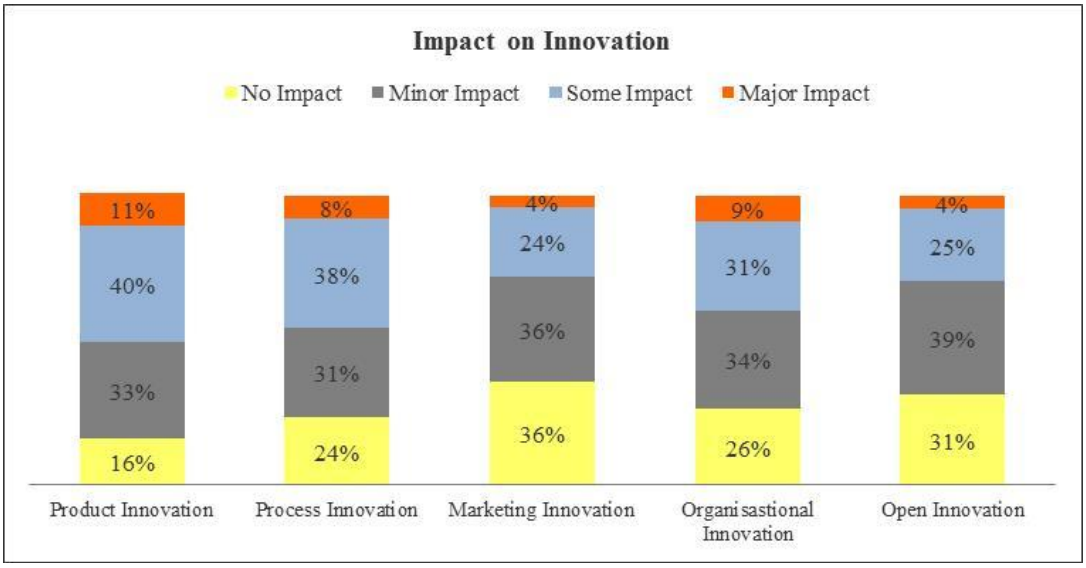


Figure 21 Impact on innovation types

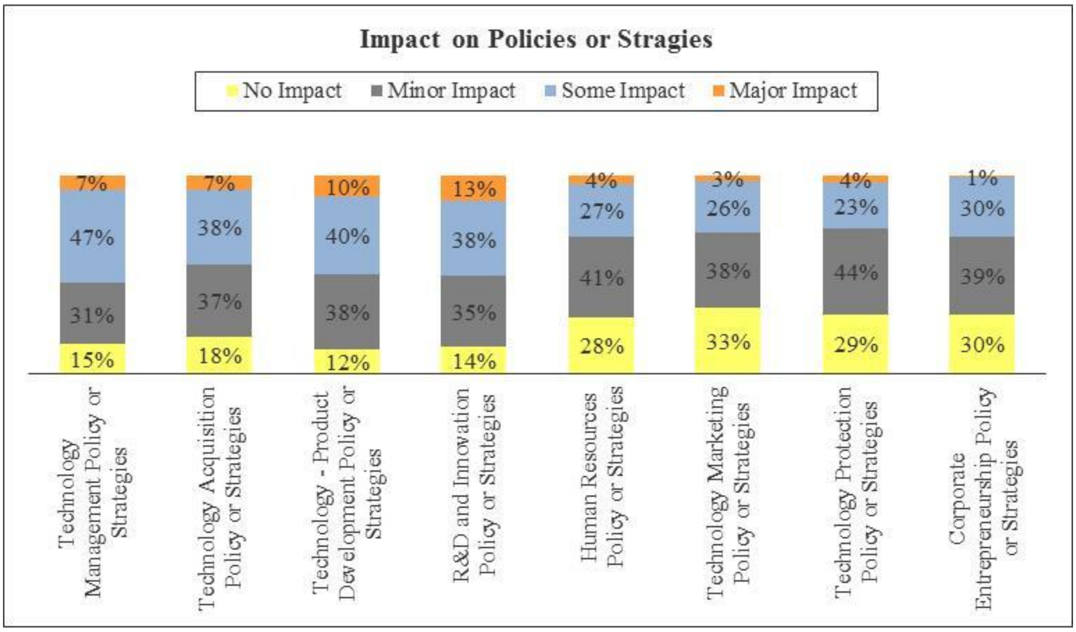


Figure 22 Impact on policy areas

6.4.4 Hyphotesis: Statistically significant differences in impact perception

The early interviews with experts brought up differences in impact assessments of the interviewees changing from major impact to minor/no impact. In addition to these insights, in Japan case impact assessment of experts could differentiate by experts age, instution, involvement in foresight intervention (Yoda, 2011). In this context, research question is stated as "Are there significant differences in the impact perception of the stakeholdres?" In order to answer this question and to define the differentiating groups the hyphotesis is defined as:

H1: There is significant difference in impact perception of participant groups (information level, age, institution and company types).

The null hyphotesis is, H0: There is no significant difference in impact perception of participant groups (information level, age, institution and company types).

The TOTAL_IMPACT is dependent variable. The independent variables are categoric. These are "information level", "age", "instution" and "company type" and each has several groups. It is tested if there is significant difference in TOTAL_IMPACT across groups. Normality of TOTAL_IMPACT variable tested with K-S test, Sig = 0,013 (less than 0.05) shows that it is not normally distributed. The existence of significant difference in impact perceptions of participant groups is analyzed with Kruskal-Wallis (for more than two groups) test and Mann-Whitney U (for two groups) test. They are more appropriate as non-parametric techniques to test the mean ranks of groups, when data is measured on categorical or ordinal scale, normality or homogeneity of variances are violated, and group sizes differ remarkably.

Difference by Information level of Participant: It was analysed if the information level groups assess the Total-Impact significantly different, $X^2_{(3,\ 156)} = 14{,}607$; $p<0.1$), (Significance level=0.002). Kruskall Wallis test indicates the existence of statistically significant difference in total impact level across Information Level groups. In order to find which groups differ statistically significantly from others, Mann-Whitney U test was done. The group "I Know Little" recorded a lower median score (Md=2,79) than others. “I Know Some” (Md=2,96) “I Know Well” (3,00) and “I Know Very Well” (3,20).

Difference by Institution Categories: It was analysed if the instutional groups assess the Total-Impact significantly different, $X^2_{(3,\ 156)} = 4{,}044$; $p>0{,}05$), (Significance level=0,257).

Difference by Age: It was analysed if the age groups assess the Total-Impact significantly different, $X^2_{(4,\ 156)} = 8{,}474$; $p>0{,}05$), (Significance level=0.076). The null hyphotesis is accepted. Kruskall Wallis test indicates that total impact perception of participants is not statistically significant different from one another across age groups.

Difference by Company Type: It was analysed if the company type groups assess the Total-Impact significantly different. The analysis was done with Mann-Whitney U test, since there are only two groups. Mann-Whitney U test indicates that total impact perception of participants is not statistically significant different across company type groups. $U_{(1,\ 101)} = 1.006$; $p>0{,}05$) (Significance level=0,077). K-S test and Mann-Whitney U test outputs are given in Appendix D.

As a summary, there statistically difference in impact perception of participant information level groups. The group has little information about Vision 2023 Technology Foresight perceive the impact less than other groups. There is no statistically difference in impact perception of institutional groups (public institutions, army, university, and industry), age groups and company type groups.

6.5 Challenges & Barriers Confronted During the Study

At the beginning of the study, impact assessment of Vision 2023 technology foresight was inferred as high time. More than 500 people were contacted through interviews, focus group and survey. During the study, big support and interest in the research presented. However, some challenges and barriers were confronted as well. These are;

Lack of ownership of Vision 2023 DAS Technology Foresight: Although TUBITAK was the responsible organisation carried out the Vision 2023 Technology Foresight program with the resolution of SCST. The information provided was limited, specifically follw-up actions of foresight.

Long Time Lapse: It has been a long time (13+ years) passed after finalising the foresight program. It required the participants to review the documents and to recall their past memories and even to review the documents. It had a deterrent effect on participants. Some experts were retired or lost their interest in the subject.

Reache to Stakeholders: Lack of ownership of foresight program has set challenges in the reaching to contact info of participants who involved in the foresight program and Delphi exercises. It was difficult to reach to people who are knowledgeable about foresight and from different industrial sectors (ICT, machine, etc). The reaching to army personnel for interviews and survey was problematic as well.

Dissemination and Diffuse of Knowledge: Diffuse of foresight knowledge was limited in the defense industry by involvement in the foresight program and with a time frame. Therefore, it was limited to reach the knowledgable people from younger generations and SMEs.

Attribution Problem: The impact is generally intangible and it is difficult to trace the cause-effect relation back to attributions. It brought the challenge to define, communicate, relate, and monitor the intangible impact variables. There are not widely accepted indicators to measure the success or impact of technology foresight. Vision 2023 technology foresight had the same limitation to find indicator data due to lack of appropriate indicators and SMART objectives.

No Follow-up Activities: In defense sector there were no follow-up actions planned or executed on purpose to complete the foresight cycle. Lack of documentation regarding foresight monitoring and evaluation activities was another barrier.

Classified documents: In scope of the document analysis, some of the required documents were not in reach, because of the classification required by the nature of defense sector and commercial organisations. Military documents or company documents were not avaliable due to ‘Secret’ or ‘Commercially Sensitive’ classifications. R&D expenditure breakdown was not available to conduct economic analysis.

Trust: Another observed challenge was the lack of trust. The reluctance to share documents (even magazines published by companies), and to discuss impact of technology foresight in defence sector context. Its reflection was seen in the personnel behaviours as well.

6.6 Impact Assessment Model

One of the objectives of this research is the development of an impact assessment model for technology foresight. By using the outputs and findings of interviews, focus group and survey analysis, recommendations inferred from foresight evaluation programs around the world, as well as challenges and barriers encountered during this study, a technology foresight impact assessment model was developed. The model consists of process areas based on CMM/CMMI model, organizational structure, and the impact assessment scale. In this research, it was benefitted from the the staged process improvement model of CMM/CMMI.

6.6.1 Process area framework for impact assessment model

The whole activities, processes, methods, and tools applied to assess the technology foresight impact throught the thesis were reviewed. The activities conducted during the thesis are;

- Defining goals and objectives of the research project,
- Defining work packages and work breakdown of the research
- Assignment of team,
- Defining data needs and sources,

- Gathering information in the context of the technology foresight, assessment and Vision 2023 Technology Foresight;
- Defining stakeholders,
- Consulting by experts throughout the processes;
- Defining resource needs (humanpower, fund, infrastructure, tools,..), and planning resources;
- Defining training needs and planning;
- Preparing the research plan including schedule,
- Development of work packages (development of CSFs, impact types, impact assessment scale, impact level, impact assessment model);
- Progress reviews,
- Providing validity and reliability of the work packages;
- Reporting outputs and the findings.

This activity list consists of some generic and specific practices which are defined by CMM/CMMI model.

The impact assessment is part of technology foresight cycle, it is recurring process, and provides input data to the renewal phase as learning tool. Lessons-learned and improvement recommendations are provided to renewal phase of the foresight cycle.

In order to design impact assessment activities in a framework, the activities were mapped into process area approach of CMM/CMMI. CMM/CMMI models contain essential elements of effective processes, not process descriptions. Processes hold together people, tools and procedures. The models (CMM for Software, CMM for Systems Engineering, CMM for Integrated Product Development, CMMI for Development, CMMI Services, and CMMI for Acquisitons) are collection of best practices and provide integrated set of guidelines to improve the processes. The models describe evolutionary improvement path from ad-hoc immature processes to disciplined and mature processes. Process area is a cluster of related practices to satisfy the goals for making improvements in that area. Staged representation of CMM models indicates the maturity of the processes from 1 to 5 (1-Initial, 2-Managed, 3-Defined, 4-Quantitatively Managed, 5-Optimizing). CMM was developed to apply in software by Watts Humprey in 1989 and were based on earlier work of Phillip Crosby in 1979, Edwards Deming in 1986, Joseph Juran in 1988 .All these studies were based on the concepts of statistical quality control of process improvement developed by Walter Shewhart in 1931 (Software Engineering Institute, 2010).

The developed technology foresight impact assessment model is given Figure 23. The model consists of project planning, information gathering, counseling with experts, CSF analysis and resolution, and evaluation-assessment process areas. Each process area of the impact assessment model is defined by the modified version of process area approach of CMM/CMMI. The modified process area framework is given in Table 34.

Table 34 Process area framework

PROCESS AREA **PURPOSE**
ACTIVITIES • Plan the process • Identify stakeholders • Assign Roles & Responsibilities • Train People • Execute the planned activities • Monitor & Control • Objectively Evaluate: • Review with Senior Management • Configuration/Change Management • Improve the Process **RESOURCES** **MEASURES** **VERIFICATIONS:**

The generic practices of process area are:

- Plan the process: To prepare a plan to perform the process, define needs to achieve the objectives, and to get agreement of stakeholders on the process plan.
- Identify stakeholders: To establish and maintain the involvement of relevant stakeholders to the process through the activities of requirement definitions, communications, committment, coordination, decisions, reviews, and resolutions

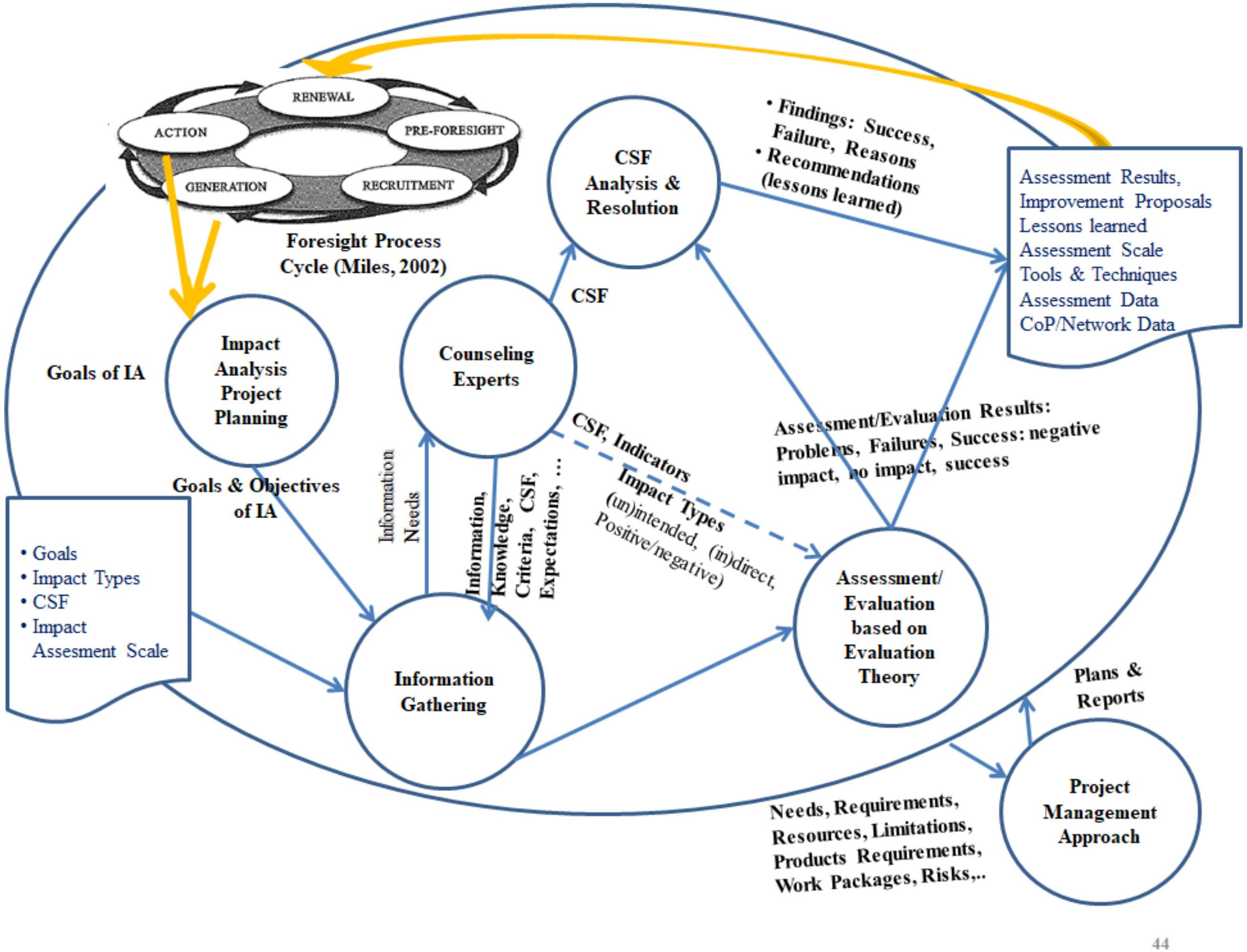


Figure 23 Technology foresight impact assessment model

- Assign roles and responsibilities: To ensure the accountability throughout the life-cycle of the process by giving authority to person to perform the assigned responsibility.
- Train people: To perform the process, people have required skills and expertise.
- Execute the planned activities: To execute the planned acitivities.
- Monitor and control: To monitor and control of the process by measuring the appropriate attributes of the process.
- Objectively evaluate: To provide assurance to the process that it was implemented as planned.
- Review with senior management: to provide appropriate visibility of the process to the higher, senior management to ensure that informed decisions are made in planning and performing the process.
- Configuration/ Change Management: To establish and maintain the integrity of the products of the process (reports, evaluation and assessment criteria, measurement criteria, decisions, etc).
- Improve the process: To provide alternative solutions to improve the process.
- Provide resources: To define the required resources (funding, physical facilities, skilled people, tools, etc) and to provide when needed to perform the process.
- Measures: The criteria of the process area objectives.
- Verification: To ensure the work meets the specified requirements.

This process area framework brings together the necessary generic practices to execute the process to achieve its objectives.

Project Planning Process Area is defined in Table 35. The purpose of this process area is to define and plan the impact assessment activities. Project plan is prepared with project management approach. The activities of the planning process starts with definition of goal, scope, content and time frame of foresight impact assessment project. Assessment team is identified. Independence of the team members is important for unbiased results. Assessment method is defined. Impact areas, analysis methods and tools are defined. Work packages of the project are generated. Project team is assigned and training needs are identified. Effort and cost is estimated, risks are defined. A time schedule and project plan is prepared.

Table 35 Impact assessment project planning process area

PROCESS AREA: IMPACT ASSESSMENT PROJECT PLANNING (IA PP) **PURPOSE:** The purpose of this process area is to define and plan the project activities to assess the impact of the technology foresight intervention.
ACTIVITIES: • **Plan the process:**   o Define goal and objectives, scope, content, time frame of impact assessment   o Define or develop Programs Logic Model of technology foresight   o Define impact areas   o Define impact analysis methods and tools   o Define work packages: *Evaluation of Delphi statements,   *Documentary analysis,   *In-depth interview analysis,   *Focus group analysis,   *Statistical survey analysis,   *Econometric analysis   …….   o Define research population and sampling size   o Define data sources   o Define resources required (effort &cost)   o Develop time schedule   o Prepare project plan   o Review plan with higher management for approval • **Identify Stakeholders:** Identify and inform stakeholders to be involved • **Assign Roles & Responsibilities:** Assign roles and responsibilites of team members who will conduct the impact assessment • **Train People:** Analyse training needs of the team and provide required training (technology foresight, foresight methods, techniques, and tools, project management tools,..) • **Execute the planned activities:** Perform the activities described in the heading “Plan the Process” • **Monitor & Control**: Monitor the process area with measures. • **Objectively Evaluate:** Make internal audits / reviews, team audits • **Review with Senior Management:** Review the outputs with senior management (steering committee, etc.) • **Configuration/Change Management:** Trace and make changes in plan, project resources, project team, etc • **Improve the Process:** Improve the process by making evidence-based changes to increase performance, quality, and reliability. **RESOURCES:** • Personnel • Funds • Data resources: Products technology foresight; Reports, plans, documents of institutions; experts, sector stakeholders. **MEASURES** Quality of planning, changes to plan (cost, effort, time, work packages,…) **VERIFICATIONS** **Reviews:** Internal reviews and senior management reviews

Measures of the process and work products are defined. Lessons learned and recommendations are developed to improve the process. Quality of planning, changes to planning (time, cost, and effort, work packages, ..) are the indicators recommended for this process area.

Information Gathering Process Area (Table 36) is designed to get data, information and insights related to technology foresight intervention in the inner and outer context, impact types, impact areas, and CSFs.

Table 36 Data, information gathering process area

PROCESS AREA: DATA, INFORMATION GATHERING (DIG) **PURPOSE:** The purpose of this process area is to get data, information and insights related to technology foresight, its inner and outer context.
ACTIVITIES: • **Plan the process:** o Define goal and objectives of the process o Define data sources o Define analysis methods o Plan analysis schedule o Acquire data and information o Analyse data o Review outputs with senior management for approval o Report approved outputs • **Identify Stakeholders:** Identify data sources and stakeholders which will be contacted. • **Assign Roles & Responsibilities:** Assign roles and responsibilites of team members • **Train People:** Analyse training needs and provide the required training (data analysis methods, techniques, tools, INVIVO, econometric analysis, etc) • **Execute the planned activities:** Perform the activities described in the heading "Plan the Process" • **Monitor & Control**: Monitor the process area with measures. • **Objectively Evaluate:** Make internal audits / reviews, peer reviews, team audits • **Review with Senior Management:** Review the outputs with steering committee, etc.) • **Configuration/Change Management:** Trace and make changes in data types, definitions, sources, analysis methods, analysis outputs • **Improve the Process:** Improve the process by making evidence-based changes to increase process performance, quality, and reliability. **RESOURCES:** • Personnel • Funds • Data resources: In-country, international statistical data, plans, reports, outputs of project planning process, CSFs, Impact Assessment Scale. **MEASURES** Quality of data, validity of data sources and analysis output **VERIFICATIONS** **Reviews:** Internal reviews and senior management reviews

The activities are planning of the process including identification of data sources, stakeholders, analysis methods and tools, and work packages. Data validity, reuse of the code book/codes, use of analysis outputs in foresight scoping, policy planning, or action plans are the recommended indicators for this process area. Counselling with Experts Process Area (Table 37) is designed to get insights of experts on different perspectives of technology foresight.

Table 37 Counseling with experts process area

PROCESS AREA: COUNSELING with EXPERTS (CE) **PURPOSE:** The purpose of this process area is to get insight of experts on ttechnology foresight.
ACTIVITIES: • **Plan the process:**   ○ Define objectives of counseling   ○ Define analysis methods (in-depth interviews, focus group, ..)   ○ Define methods and criteria to chose experts to be consulted / interviewed   ○ Choose of experts to be consulted.   ○ Decide on data analysis methods (theory-driven, data-driven, ?)   ○ Develop counsulting / interview questions   ○ Define interview methods and tools   ○ Conduct counseling/interviews   ○ Analyse data   ○ Generate code book and codes   ○ Define impact factor weight scores and prioritize   ○ Review output of analysis with senior management for approva**l**   ○ Report approved outputs • **Identify Stakeholders:** Choose of experts, informants to be consulted and receive acknowledgement • **Assign Roles & Responsibilities:** Assign roles and responsibilites of team members who will run the consulting/interviews (interviwers, moderator, assistance, data analyser,..) • **Train People:** Analyse training needs of the team and provide the required training (interview, data analysis methods and tools) • **Execute the planned activities:** Perform the activities decsribed in the heading “Plan the Process” • **Monitor & Control**: Monitor the process area with measures**.** • **Objectively Evaluate:** Make internal audits / reviews, team audits • **Review with Higher Management:** Review the outputs with senior management (steering committee, etc.) • **Configuration/Change Management:** Trace and make changes in experts groups, analysis outputs • **Improve the Process:** Improve the process by making evidence-based changes to increase quality, reliability of the process. **RESOURCES:** • Personnel • Funds • Data resources: Technology foresight participants (panels, scenarios, Delphi exercises, commities) data base, informants (experts, officers, individuals), participants to long-term planning activities, etc. Needs, requirements generated through information gathering process. **MEASURES** Data/informant/method triangulation, reuse of codebooks or codes, use of outputs in technology foresight scoping, policy planning, or action plans **VERIFICATIONS** **Reviews: I**nternal reviews and senior management reviews

Decide on how to choose experts, criteria, and methods. Decide on analysis methods and tools. Execute the activities and monitor the process. Data validity, reuse of the code book/codes, use of analysis outputs in foresight scoping, policy planning, action plans are the indicators for the process area to develop lessons-learned and improve the process.

CSF and Resolution Process Area (Table 38) is designed to derive CSFs of technology foresight and make decisions about the findings as success, failures, reasons, cause-and-effect relations. Decide on analysis methods and tools to generate the desired outputs. The outputs of the counseling and assessment processes area are the inputs of CSFs and Resolution process area. Validity of CSF analysis and resolution, use of CSFs, findings, and recommendations in foresight scoping phase, policy planning phase or in action plans could be KIs for the process area to develop lessons-learned and improve the process.

Table 38 CSF&R analysis and resolution process area

PROCESS AREA: CSF ANALYSIS & RESOLUTION (CSF & R) **PURPOSE:** The purpose of this process area is to analyse and decide on CSFs of technology foresight and to analyse the root causes of success or failure of technology foresight
ACTIVITIES: • **Plan the process:**   o Define the goals and objectives of the process   o Define analysis methods and tools   o Analyse and develop CSFs   o Decide on cause-and-effect relations and root causes   o Report finding   o Develop recommendations   o Share the finding and recommendations with senior management for approva**l**   o Report approved outputs • **Identify Stakeholders: S**enior management (sponsor and prime client of the foresight, steering committee, ..), experts to be counsulted. • **Assign Roles & Responsibilities:** Assign roles and responsibilites of team members who will run the CSF analysis and resolution (data collection and data analyser,) • **Train People:** Analyse training needs and provide the required training • **Execute the planned activities:** Perform the activities decsribed in the heading “Plan the Process” • **Monitor & Control**: Monitor the process area with measures**.** • **Objectively Evaluate:** Make internal audits / reviews, team audits • **Review with Senior Management:** Review the CSFs, root-causes with senior management (steering committee, etc.)

Table 38 (Continued)

PROCESS AREA: CSF ANALYSIS & RESOLUTION (CSF & R)
• **Configuration/Change Management:** Trace and make changes in CSFs, cause-and-effect relations, attributes, etc) • **Improve the Process:** Improve the process by making evidence-based changes to increase quality, reliability of the process. **RESOURCES:** • Personnel • Funds • Data resources: Output data/reports of information gathering, counseling and assessment processes. Code books, codes, attributes, failures/successes, problems generated through these processes. **MEASURES** Validity of CSF analysis and resolution. Use of CSFs, findings, recommendations in foresight scoping phase, policy planning phase or in action plans. **VERIFICATIONS** **Reviews: I**nternal reviews, senior management reviews

Evaluation / Assessment Process Area (Table 39) is designed to assess the (un)intended, (un)targeted, primary or secondary, positive or negative impact and impact levels of the technology foresight on impact areas with impact scale. Activities are deciding on sampling structure and size of population for statistical analysis, application of Impact Scale survey, analysis of survey data, and consolidation of findings from other processes and reporting. The outputs of the counselling and information gathering processes are the inputs of the process. Validity and reliability of statistical analysis, reuse of Impact Assessment Scale, use of assessment results in foresight scoping phase, policy planning phase or in action plans are the recommended indicators for the process area. Based on these indicators and evidence-based information, lessons-learned are derived to improve the processes.

Implementing a staged model CMM/CMMI in technology foresight cycle and processes will help developing the foresight capacity and increasing the maturity level in the industry and country. There are a few studies applied CMM for company foresight (Grim, 2009), (Rohrbeck, 2011).

Table 39 **A**ssessment / evaluation process area

PROCESS AREA: ASSESSMENT/ EVALUATION (EA) **PURPOSE:** The purpose of this process area is to make the statistical analysis of technology foresight impact.
ACTIVITIES: • **Plan the process:**   o Define goals and objectives of impact assessment   o Define analysis methods and tools   o Review and update/customize Impact Scale Questionnaire   o Apply Impact Scale survey   o Analyse survey data   o Review statistical analysis results and findings   o Consolidate all analysis outputs and findings   o Develop recommendations   o Review output, finding & recommendations with senior management for approval   o Report approved outputs and recommentations • **Identify stakeholders:** Identify research sampling area to make survey and analysis. • **Assign Roles & Responsibilities:** Assign roles and responsibilites to apply the survey and statistical analysis • **Train People:** Analyse training needs and provide the required training (Statistical analysis with SPSS, LISREL) • **Execute the planned activities:** Perform the activities decsribed in the heading “Plan the Process” • **Monitor & Control**: Monitor the process area with measures. • **Objectively Evaluate:** Make internal audits / reviews, team audits • **Review with Senior Management:** Review the outputs with senior management (steering committee, sponsor, prime client, etc.) • **Configuration/Change Management:** Trace and make changes in Impact Scale, impact areas, Impact types, weights of impact types, CSFs, etc.,) • **Improve the Process:** Improve the process by making evidence-based changes to increase quality, reliability of the process. **RESOURCES:** • Personnel • Funds • Data resources: Output data/reports of information gathering, counseling processes. Code books, codes, impact types, impact generated through these processes. **MEASURES** Validity and reliability of statistical analysis, reuse of Impact Assessment Scale, use of assessment results in foresight scoping phase, policy planning phase or in action plans. **VERIFICATIONS** **Reviews:** Internal reviews and senior management reviews

The proposed Technology Foresight Impact Assessment Model with process area approach of CMMI is developed for macro level applications. The model frames the primary processes, generic practices, activities, and measures in one table. It is proposed as a tool to ease the monitoring and evaluation, and help to increase the impact of the the technology foresight. It was developed to benefit the staged model, link actions to actors and set SMART targets for monitoring and evaluation attributes. Meantime, the process areas are preliminary and open to rework. The model and process areas cover only the assessment part of the foresight, not the whole cycle. The developed model can be reworked to extend the application of CMM/CMMI model to whole cycle of the technology foresight.

6.6.2 Organisational structure for technology foresight cycle

As it was derived from in-depth interview analysis, acceptance and full committment to technology foresight is a CSF. In Vision 2023 case, especially the committment for its success is weak on both government instutitions and industry sides, except TAF. In connection with this finding, sponsor and clearly identified client definitions are covered by the model. The organisational model to conduct the full cycle of technology foresight is given in Figure 24.

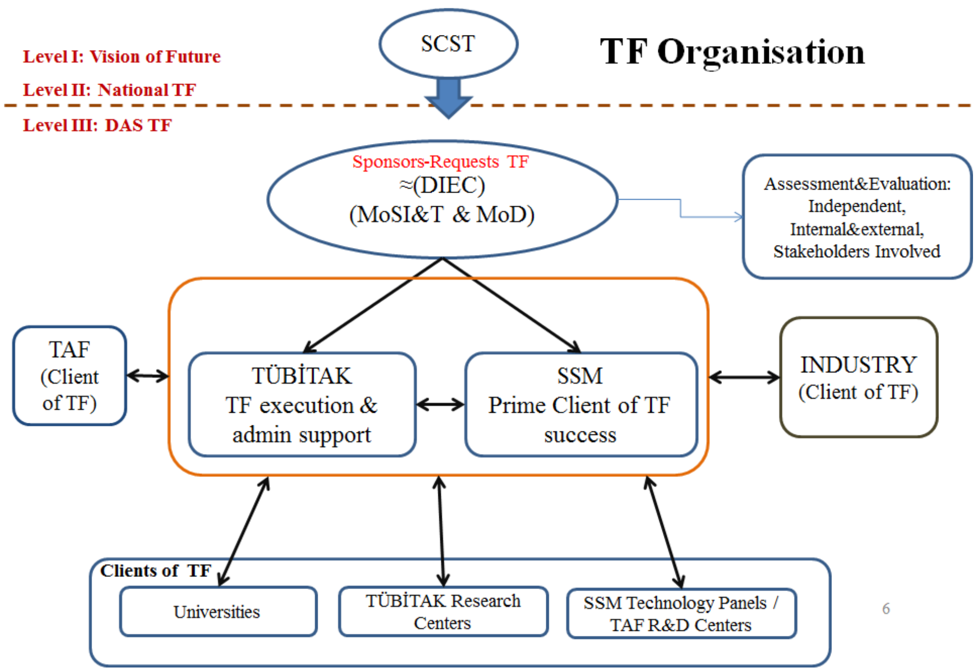


Figure 24 Organisation model to conduct technology foresight cycle

Sponsor of the technology foresight: Sponsor is critical for the success of the foresight. Sponsor is the requestor institution with high authority ordering the execution of technology foresight. A structure similiar to DIEC is proposed with senior members from MoND and MoSIT. Sponsor will have the authority to assign organisations to start, plan, conduct, implement and monitor, evaluate and renew the whole foresight cycle and action plans. Sponsor will assign and hold organisations accountable for the success of foresight. Sponsor may assign a seperate organisation for the assessment and evalution of the technology foresight and makes stakeholders be part of assessment to increase the validity and learning effect.

Client: Clearly identifying and assigning client institution for the technology foresight results is another CSF. It is recommended that SSM is the primary client for technology foresight results. TUBITAK is assigned to conduct the foresight cycle in coordination with SSM. TAF, universities and industry are the client of the foresight result as well. SSM as the prime client has the main responsibility to achieve the success of the foresight.

Functions of Prime Client (SSM): Leader; Providing involvement of senior managers, decision makers in technology foresight; Providing funds for S&T and R&D projects; Responsible of realization of foresight; Providing independant and autonomous platforms for military and civilian co-work; Same distance to stakeholders; Taking over the R&D risks; Directing S&T investments and R&D projects according to technology foresight roadmaps not the short-term needs; Realisation of technology foresight; Implementing technology management processes; Monitoring technological progress with TRL tools; Setting technological targets aligned with platform projects (based on TAF system needs); Splitting fund allocation for exisiting and emerging technologies; Splitting system and technology level R&D; Positioning research centers, universities and industry according to TRL levels, monitoring foresight with indicators.

Academic Receptor: Clearly identifying and assigning a university (METU) as an academic receptor and training capacity is another critical factor for the success of the foresight. University will provide training, and be the source of policy ideas related to future challenges, and international foresight connections.

Military R&D Centers and Technology Panels: The platforms will have role in creation and stimulation of S&T knowledge and R&D programs by enabling the co-work of scientists, enginerrs, and experts from military, industry, and universities.

6.7 Discussion

In this chapter, empirical data was analysed through in-dept interviews, focus group, documents analysis and survey. The study demonstrated that the impact types of technology foresight and their weights differ by the technology foresight under assessment. The impact types developed through the research are classified in two groups. The first group has “Influencing” impact type with the highest weight. The second group has “Influencing and Enabling”, “Awareness Raising and Informing”, “GUIC”, “Foresight Culture” impact types. The weight of this second group is quite low compared to the first group. The ratio of weights is 65 / 35. Since no negative impact was voiced throughout the interviews, the impact scale was designed with 5-likert from no contribution to significant contribution. In order to cover the full spectrum of impact, the “Negative Impact” is added to the scale questionnaire.

Total impact level of Vision 2023 Technology Foresight in defense sector is 2,92 (max level is 5) which corresponds to ‘Some Contribution’. The weighted total impact level increased from 2,92 to 3,04 which still corresponds to “Some Contribution” level. Perceived impact levels differred statistically significant by the information level groups of participant. The group (knows very well Vision 2023 Technology Foresight) perceive the impact higher than others. Impact perception of institutional groups (public institutions, army, university, industry) does not differ significantly. This finding is not in line with the findings of the interviews.

The complementary evidence for technology foresight impact is extracted from the document analysis. Vision 2023 Technology Foresight has had policy informing impact on defense sector through SSM S&T policies and plans. Influencing impact was realized by identifying focused S&T fields, selecting and directing military R&D projects. Enabling impact was realised by implementing foresight techniques. Indications of awareness raising impact were concluded from the agendas of sectoral magazines. Not limited with defense sector, the foresight exercise has affected the post graduate theses by being the research subject. The impact was increased upon completion of foresight program and declained afterwards due to absence of foresight renewal.

Renewal of technology foresight and the conducting foresight programs in systematic and continuous cycles were concluded as necessity. Update of the technology foresight every 2-3 years and renewall of every 5 years were defined as the requirements and needs of Turkish defense sector.

The continuity of foresight cycle, monitoring and evaluation of foresight cycle, monitoring with KPIs/KI, accountibiliy, trust, funds allocation, holistic view, and consistency of STI policies are derived as country specific CSFs.

The additional recommendations are inferred from the interviews: The development of DAS strategy paper as output of technology foresight for the sector; The positioning of research centers and industry on TRL scale for S&T and product development programs; The design of policies to facilitate the prototype development as part of product and R&D culture development.

Impact assessment model based on CMM/CMMI process area offers an approach for the measurement, analysis and improvement of technology foresight cycle processes. Implementing the staged model CMM/CMMI in technology foresight cycle will help developing the foresight capacity and maturity in the industry and country. It was developed to benefit from the stage level approach, to link actions to actors and to set SMART targets for monitoring and evaluation of the attributes. There are few studies applied CMM/CMMI for foresight at corporate level. The proposed model of the thesis differs from them by applying the CMM/CMMI model at macro level. Organizational structure and indicators are developed as recommendation for the evaluation and assessment phases of the technology foresight.

CHAPTER 7

CONCLUSION

7.1 Main Issues and Research Findings

The first objective of this thesis is to analyze and assess the impact of Vision 2023 Technology Foresight on STI polices and decision making processes in defense sector. The second objective is the development of assessment model.

The evidence of value created by the foresight intervention is provided by assessing its impact in defense sector. Therefore, an impact assessment scale is developed to assess the ex-post impact of technology foresight intervention. Program-based theory, qualitative and quantitative data analysis techniques (in-depth interview, focus group, document analysis and survey) are implemented in the research. The scale constructed of 5 different impact types with different weighting points, reflecting the relative importance degree of Vision 2023 technology foresight goals for defense sector. The developed impact types are; Influencing, Awareness Raising and Informing, Enabling, Cooperation between Government-University-Industry, and Foresight Culture. "Influencing" has the highest weighting score.

The ex-post impact of Vision 2023 technology foresight in defense sector is assessed with the developed scale. In the scale, the contribution of the technology foresight is questioned instead of its attribution due difficulty in linking cause-effect relationship and lack of tangible indicators. The total impact level is measured as "Some Contribution" with 3.02 out of 5.0 score. The highest score is observed at "Influencing" which covers mainly the STI policies, selection and prioritization of

R&D projects. The least impact is measured at “Enabling”, followed by the “Cooperation of Government-University-Industry”, and “Foresight Culture”.
There is statistically significant difference in the perceived total impact depending on the participant information level groups. Participants having more information on the Vision 2023 technology foresight have more positive perception of the impact.

Comprehensive and evidence-based complementary information and knowledge are derived in the context of Vision 2023 DAS technology foresight as result of qualitative data analysis. Selection and approval of R&D projects were influenced by the foresight program. The marks of the impact are more visible in the early years upon completion of the technology foresight program. Some cultural impact and awareness increase on STI and foresight are achieved in defense sector. The technology foresight had some contribution to the increase of long-term planning activities, development and use of technology taxonomies, the increase in use of foresight techniques, and the increase in the information transfer in the industry.

It is concluded that lack of ownership of the technology foresight and commitment to its immediate-to-long-term outcomes, and lack of monitoring and evaluation are the reasons behind not achieving the objectives of the Vision 2023 technology foresight in defense sector. No agent / institution was held responsible for the follow-up programs, and the monitoring and evaluation of foresight was not conducted.

An organizational/institutional structure with its functions is recommended to meet the CSFs of technology foresight. Establishment of a committee similar to DIEC as the sponsor of the foresight, and assignment of SSM as the client which is responsible for the success of technology foresight program are recommended.

An impact assessment model is developed based on CMM/CMMI at macro level to increase the technology foresight capacity and maturity. The staged and process improvement principles, and process area approach of CMM/CMMI are benefitted in the development of the model. New process areas and KIs are defined in the scope of the model.

A new S&T vision is developed for defense sector including the concept of ‘agility’ as difference from the existing vision.

As a conclusion, it is the high time to conduct a technology foresight program for defense sector. The renewal of technology foresight, and executing the foresight cycle in systematic and holistic view came out as a necessity. The update and evaluation of technology foresight every 2-3 years and renewal every 5 years were defined as requirements and needs.

7.2 Policy Implications

The rationale of conducting technology foresight programs is to influence policies and decisions to benefit from S&T to create a knowledge society and innovative economy. The long-term, structural impact of technology foresight focuses on policy making and policy system. Therefore, one of the most important goals of technology foresight is the achievement of its impact through the policies.

The policy implication of this research is focused on the increasing the impact of technology foresight programs. Some policies and policy tools are recommended to increase the impact of technology foresight, to develop technology foresight capacity and culture Table 40.

Recommended Policies:

1. Renewal of technology foresight: Renewal of a participative technology foresight with long-term, holistic and systematic view in continuous cycles every 2-5 years, evidence based, involvement of senior policy / decision makers, integrated with defense needs, integrated with policy processes and STI policies, participation of all stakeholders (military-government-university-industry-public), enabling common wisdom, defining SMART targets, providing accountability, and building trust between stakeholders. Development of defense strategy paper for defense sector.

Table 40 Recomended policies and policy tools

Recommended Policies	Recommended Policy Tools
Renewal of Technology Foresight	Setting Sponsor Committee Assignment of SSM Think-Tank Groups Military R&D Centers, Technology Panels Communication Law on executing technology foresight Law on prototype development
Evaluation and Assessment	Evaluation and Assessment Teams Foresight Assessment Model KIs TRL tools Delphi
Evaluation of Technology Levels	Evaluation and Assessment Teams TRL tools Delphi
Assignment of Responsibilities	Setting Sponsor Committee Assignment of SSM
Structuring Military STI Agents	Military R&D Centers, Technology Panels
Positioning STI system agents	KIs TRL tools Delphi Law on prototype development

2. Evaluation and Assessment: Monitoring of technology foresight impact (ex-ante, in process, ex-post) with tangible KIs. Evaluation and assessment of technology foresight programs in an independent structure with involvement of internal and external stakeholders, and by making part of learning process on a regular base (every 2-3 years).
3. Evaluation of technology levels: Evaluation of achieved maturity levels of strategic science and technology areas. Encouragement the use of TRL tools to assess the S&T maturity levels on a regular base (2-3 years).
4. Assignment of Responsibilities: Assignment of responsibilities for technology foresight and follow-up actions to STI system agents. Assignment of SSM to conduct technology foresight and for its success in defense sector. Assignment of industry to take responsibility in technology foresight, follow-up programs, and evaluation programs actively.

5. Restructuring Military R&D Centers: Assignment of R&D centers, technology panels to facilitate autonomously, to create and exchange knowledge, and to cooperate on R&D programs.
6. Positioning STI system agents: Positioning military and TUBITAK R&D centers, university, and industry on TRL scale to increase technological development and cooperation.

Recommended policy tools to enable and facilitate the implementation of the policies:

1. Sponsor committee: Setting of a committee similar to DIEC composed of ministers and senior decision makers of MoSIT and MoND and directed by SCST to sponsor the technology foresight and to assign tasks to continuity of the foresight cycle.
2. Assignment of SSM: Assignment SSM as main client of technology foresight program and its success.
3. Evaluation/Assessment Teams: Design and assignment of participative, independent evaluation/assessment teams.
4. Think-Tank Groups: Setting-up think-tank groups to understand and detect challenges, weak signals and black swan events, and to understand and shape the future.
5. Foresight Assessment Model: Implementing foresight maturity model / foresight assessment model to improve the technology foresight processes.
6. TRL Tools: Use of TRL tools in assessment of technology maturity levels.
7. Delphi Exercises: Use of Delphi techniques to evaluate and benchmark the technological developments
8. Military R&D Centers, Technology Panels: Assignment of the R&D centers and technology panels as STI system agents of defense to create STI knowledge, information/technology transfer, and cooperation between stakeholders.
9. KIs: Defining knowledge/technology transfer from military R&D centers to industry, and fund transfer from industry to R&D centers and universities as new KIs. Defining cooperation of technopark companies (SMEs) with defense companies on R&D projects as new KIs.

10. Communication: Involvement of defense sector NGOs (SaSaD, TOBB Defense Chambers, etc.,), defense clusters, technoparks, and sectoral periodicals to have the stakeholders aware of foresight objectives, projects and activities, and outputs.
11. Law on foresight: Design of a binding law clause to implement technology foresight programs and to link its outputs to policy cycles and processes, and to evaluate the impact on a regular base systematically.
12. Laws/Regulations on prototype development: Amendment of R&D law and procurement law to enable the development of prototypes as a phase between R&D and product.

The above policies and policy tools are recommended to increase the success (impact and sustainability) of technology foresight in defense sector. Specific to defense sector, army R&D centers and technology panels need to be inserted into STI system as S&T generation agents to increase the STI system performance. The structure of the army R&D centers needs to be reviewed to facilitate the co-work of experts and scientists from army-university-industry together. Knowledge and technology transfer from army R&D centers and technology panels to industry is another KI to observe the performance of the STI system.

The positioning of research centers and industry on TRL scale for S&T and product development programs to increase maturity of the sector in S&T, and the use of funds appropriately. Leveraging prototype development would increase the technological level and self-sufficiency of the sector. Positioning technopark SMEs as technology companies into defense company supplier list and monitoring with cooperation on R&D projects.

The countries which successfully implement the technology foresight cycles are those with strong laws to link foresight outputs to policy development processes. Specifically to overcome the problem of lack of ownership and support of government and public institutions, there should be a binding law to implement participatory technology foresight exercises to link the outputs to policy development cycles and processes, and to evaluate the impact of S&T policies and foresight exercises with a holistic view.

7.3 Possible Future Research

It has been obtained from this thesis that, Vision 2023 Technology Foresight has the highest impact on the ‘Sensor, Electronics and Communication Technologies’. It had affected the use of Technology Readiness Levels (TRL). TRL was developed by NASA, and it is widely known in defense sector. It is important to monitor and evaluate the developments in S&T with more objective indicators. It will help to trace cause and effect relation and increase the attribution of technology foresight to S&T development. Therefore, the next research subject would to assess the impact of Vision 2023 Technology Foresight by using TRL tools. The challenge in using TRL to assess the maturity of S&T is, although it is commonly known and said to be used by the defense institutions, there is no detailed and verifiable data set avaliable. It requires the development of a set of detailed questions and replies with evidences. As a result, TRL will be a valuable and tangible tool and KI to monitor, assess and evaluate the impact of technology foresight.

Another research subject is the IA, OA analysis of Vision 2023 Technology Foresight in defense sector. The challenge is to reach the detailed R&D expenditure data. SSM sponsorship of such research will increase the realisation of both research studies.

A third research subject would be the application of CMM/CMMI approach to the technology foresight cycle and processes at macro level by defining process areas, practices and indicators. Since CMM/CMMI is known widely and applied in defense sector, the research subject will find a base in the sector and help them to integrate technology foresight into their internal processes.

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APPENDIX A

INTERVIEW QUESTIONS

Table A Interview questions

	Interview Questions
1	Why V2023 DAS TF was conducted? What are the specific needs to cunduct the TF? Was it a cop yor repeat of other nations TF activities?
2	Were the vision, goals, objectives, priority criteria of Vision 2023 DAS TF clear? Were definitions detailed to define follow up actions and responsbile agents?
3	What is the direct impact of Vision 2023 DAS TF? (genuine policies, awareness in public and sector, increase in Government-University-Industry Cooperation, starting new programs, impact on innovation infrustructure,…)
4	Were there good communication amang Vision 2023 DAS TF panel and other sectoral and tematic panels?
5	What and how should be the institution which will renew the TF (TÜBİTAK, SSM, etc)?
6	Would it be useful to employ Vision 2023 TF Project team in renewal of the foresight?
7	Was Vision 2023 DAS TF undertaken ownership and supported by politicians, government agencies? What is the case today?
8	Was Vision 2023 DAS TF was undertaken ownership and supported by industry and waht should be done for active involvement?
9	What are the Critical Success Factors of Vision 2023 DAS TF?
10	What are the sponsor / requestor, client and responsible for the success of V2023 DAS TF? Were they identifed?
11	Was Vision 2023 DAS TF implemented in national Science Technology and Innovation policies?
12	How was the communication of Project organisation of Vision 2023 DAS TF with senior authorities responsible for policy making?
13	Is it necessary to set a structure to provide sustainability in knowledge creation related with problems, trends, policy ideas, and to provide training?
14	Was Vision 2023 DAS TF outputs implemented in your institution? Did you implement Vision 2023 DAS TF outputs? What were the impact (awareness, foresight culture, policy informing, change in decision making, etc.,)
15	What should be done to increase the impact of Vision 2023 DAS TF?
16	Did TF renewed or is there a need for the renewal of TF?
17	What are your additional expectations from TF in case of renewal?

TF: Technology Foresight

APPENDIX B

EFA STRUCTURE OF TECHNOLOGY FORESIGHT IMPACT ASSESSMENT SCALE

Table B Technology foresight impact assessment scale factor structure

SCALE ITEMS	INFLUENCING	AWARENESS & INFORMING	INFLUENCING & ENABLING	GUIC	CULTURE
TSM3	,819				
TLB5	,800				
KUSI3	,777				
KUSI1	,777				
TLB7	,774				
PER6	,754				
KUSI5	,737				
TLB6	,720				
TSM2	,719				
PER7	,716				
KUSI4	,696				
TLB4	,694				
TSM4	,687				
TLB3	,682				
TLB2	,673				
KUSI2	,664				
TLB8	,625				
TLB1	,583				
BTY8	,542				
PER1	,522				
PER2	,501				
FRK7		,835			
FRK2		,778			
FRK3		,777			
FRK1		,775			
FRK6		,754			
FRK8		,750			
FRK5		,697			
FRK4		,665			

Table B (Continued)

SCALE ITEMS	INFLUENCING	AWARENESS & INFORMING	INFLUENCING & ENABLING	GUIC	CULTURE
ARC1		,637			
BK2		,600			
BK3		,523			
ARC5			,761		
ARC3			,712		
ARC4			,702		
ARC6			,672		
ARC8			,654		
ARC7			,624		
BTY3			,582		
BTY1			,566		
BTY2			,557		
BTY4			,557		
KUSI8				,788	
KUSI9				,755	
KUSI7				,749	
TSM1				,676	
KUSI10				,657	
KLT3					,693
KLT2					,669
KLT4					,655
KLT5					,615
KLT1					,611
KLT8					,529
EIGENVALUES	30,50	4,80	1,69	1,63	1,25
EXPLAINED VARIANCE	57,55 %	9,06 %	3,96 %	3,07 %	2,36 %
TOTAL EXPLAINED VARIANCE	76,00 %				

APPENDIX C

SCALE FACTORS RELIABILITY TESTS

TABLE C1 INFLUENCING

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,975	,976	21

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TSM3	61,7876	212,776	,828	.	,973
TLB5	62,0000	214,571	,859	.	,973
KUSI3	62,0619	213,237	,822	.	,973
KUSI1	61,9027	212,017	,847	.	,973
TLB7	61,9292	212,870	,842	.	,973
PER6	62,0708	209,959	,827	.	,973
KUSI5	61,9735	213,740	,823	.	,973
TLB6	61,8319	213,570	,847	.	,973
TSM2	62,0265	212,544	,805	.	,974
PER7	62,0354	211,231	,833	.	,973
KUSI4	62,0619	213,576	,829	.	,973
TLB4	61,9823	216,268	,752	.	,974
TSM4	61,9469	215,569	,801	.	,974
TLB3	61,9823	214,946	,787	.	,974
TLB2	61,9912	213,955	,833	.	,973
KUSI2	62,1327	213,455	,765	.	,974
TLB8	62,0885	213,385	,756	.	,974
TLB1	62,0088	215,562	,784	.	,974
PER1	62,3363	212,672	,699	.	,975
PER2	62,3982	214,170	,701	.	,975
BTY8	61,9292	214,156	,744	.	,974

TABLE C2 AWARENESS RAISING &INFORMING

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,960	,960	10

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ARC3	25,8992	43,871	,788	,690	,957
ARC4	25,8403	43,440	,875	,825	,954
ARC5	26,2941	44,531	,752	,642	,959
ARC6	25,8992	43,956	,822	,757	,956
ARC7	26,0924	44,508	,786	,691	,957
ARC8	26,0588	43,937	,820	,716	,956
BTY1	25,7563	43,271	,837	,763	,955
BTY2	25,8319	43,938	,831	,812	,956
BTY3	25,7983	43,196	,859	,830	,954
BTY4	25,8655	43,168	,852	,774	,955

TABLE C3 INFLUENCING&ENABLING

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,960	,960	10

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ARC3	25,8992	43,871	,788	,690	,957
ARC4	25,8403	43,440	,875	,825	,954
ARC5	26,2941	44,531	,752	,642	,959
ARC6	25,8992	43,956	,822	,757	,956
ARC7	26,0924	44,508	,786	,691	,957
ARC8	26,0588	43,937	,820	,716	,956
BTY1	25,7563	43,271	,837	,763	,955
BTY2	25,8319	43,938	,831	,812	,956
BTY3	25,7983	43,196	,859	,830	,954
BTY4	25,8655	43,168	,852	,774	,955

TABLE C4 GUIC

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,948	,948	5

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
KUSI7	11,6018	10,045	,857	,768	,936
KUSI8	11,6283	9,771	,886	,806	,930
KUSI9	11,6372	9,501	,862	,762	,935
KUSI10	11,6814	9,737	,859	,749	,935
TSM1	11,7522	10,081	,823	,680	,941

TABLE C5 CULTURE

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0,963	0,963	6

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
KUSI7	11,6018	10,045	,857	,768	,936
KUSI8	11,6283	9,771	,886	,806	,930
KUSI9	11,6372	9,501	,862	,762	,935
KUSI10	11,6814	9,737	,859	,749	,935
TSM1	11,7522	10,081	,823	,680	,941

TABLE C6 TOTAL_IMPACT

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
,985	,986	53

Item-Total Statistics					
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TSM3	157,1770	1234,736	,724	.	,985
TLB5	157,3894	1237,043	,776	.	,985
KUSI3	157,4513	1235,143	,728	.	,985
KUSI1	157,2920	1230,834	,777	.	,985
TLB7	157,3186	1233,630	,757	.	,985
PER6	157,4602	1226,161	,762	.	,985
KUSI5	157,3628	1234,823	,752	.	,985
TLB6	157,2212	1232,013	,816	.	,985
TSM2	157,4159	1233,049	,724	.	,985
PER7	157,4248	1226,461	,805	.	,985
KUSI4	157,4513	1233,250	,778	.	,985
TLB4	157,3717	1240,361	,689	.	,985
TSM4	157,3363	1237,868	,749	.	,985
TLB3	157,3717	1235,111	,761	.	,985
TLB2	157,3805	1231,774	,822	.	,985
KUSI2	157,5221	1233,680	,710	.	,985
TLB8	157,4779	1231,948	,726	.	,985
TLB1	157,3982	1233,938	,803	.	,985
PER1	157,7257	1225,504	,741	.	,985
PER2	157,7876	1228,794	,749	.	,985
BTY8	157,3186	1231,648	,746	.	,985
FRK1	157,2920	1232,155	,774	.	,985
FRK2	157,3451	1231,496	,740	.	,985
FRK3	157,3540	1233,141	,768	.	,985
FRK4	157,3363	1229,082	,752	.	,985
FRK5	157,4867	1235,931	,714	.	,985
FRK6	157,5752	1232,497	,693	.	,985
FRK7	157,3363	1241,118	,609	.	,985
FRK8	157,5221	1235,198	,679	.	,985
BK2	157,3009	1231,819	,747	.	,985
BK3	157,3717	1239,253	,595	.	,985
ARC1	157,4779	1233,002	,749	.	,985
ARC3	157,6195	1238,434	,674	.	,985
ARC4	157,5575	1234,874	,760	.	,985
ARC5	158,0088	1244,223	,595	.	,985
ARC6	157,6018	1235,510	,747	.	,985
ARC7	157,8142	1235,778	,769	.	,985
ARC8	157,7611	1234,505	,764	.	,985
BTY1	157,4602	1228,572	,813	.	,985
BTY2	157,5487	1231,303	,825	.	,985
BTY3	157,5133	1229,377	,817	.	,985
BTY4	157,5752	1227,175	,850	.	,985
KUSI7	157,5398	1240,143	,696	.	,985
KUSI8	157,5664	1241,659	,649	.	,985
KUSI9	157,5752	1239,014	,642	.	,985
KUSI10	157,6195	1236,934	,707	.	,985
TSM1	157,6903	1242,037	,647	.	,985
KLT1	157,4867	1226,466	,814	.	,985
KLT2	157,6195	1226,952	,816	.	,985
KLT3	157,6549	1231,032	,782	.	,985
KLT4	157,4690	1228,608	,807	.	,985
KLT5	157,4956	1228,681	,819	.	,985
KLT8	157,4602	1226,143	,799	.	,985

APPENDIX D

TECHNOLOGY FORESIGHT IMPACT ASSESSMENT SCALE

Table D VISION 2023 DAS impact assessment scale questionnaire

No	CODE	Scale Questionnaire Items	Negative Contribution	No Contribution	Little Contribution	Some Contribution	Significant Contribution	Major Contribution
1	**TSM3**	Vision 2023 DAS TF contributed to increase of grants and incentive programs for Government-University-Industry cooperation.						
2	**TLB5**	Vision 2023 DAS TF contributed to enhancement of defense industry R&D and innovation capacity..						
3	**KUSI3**	In defense sector, Vision 2023 DAS TF contributed to increase of R&D budget transferred from industry to universities.						
4	**KUSI1**	Vision 2023 DAS TF contributed to increase of academic studies done by Government-University-Industry cooperation.						
5	**TLB7**	In defense sector, Vision 2023 DAS TF influenced increase of R&D funds						
6	**PER6**	In defense sector, Vision 2023 DAS TF contributed to increase of number of researchers working in prioritized technology fields.						
7	**KUSI5**	In defense sector, Vision 2023 DAS TF contributed to development of projects by Government-University-Industry cooperation.						
8	**TLB6**	Vision 2023 DAS TF contributed to meeting the defense industry needs in-country.						
9	**TSM2**	Vision 2023 DAS TF contributed to development of new technology transfer mechanisms between defense and other sectors.						

Table D (Continued)

No	CODE	Scale Questionnaire Items	Negative Contribution	No Contribution	Little Contribution	Some Contribution	Significant Contribution	Major Contribution
10	PER7	In defense sector, Vision 2023 DAS TF contributed to continuation of personnel working in basic science to post graduate programs (Ms, PhD)						
11	KUSI4	In defense sector, Vision 2023 DAS TF contributed to increase of knowledge transfer from universities to industry.						
12	TLB4	Vision 2023 DAS TF contributed to increase of funds allocated from government institutions annual budgets for guidance projects.						
13	TSM4	Vision 2023 DAS TF contributed to development of policies to support the demand in defense sector.						
14	TLB3	In defense sector, Vision 2023 DAS TF contributed to increase of R&D needs of government intitutions.						
15	TLB2	In defense sector, Vision 2023 DAS TF contributed to increase of R&D projects in prioritised technology fields.						
16	KUSI2	In defense sector, Vision 2023 DAS TF contributed to cooperation of companies in R&D projects						
17	TLB8	Vision 2023 DAS TF contributed to increase of defense companies to join international defense R&D projects						
18	TLB1	Vision 2023 DAS TF contributed to be taken into consideration of stragic technology prioritisations during acquisition planning of national defense needs.						
19	BTY8	In your institution, Vision 2023 DAS TF contributed to increase in harmony among public polices.						
20	PER1	In your institution, Vision 2023 DAS TF contributed to increase of R&D personnel number (researcher, technician, assistant personnel)						
21	PER2	In your institution, Vision 2023 DAS TF contributed to increase of trainings provided to R&D personnel.						
22	FRK7	In your institution, Vision 2023 DAS TF contributed to increase of awareness of technology maturity levels.						
23	FRK2	In your institution, Vision 2023 DAS TF contributed to increase of awareness about importance of technology management.						
24	FRK3	In your institution, Vision 2023 DAS TF contributed to increase of awareness about R&D and Innovation management.						

Table D (Continued)

No	CODE	Scale Questionnaire Items	Negative Contribution	No Contribution	Little Contribution	Some Contribution	Significant Contribution	Major Contribution
25	FRK1	In your institution, Vision 2023 DAS TF contributed to increase of awareness about importance of S&T.						
26	FRK6	In your institution, Vision 2023 DAS TF contributed to increase of awareness about development of technology management modelling and simulations.						
27	FRK8	In your institution, Vision 2023 DAS TF contributed to use of technology maturity level evaluation tools.						
28	FRK5	In your institution, Vision 2023 DAS TF contributed to increase of awareness about development of competent personnel						
29	FRK4	In your institution, Vision 2023 DAS TF contributed to increase of awareness about importance of competency in technology.						
30	ARC1	In your institution, Vision 2023 DAS TF contributed to constitude of technology management process.						
31	BK2	In your institution, Vision 2023 DAS TF contributed to new issues (cybersecurity, dual use,..) taken into the agenda.						
32	BK3	In your institution, Vision 2023 DAS TF was cited as reference in plans.						
33	ARC5	In your institution, Vision 2023 DAS TF contributed to detection of early warning signals (weak signals, black swan).						
34	ARC3	In your institution, Vision 2023 DAS TF contributed to long term (>10 years) planning.						
35	ARC4	In your institution, Vision 2023 DAS TF contributed to conduction of foresight exercises						
36	ARC6	In your institution, Vision 2023 DAS TF contributed to constitution of technology foresight process.						
37	ARC8	In your institution, Vision 2023 DAS TF contributed to use of foresight techniques.						
38	ARC7	In your institution, Vision 2023 DAS TF contributed to increase of resources allocated for foresight exercises.						
39	BTY3	In your institution, V2023 SHU TF contributed to design of evidence based STI policies.						
40	BTY1	In your institution, Vision 2023 DAS TF contributed to design of science technology and innovation policies or strategies.						

Table D (Continued)

No	CODE	Scale Questionnaire Items	Negative Contribution	No Contribution	Little Contribution	Some Contribution	Significant Contribution	Major Contribution
41	**BTY2**	In your institution, Vision 2023 DAS TF contributed to making accured foresight regarding critical technologies.						
42	**BTY4**	Vision 2023 DAS TF contributed to the increase of allocations from annual budgets of public instutions (TAF, SSM, MoND) for guided R&D projects						
43	**KUSI8**	Vision 2023 DAS TF contributed to building cooperation platforms (defense-health, defense-informatics, defence-communication, defense-energy, etc.,) between defense and other sectors.						
44	**KUSI9**	Vision 2023 DAS TF contributed to the establishment of technology networks between defense and other sectors.						
45	**KUSI7**	Vision 2023 DAS TF contributed to increase of communication between defense and other sectors (ICT, electronics, health, energy, etc,).						
46	**TSM1**	Vision 2023 DAS TF contributed to coopearation of defense and other sectors in R&D projects.						
47	**KUSI10**	Vision 2023 DAS TF contributed to products and services developed for defense sector to be used in other sectors (dual use).						
48	**KLT3**	In your institution, Vision 2023 DAS TF contributed to development of systematic thinking culture.						
49	**KLT2**	In your institution, Vision 2023 DAS TF contributed to development of holistic thinking culture.						
50	**KLT4**	In your institution, Vision 2023 DAS TF contributed to development of the understanding that future can be shaped.						
51	**KLT5**	In your institution, Vision 2023 DAS TF contributed to development of long term thinking culture						
52	**KLT1**	In your institution, Vision 2023 DAS TF contributed to development of long term thinking culture.						
53	**KLT8**	In your institution, Vision 2023 DAS TF contributed to enhance of joint vision development capability.						

DAS: Defense AeroSpace
TF: Technology Foresight

APPENDIX E

NON-PARAMETRIC TESTS

Table E.1 Kruska-Wallis test outputs

TOTAL_IMPACT and INFORMATION LEVEL GROUPS						
INFORMATION_LEVEL		N	Mean Rank	Chi-Square	df	Asymp. Sig.
TOTAL_IMPACT	I Know Little	26	56,31	14,607	3	0,002
	I Know Some	64	76,60			
	I Know Well	50	82,34			
	I Know Very Well	16	110,16			
	Total	156				

TOTAL_IMPACT and INSTITUTION GROUPS						
INSTITUTION		N	Mean Rank	Chi-Square	df	Asymp. Sig.
TOTAL_IMPACT	PUBLIC INSTITUTIONS	32	77,73	4,044	3	0,257
	ARMY	16	95,88			
	UNIVERSITY	7	56,79			
	INDUSTRY	101	77,50			
	TOTAL	156				

TOTAL_IMPACT and AGE GROUPS						
AGE		N	Mean Rank	Chi-Square	df	Asymp. Sig.
TOTAL_IMPACT	Younger than 29	23	90,02	8,474	4	0,076
	30-39	46	87,04			
	40-49	50	69,04			
	50-59	31	78,85			
	Older than 60	6	45,83			
	Total	156				

TOTAL_IMPACT and COMPANY TYPE GROUPS							
CMPNYTYPE		N	Mean Rank	Mann-Whitney U	Willcoxon W	Z	Asymp. Sig. (2-tailed)
TOTAL_IMPACT	PUBLIC	46	56,63	1006,000	2546,000	-1,767	0,077
	PRIVATE	55	46,29				
	TOTAL	101					

Table E.2 Mann-Whitney U test outputs

TOTAL_IMPACT & INFORMATION LEVEL GROUPS							
LEVEL	N	Median	Mean Rank	Mann-Whitney U	Willcoxon W	Z	Asymp. Sig. (2-tailed)
I Know Little	26	2,7924	36,54	599,000	950,000	-2,075	,038
I Know Some	64	2,9600	49,14				
Total	90						
LEVEL	N	Median	Mean Rank	Mann-Whitney U	Willcoxon W	Z	Asymp. Sig. (2-tailed)
I Know Little	26	2,7924	30,88	452,000	803,000	-2,169	0,030
I Know Well	50	3,0000	42,46				
Total	76						
LEVEL	N	Median	Mean Rank	Mann-Whitney U	Willcoxon W	Z	Asymp. Sig. (2-tailed)
I Know Little	26	2,7924	15,88	62,000	413,000	-3,783	0,000
I Know Very Well	16	3,3195	30,63				
Total	42						
LEVEL	N	Median	Mean Rank	Mann-Whitney U	Willcoxon W	Z	Asymp. Sig. (2-tailed)
I Know Some	64	2,9600	55,52	1473,500	3553,500	-0,722	0,47
I Know Well	50	3,0000	60,03				
Total	114						
LEVEL	N	Median	Mean Rank	Mann-Whitney U	Willcoxon W	Z	Asymp. Sig. (2-tailed)
I Know Some	64	2,9600	36,94	284,000	2364,000	-2,743	0,06
I Know Very Well	16	3,3195	54,75				
Total	80						
LEVEL	N	Median	Mean Rank	Mann-Whitney U	Willcoxon W	Z	Asymp. Sig. (2-tailed)
I Know Well	50	3,0000	30,85	267,500	1542,500	-1,983	0,047
I Know Very Well	16	3,3195	41,78				
Total	66						

CURRICULUM VITAE

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EDUCATION

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BS	Hacettepe University Electric and Electronic Engineering	1986

WORK EXPERIENCE

Year	Place	Post
2004- 2014	HAVELSAN	Director, Strategy & Business Development
1999-2004	HAVELSAN	Manager, Business Development & Marketing
1996-1999	HAVELSAN	Manager, Simulation & Modelling Projects
1993-1994	MIKES / LORAL, USA	System Engineer
1990-1993	AYESAS / AYDIN Corp., USA	Design Engineer
1988-1990	TAI	System Engineer
1986-1988	ASELSAN	Test Engineer

FOREIGN LANGUAGES

English

PUBLICATIONS

1. Burhan M., and Özkil A.”Disruptive Technology Innovation Effect of Game Technologies into Military Simulation Technology and Industry”. 6th National Defense Applications Modelling and Simulation Conference (USMOS 2015), METU, 2015.

2. Burhan M. And Erkuş A. “Reporting of Intellectual Capital”, SAVTEK-2006, METU, 2006.

3. Burhan M. And Erkuş A. “Analysis, Measurement and Assesment of Intellectual Capital in High Tech Companies”, XIII Management and Organization Congress, 2005, Marmara University,

ADDITIONAL INFORMATION

Presentations and Articles:

1. ‘Towards 100th Year of Republic of Turkey, S&T and Technology Foresight in Defense Sector’, 3rd Land Systems Seminar, 2016,

2. ‘Integration of Systems Engineering Discipline Approach to Technology Management: Boeing Company Case Study’, 09 April 2015, Atılım University

3. ‘Technology and Innovation Management for Sustainable Competition’, TBD 31.National Informatics Congress, Informatics Magazine, December 2014, page 52-60

4. ‘Data Visulization and Defense Systems’, Informatics Association of Turkey, Informatics Magazine, Jan 2010, Issue:117

Lecturer Experience:

1. 'Strategic Management of Technology and Innovation', Army Academy, 2013, 2014, 2015, 2016

2. ‘Strategic Management, Performance Management and Risk Management’, HAVELSAN, 2009-2013

3. ‘Performance Management’, Turkish Armed Forces Foundation, 2010

4. ‘Business Practice’ course, Bilkent University, eMBA, 2010-2013.

Memberships:

1. The Chamber of Electrical Engineers (EMO)
2. Informatics Association of Turkey (TBD), Founder Member of Ankara Office
5. Committee member of Defense and Aerospace Industry Manufacturers Association (SASAD), TOBB Defense, TOBB Software, and TOBB Telecommunication Sectors.

INDEX

TURKISH SUMMARY/TÜRKÇE ÖZET

Bu araştırmada, Vizyon 2023 Teknoloji Öngörüsünün, savunma sektöründe etkisinin analizi, etki değerlendirme için model geliştirilmesi ve yeni öngörü çalışmaları için öneriler geliştirilmiştir. Türkiye'de Bilim, Teknoloji ve Yenilik politikaları incelenmiş, Vizyon 2023 Teknoloji Öngörüsünün Kritik Başarı Faktörleri araştırılmış ve teknoloji öngörü müdahale programlarının etki değerlendirmesinde kullanılmak üzere ölçek geliştirilmiştir.

Araştırma kapsamında literatür taraması yapılmış teknoloji öngörüsü, değerlendirme (evaluation), etki değerlendirme (impact assessment) ve Türkiye'de bilim ve teknoloji politikalarının tarihsel gelişimi incelenmiştir. Teknoloji öngörüsü tanımları, nesilleri, amaçları, süreçleri, teorisi, araçları ve uygulama örnekleri araştırılmıştır. Değerlendirme disiplini tanımları, amaçları, teorisi, süreci, çeşitleri hakkında yazın taraması yapılmıştır. Bir müdahale proje, program veya politikasının değerlendirilmesine yönelik örnekler araştırılmıştır. Türkiye'de bilim ve teknoloji politikalarının tarihi, politikaların ulusal, sektörel, kurumsal politika ve uygulamalara yansıması, başarı ve başarısızlık nedenleri araştırılmıştır. Bu kapsamda Vizyon 2023 Teknoloji Öngörüsü, Vizyon 2023 Savunma Havacılık Uzay (SHU) Teknoloji Öngörüsü incelenmiştir.

Teknoloji Öngörüsü

Öngörü teknolojik, ekonomik ve sosyal gelişmeler için orta ve uzun vadeli vizyonun oluşturulmasında bilinen ve yaygın olarak kullanılan bir metodolojidir. Öngörü ilk olarak 1930'larda kullanılmaya başlanmıştır. 1990 yılından sonra Avrupa'da ulusal teknoloji öngörü projelerinin sayısı artmıştır. ABD, Japonya, Almanya, Güney Kore, Kolombiya, Çin dahil 40'dan fazla ülkede ulusal öngörü çalışması yapılmıştır.

2000’li yıllarla birlikte teknoloji öngörüsü etki değerlendirme çalışmaları da artmıştır.

Değerlendirme

Belirli amaçları olan ve planlı yapılan her programın bütün fazlarında ve sonunda, değerlendirme yapılması yönetim sisteminin bir parçası olmakla birlikte değerlendirmenin kapsamı, yöntemleri konusunda farklı görüşler, uygulamalar vardır. Özellikle amaçların uzun vadede tanımlandığı, önemli kaynakların aktarıldığı, büyük kitleleri etkileyen proje, program veya politikaların değerlendirmesi konusunda metotlarda farklılıklar gözlenmektedir. Uluslararası yardım veya büyük yatırım projelerinin değerlendirilmesi, etki değerlendirmesi ile ilgili esasları tanımlayan çalışmalar yapılmaktadır. Dünya Bankası, Asya Yatırım Bankası, International Initiative on Impact Evaluation (3ie), OECD tarafından hazırlanan kılavuz ve raporlar bu alanda referans olarak kullanılmaktadır.

Değerlendirme alanında özellikle uzun vadeyi tanımlayan sonuç, netice, etki gibi terimler arasındaki mesafe belirsizleşmekte ve bazı terim ve kavramlar birbirinin yerine kullanılmaktadır. Araştırma kapsamında öncelikle değerlendirme disiplini içinde tanımlanan etki ve değerlendirme kavramları ve çeşitleri araştırılmıştır.

Etki değerlendirme çalışmalarında eğilim, seçilen sonuçlardaki değişimin spesifik bir müdahaleye dayandırılmasıdır. Nicel etki değerlendirme, müdahale projesi ve sonuçları arasında bağlantı kurmak için daha uygundur. Müdahale projesi ile ilgilenilen sonuç ve etki değişkenleri arasında nedensellik bağlantısı araştırılır. Ancak etki göstergeleri, müdahale projesi dışındaki olaylardan da etkilenebilir. Etki göstergelerinin soyut olması, nedenselliği bir çıktıya dayandırmayı (attribute) zorlaştırmaktadır. Nicel değerlendirmenin yapılamadığı vakalarda, nitel değerlendirme yöntemi uygulanmakta ve müdahale projesinin katkısı ölçülmektedir. Ayrıca nitel değerlendirme yönteminin proje hakkında daha fazla bilgi sağlaması ve gözlenen nicel analiz sonuçlarına ilişkin derinlemesine bilgi vermesi nedeniyle kabul görmeye başlamıştır. İyi bir etki değerlendirme çalışmasında nitel ve nicel metotlar birlikte kullanılmaktadır.

Etki değerlendirme için Program Teori-Bazlı değerlendirme yaklaşımı uygulanmıştır. Program Mantıksal Modeli olarak Vizyon 2023 Savunma Havacılık ve Uzay teknoloji öngörüsünde yer alan model kullanılmıştır. Modelde teknoloji öngörüsü, girdileri (kaynaklar), süreç, çıktıları ve uzun vade etkileri sistem kavramı çerçevesinde tanımlanmıştır. Değerlendirmenin bir öğrenme aracı olması ve paydaşların dahil edilmesi bu amacın gerçekleşmesi için bir gereklilik olarak görülmektedir.

Derin görüşme ve anket uygulamalarında görüşme yapılan kişilere ve katılımcılara görüşleri ve teknoloji öngörüsünün etkilerine dair çeşitli sorular yöneltilmiştir. Bu süreçte amaç katılımcıların etki algıları hakkında bilgi toplamaktır. Ancak katılımcıların etki algıları dolayısı ile etki değerlendirmeleri ön yargılı veya gerçeklerden farklı olabileceği dikkate alınmıştır. Literatürde algı insanların onları çevreleyen dünyadaki bilgiye dikkat etme ve seçme, düzenleme, anlamlandırma ve cevap verme süreci olarak tanımlanmıştır (Schermerhorn et al., 2011). Bununla birlikte araştırma evreninde bulunan kişiler savunma sektörü veya savunma sektörü ile etkileşimi olan diğer sektörlerden olup politika ve kararlardan doğrudan veya dolaylı olarak etkilenmektedir. Dolayısı ile etki değerlendirmesinde onların algıları esastır. Bununla birlikte güvenirliği artırmak için veri ve metod çeşitlendirmesi metodları uygulanmıştır.

Türkiye'de Bilim ve Teknoloji Politikaları ve BTY Sistemi:

Türkiye'nin B-T politikalarını şekillendirme yönünde geçirdiği aşamaları araştırmak için 5 yıllık kalkınma planları, orta vadeli planlar, B-T dokümanları incelenmiştir. Özellikle bu dokümanlarda yer alan B-T ile ilgili planlar, stratejiler incelenmiş, karşılaştırılmış, her plan döneminde nasıl değiştiği veya değişmediğine bakılmıştır. Uzun vadeli planlardan orta vadeli planlara nasıl aktarıldığı, B-T politikalarının bu planlara ne derece girdi sağladığı araştırılmıştır.

Türkiye'de bilim ve teknolojinin önemi, sosyo-ekonomik hedeflerin gerçekleşmesindeki rolü ve dolayısıyla ulusal bir bilim ve teknoloji politikası oluşturulması ve uygulanmasına yönelik çabalar 1960'lı yılların başında başlamıştır. Birinci 5 yıllık kalkınma planı bu yönde hazırlanan ilk dokümandır. Bilim ve teknoloji politikaları önceleri 5 yıllık kalkınma planları içinde yer alırken, 1983 yılında hazırlanan ilk bilim politikası ile birlikte ulusal boyutta ve bütünsel bir yaklaşımla ele alınmış ve uzun ve orta vadeli planlarda ve politikalarda uygulamaya geçmesi hedeflenmiştir.

Temel araştırma ve uygulamalı araştırmaların belirlenmesinde, ülkenin kalkınma hedefleri yanında sanayi ihtiyaçları ilk defa Üçüncü 5 Yıllık Kalkınma Planı'nda (1973-1977) dikkate alınmıştır. Teknoloji politikası terimi ilk defa Dördüncü 5 Yıllık Kalkınma Planında (1979-1983) kullanılmıştır. Yenilikçilik terimi ilk defa Dokuzuncu kalkınma Planı (2009-2013) geçmiştir. Birinci plandan Onuncu plana kadar bakıldığında genel olarak B-T politikalarının tekrar ettiği görülmektedir. Bazı plan dönemlerinde B-T hedefleri önceki dönem hedeflerinin gerisine çekilmiştir. Ulusal kalkınma planları, bilim ve teknoloji politika dokümanlarında tanımlanan B-T hedefleri karşılaştırıldığında planlar arasında ve dönemsel hedefler arasında koordinasyonun eksik olduğu görülmektedir.

B-T Orta Vadeli Planlarda (OVP) bilim ve teknolojinin temel amacı bilim, teknoloji ve yenilikte yetkinleşmek ve bu yetkinliği ekonomik ve sosyal faydaya dönüştürmek olarak tanımlanmıştır. Özel sektörün yenilik yeteneğini arttırma amacı ise 2007-2009 ve sonraki OVP'lerde yer almıştır.

BTY sisteminin stratejik çerçevesi hedef odaklı yaklaşım (AR-GE ve yeniliğin güçlü olduğu alanlar), ihtiyaç odaklı yaklaşım (ivme kazanmamız gereken alanlar: savunma, uzay, sağlık, su, enerji ve gıda) ve temel araştırma alanlarında aşağıdan yukarı yaklaşım olarak belirlenmiştir. BTY ihtiyaç duyacağı insan kaynağının gelitirilmesi, araştırma sonuçlarının ürün ve hizmetlere dönüştürülmesi, disiplinlerarası AR-GE kültürünün geliştirilmesi, KOBİlerin BTY systeminde rolünün güçlendirilmesi, AR-GE altyapısının TARAL bilgi üretmesine katkısı, uluslararası BTY işbirlikleri stratejik çerçevenin yatay katmanlarını oluşturmaktadır. Kalkınma planları, OVP ve B-T politikalarında sanayi ihtiyaçlarının dikkate alınması, teknoloji ve yenilik kavramlarının gündeme girmesiyle planların odağı araştırmadan yeniliğe, araştırma sonuçlarının ürün ve hizmetlere dönüştürülmesine kaymıştır. Savunma ivme kazanılması gereken alan olarak belirlenmiştir.

AR-GE ve yenilik programlarına büyük bütçeler ayrılmasına rağmen henüz AR-GE politikaları veya öngörü çalışmalarının sistematik değerlendirilmesi için mekanizmalar geliştirilmemiştir.

Vizyon 2023 SHU Teknoloji Öngörüsü Etki Değerlendirmesi

Bu araştırmada nitel ve nicel etki değerlendirme yöntemleri birlikte uygulanmıştır. Nitel yöntem kapsamında derin görüşme analizi, odak grup çalışması, doküman, belge analizi teknikleri ve araçları kullanılmıştır. Nicel analiz yöntemi kapsamında, etki değerlendirmesi için ölçek geliştirme ve anket çalışması yapılmıştır. Nicel analiz metodu doküman analizinde de uygulanmıştır. Veri kaynakları, uzman görüşleri, TÜBİTAK, MSB/SSM, TÜBİTAK, TÜİK, YÖK, reel sektör ve üniversitelerin planları raporları ve veritabanlarından oluşturulmuştur.

Tez çalışmasının başında 14 uzman, bilim insanı, iş insanı ile görüşülmüş ve tez konusuna ilgi olup olmadığı, teknoloji öngörüsü etki tipleri, Vizyon 2023 teknoloji öngörüsünün etkileri hakkında genel görüşler derlenmiştir. Bu görüşmelerden elde edilen bilgiye dayanarak tez araştırma soruları ve hipotezleri, araştırma değişkenleri tanımlanmıştır. 14 kişiden 7’si ile çekirdek danışma grubu oluşturulmuştur. Grup araştırma süresince gönüllü olarak destek vermiştir. Grupta yer alan 5 kişi teknoloji öngörü çalışmaslarına katılmış, 2 kişi katılmamıştır. Derin görüşme yapılacak kişiler ve odak grup çalışmasına davet edilecek olanlar bu çekirdek gruba danışılarak belirlenmiştir. Bu kişilere ve anketin uygulanacağı örnekleme ulaşmak için çekirdek danışma grubunun iletişim ağından dolayısı ile kartopu etkisinden yararlanılmıştır.

Doküman, Belge Analizi

Belge analizinde nitel ve nicel yöntemlerin her ikisi de kullanılmıştır. Sektörde kamu kurumları, şirketler, üniversiteler tarafından üretilen belge, doküman, süreli yayınlar üzerinde “Vizyon 2023” ve “Teknoloji Öngörüsü” kelime gruplarını içeren kodlarla nicel analiz yapılmıştır. Bu çerçevede, MSB, SSM, reel sektör, üniversiteler, SaSaD, TOBB Savunma Meclisi planları, raporları, sunumları, yayınladıkları dergi ve bültenler, sektör dergileri incelenmiştir. TSK planları, raporları erişime açık olmadığı için inceleme dışında kalmıştır. Araştırma “Vizyon 2023” ve “Teknoloji Öngörü” kodları (kelime veya kelime grupları) ile yapılmıştır. SSM’nin erişime açık dokümanları üzerinde yapılan analiz sonucunda, Vizyon 2023 Teknoloji Öngörüsünün SSM Stratejik Planı (2007-2011), Teknoloji Yönetimi planında bilgi kaynağı, referans olarak yararlanıldığı görülmüştür.

SSM’nin odaklanılacak stratejik teknoloji alanlarının belirlendiği ve bu alanlarda sanayi-üniversite işbirliğinin teşvik edildiği Teknoloji Mükemmeliyet Ağları (MÜKNET) ile teknoloji öngörüsünün öncelikli Teknoloji Alanlarının karşılaştırması yapılmıştır. SSM’nin TÜBİTAK kaynaklı AR-GE projeleri araştırılmıştır. Bu araştırmada nitel analiz yöntemi uygulanmıştır. Analiz sonucunda, SSM ve teknoloji öngörüsünün öncelikli teknoloji alanları arasında sağlık teknolojileri alanı hariç benzer oldukları tespit edilmiştir. Sağlık teknolojileri teknoloji öngörüsünün stratejik teknoloji alanında yer almıştır. SSM MÜKNET’leri arasında yer almamıştır.

Savunma AR-GE projelerinin desteklenmesi için Savunma Araştırma Grubu (SAVTAG) 2005 yılında BTYK kararı (2005/8) ile kurulmuştur. SSM faaliyet raporları ve sunumları, TÜBİTAK SAVTAG AR-GE proje duyuruları incelenerek, SSM’nin TÜBİTAK destekli AR-GE projeleri listesi çıkarılmıştır. 2005 yılından itibaren TSK/SSM TÜBİTAK destekli Ar-Ge projelerinde artış gerçekleşmiştir. Teknoloji öngörüsü özellikle TÜBİTAK kaynaklı SSM AR-GE projelerinin seçilmesinde ve onaylanmasında etkili olmuştur.

Savunma sektörünün AR-GE harcamaları, SSM, SaSaD, TÜİK verilerine dayalı olarak 2003-2015 yılları arasında incelenmiştir. 2007 yılı ve sonrasında sanayi şirketlerinin toplam AR-GE harcamaları ve kendi özkaynaklarından yaptıkları AR-GE harcamalarında artış gerçekleşmiştir. Toplam AR-GE ile özkaynaklardan yapılan AR-GE harcamaları arasındaki büyük fark müşteri kaynaklı AR-GE harcamaları ve teşviklerden kaynaklanmaktadır. Elde edilen bu veri, Vizyon 2023 teknoloji öngörüsünün savunma sektörü reel sanayisine bir etkisinin olup olmadığını analiz etmek, örneğin Girdi Artımsallığı, Çıktı Artımsallığına yönelik ekonometrik analiz yapmak için yeterli değildir. Ayrıca SaSaD verileri savunma şirketlerinin sivil havacılık ve uzay çalışmalarına ait AR-GE harcamalarını da kapsamaktadır. Ekonometrik analiz yapılmasını sağlayacak detayda veri olmamakla birlikte, reel sektörün 2007 yılından itibaren özkaynaklarla finanse edilen AR-GE harcamalarında artış olduğu gözlenmiştir.

Sektörde faaliyet gösteren yayın şirketlerinin (Savunma ve Havacılık, MSI Savunma Teknolojileri dergisi, Defense Turkey, vb. süreli yayınları (dergiler), şirketlerin süreli yayınları (dergi, bülten), SSM'nin süreli yayınları (GÜNDEM Dergisi) incelenmiştir. Internette erişime açık olmayan yayınlar ilgili kurumlardan istenmiştir. Sonuç olarak, Vizyon 2023 Teknoloji Öngörüsü, çalışmanın yapıldığı dönemin ardından birkaç yıl sektör ve SSM dergilerinde sınırlı sayıda yer almıştır. Vizyon 2023 Teknoloji öngörüsü, 2023 hedefleri hakkında bilgi paylaşılmıştır.

Vizyon 2023 Teknoloji Öngörüsünün akademik çalışmalarda ne kadar yer aldığı YÖK Tez Arşiv kayıtları yüksek lisans ve doktora tezlerinin özet bölümleri analiz edilmiştir. Analiz de "Vizyon 2023", "Teknoloji Öngörü" kodları yanında, "Teknoloji Yönetimi", "Ar-Ge Yönetimi" kelime grupları ile arama yapılmıştır. Teknoloji öngörü çalışmasının tamamlanması sonrasında kelime gruplarını içeren toplam tez sayısında (yüksek lisans ve doktora) artış gerçekleşmiştir. 2011 yılı itibariyle azalan eğilime geçse de, öncesine kıyasla daha fazla sayıda tezde yer almıştır.

Savunma Teknolojileri (SAVTEK) semineri ODTÜ-TSK işbirliği ile 2002 yılında. Modelleme ve Simülasyon (MODSİM) semineri 2003 yılında, Ulusal Modelleme ve Simülasyon (USMOS) semineri ODTÜ-TSK ve SSM, işbirliği ile 2005 yılında başlatılmıştır. Bu organizasyonlar ve Vizyon 2023 Savunma Havacılık ve Uzay Teknoloji Öngörüsü arasında nedensellik bağlantısını kuracak açık veriler olmamakla birlikte zamanlama ve teknoloji alanları açısından büyük benzerlik vardır. O dönemde bu organizasyonların kurulmasında ve teknoloji öngörüsünde aynı kişiler çalışmıştır. Dolayısı ile nedensellik açık olarak kurulamasa bile, bilgi "bilgi ajanları" tarafından taşınmış ve paylaşılmıştır.

Derin Görüşme Analizi

Araştırmada literatür taraması yapılmış ve öncelikle Vizyon 2023 Teknoloji Öngörüsü hakkında bütün boyutlarıyla kapsamlı bilgi edinilmeye çalışılmıştır. Bu çerçevede doküman incelemesi, doküman analizi yapılmış, projede görev almış uzmanlarla, iş insanları ve bilim insanları ile görüşmeler yapılmıştır. Görüşmelerde uzmanlara açık uçlu sorular yöneltilmiş, derin görüşme tekniği uygulanmıştır.
Uzmanların seçilmesinde, sektör hakkında bilgili, bu alanda çalışmış, uzun vadeli planlama ile ilgilenen kişilerin olmasına dikkat edilmiştir. Vizyon 2023 Teknoloji Öngörü projesine katılan ve katılmayan; askeri, kamu, sanayi, üniversite gibi farklı kurumsal kategorilerden kişiler olmasına dikkat edilmiştir. Savunma sektörü dışından olan kişilerle yapılan görüşmelerde sorular ve görüşler, savunma ve diğer sektör arasında etkileşim, işbirliği üzerinde yoğunlaşmıştır.

17 uzman ile görüşme yapılmıştır. Görüşmelerin mümkün olduğu yerlerde ses kaydı alınmıştır. Ses kayıtları çözülerek yazıya aktarılmış ve her bir görüşmenin sesli ve yazılı kayıtları (Microsoft Word dokümanı) oluşturulmuştur. Toplanan görüşler ile büyük bir veri havuzu oluşturmuştur. Bu veri havuzunun analizinde içerik analizi teknikleri uygulanmıştır. Metin kümesi içindeki belli temalar, kavramlar ve aralarındaki bağlantılar ortaya çıkarılmıştır. Metindeki mesajlara dair çıkarımlar yapılmıştır.

Analizi için yazında ve uygulamalarda çeşitli yazılımlar (NVIVO vb) kullanılmaktadır. Bununla birlikte, analiz için tanımlanan süreçler Ms Excel ofis programı ile yapılmıştır. Ms Excel Ofis programı veri tabanı gibi kullanılarak Wizard aracı ile dinamik raporlar (tablolar) oluşturulmuştur. Söylenenler ve söylenenlerin altındaki anlam ve ilişkiler ortaya çıkarılmaya çalışılmıştır.

Kodların geliştirilmesinde veri itmeli (data-driven) metod uygulanmıştır. İlk aşamada metinsel veri tekrar, tekrar incelenerek anlamlı bölümlere ayrılmış ve her bölümde ifade edilen kavramlar, kelime grupları, kavramsal kodlarla özetlenmeye çalışılmıştır. Yazılı metinler paragraf, paragraf Ms Excel tablosu hücrelerine taşınmıştır. Bu işlemde paragraflardaki anlam bütünlüğünün korunmasına dikkat edilmiştir. Her bir soruya verilen görüşler benzer şekilde 2 ve 3 ncü kez benzer filtrelerden geçirilerek, ifadeyi en doğru ve öz şekilde temsil eden kavramlara, kodlara (kelime veya kelime grupları) dönüştürülmüştür. Bu yöntemde metinler ve kodlamalar tekrar tekrar gözden geçirilmiştir. Bu süreç içinde ifadelerin doğru kodlar tarafından temsil edilmesini sağlamak için önce veri tablosu (data table) oluşturulmuştur. Veri tablosu sorgulama yapılmasını kolaylaştıracak ve veri kod özelliklerinin tanımlandığı bir tablodur. Ayrıca kod sözlüğü (code book) hazırlanmıştır. Kod ve temaların belirlenmesinde görüşme yapılan kişilerin kullandığı kodlardan ve frekans analizi tekniğinden de yararlanılmıştır. Görüşme yapılan kişilerin kullandıkları kelimelerin sıklık değerleri incelenmiştir. Sonuç olarak farklı kişilerden gelen benzer görüşler aynı kodlar altında sınıflandırılmıştır.

Derin görüşme analizi tekniğinin güvenirliği, geçerliliği uzman çeşitlemesi ve bazı görüşlerin (görüşme öncesi veya sonrası) yazılı olarak da bildirilmesi ile veri çeşitlemesi (expert triangualtion, data triangulation) ile sağlanmıştır. Farklı paydaş gruplarından kişilerle görüşülmüştür. Görüşmelerde teknoloji öngörüsünün amaçları, etkileri, Kritik Başarı Faktörleri (KBF), hükümet, siyaset ve sanayi tarafından ne kadar sahiplenildiği, sahiplenmenin sağlanması ve etkisinin artmasına yönelik önerileri, teknoloji öngörüsünün yeniden yapılması ihtiyacı ve yapılması halinde beklentileri sorulmuştur. B-T bilgisini, B-T politika fikirlerini üretecek yapı, teknoloji öngörüsünün başarısı için kurumsal yapı önerileri geliştirilmiştir. Derin görüşme analizi ile görüşme verisinden temalar, kavramsal kodlar ile tema ve kodlar arasında bağlantılar şeması ortaya çıkarılmıştır. Temalar ve kapsamındaki kavramsal kodlarda literatürde yer alan genel tanımlar yanında daha spesifik, uygulamaya özgü kavramlar, bulgular da elde edilmiştir. Vizyon 2023 Teknoloji öngörüsünün amaçları, çalışmanın tanımlı amaçları yanında, gömülü amaçları, nedenleri de ortaya çıkmıştır. Araştırmada bu bulgular genel ve spesifik olarak sınıflandırılmıştır. Genel olanlar literatürde tanımlı, kabul görmüş kavramları kapsamaktadır. Spesifik olanlar da Vizyon 2023 Teknoloji Öngörüsüne veya ulusal bağlama dayalı kavramları kapsamaktadır.

Genel KBF: Öngörünün müşterisinin belli olması ve müşteriye odaklanılması; Öngörü gündemi ve politika gündemi arasında bağlantı kurulması; Üst seviye politika yapıcılarla doğrudan bağlantı kurulması; Güçlü bir kamu-özel işbirliği oluşturulması; Yeni metodoloji ve yetkinlikler geliştirilmesi; Güçlü, açık iletişim stratejisi oluşturulması, Paydaşların öngörü programına entegre olması; Akademik bir öngörü kapasitesinin oluşturulması.

Spesifik KBF: Teknoloji öngörü döngüsünün sistematik olarak sürekliliği, sürdürülebilirliği, izleme ve değerlendirme, hedeflerin SMART olması, anahtar göstergelerle izlenmesi, bağımsız olması, bütünsel yaklaşım, hesap verebilirlik, güven, kanıta dayalı olması, kaynak tahsis edilmesi, B-T politikaları ve karaların sürekliliği, öngörü proje ekibinin devamlılığı spesifik KBF kodları olarak ortaya çıkmıştır. Bu araştırmadan elde edilen çarpıcı bir bulgu ise, sektörün teknoloji öngörüsünün tekrar yapılmasını ihtiyaç olarak görmesidir. 5 yılda bir yenilenmesi, 2-3 yılda bir güncellenmesi ihtiyaç olarak tanımlanmıştır. Teknoloji öngörü yaşam döngüsünün izleme ve değerlendirme sürecinin gerekliliği, ilave göstergeler önerilmiştir.

Bilim ve teknolojik gelişmelerin ve ihtiyaçların tartışılacağı, asker ve sivil, kullanıcı ve bilim insanlarının bir arada araştırma yapılacağı, araştırma projelerinin tetiklendiği, öngörü sürecini besleyecek, girdi oluşturacak bilginin üretildiği platformlar olarak NATO RTO benzeri teknoloji panelleri bir ihtiyaç ve çözüm olarak öne çıkmıştır.

Teknoloji öngörüsünün sektörde etkisine dair olumlu ve olumsuz tespitler ortaya çıkmıştır. Öngörü çalışmasının sektör paydaşları tarafından ne kadar sahiplenildiğine dair de olumlu ve olumsuz tespitler yapılmıştır. Beklenen veya gözlenen etki tipleri, etki göstergeleri, gerçekleşen etki, geliştirilecek etki değerlendirme ölçeğinde girdi olarak kullanılmıştır. Uzman görüşleri alınarak belirlenen etki tipleri ile birlikte etki değerlendirme ölçeğinin temelini oluşturmuştur.

Odak Grup

Odak grup çalışması yapmanın amacı, sağlıklı bir tartışma ortamında, farklı bakış açıları, fikirler, değerlendirmeler ve tecrübelerin sentezlenmesi ile; savunma sektörü için yeni bir B-T Vizyonu tanımlanması; Öngörü etki değerlendirme ölçeğinde yer alan faktörlerin (etki tiplerinin) ağırlıklarının belirlemesidir.
Odak grup çalışması, V2023 Teknoloji Öngörüsü ve savunma sektörü hakkında deneyim, bilgi ve görüş sahibi yetkin kişiler arasından seçilen temsili bir grupla yapılmıştır. Odak grup katılımcıları çekirdek grup görüşü alınarak belirlenmiştir. Seçilen kişilere çalışma öncesinde, amaç, kapsam ve program hakkında bilgi (e-postalar) gönderilmiştir. Yaklaşık yarım günlük bir çalışma yapılmıştır. Odak grup bir moderator ve bir asistan olmak üzere 2 kişi tarafından yönlendirilmiştir. Moderator hakem yönetici rolünü üstlenerek her görüşün dile getirilmesini sağlamıştır.
Katılımcılar tarafından üretilecek ve yeni B-T vizyonunu oluşturacak kavramsal kodlar, kodların sınıflandırılması ve puanlaması ile Ulusal Savunma Sektörü B-T Vizyonu tanımlanmıştır.

Odak Grup Çalışması sonucu ortaya çıkan Ulusal Savunma Sektörü Bilim ve Teknoloji Vizyonu:‘*Savunma alanında, kaynaklarını etkin ve etkili kullanarak, diğer sektörlerle yakın işbirliği içinde geliştireceği, ülke ihtiyaçlarına odaklanmış,* *çok amaçlı özgün teknolojiler ve yenilikçi ürünlerle, uluslararası rekabet gücüne sahip, nitelikli, çevik, kendine yeten bir bilim ve teknoloji üssü olmak*'

Yeni B-T vizyonu, Vizyon 2023 Teknoloji Öngörüsü savunma panelinde tanımlanan vizyon ile kıyaslanmış ve "çevik" kavramının yeni tanımda farklılık olarak yer aldığı tespit edilmiştir. "Çevik" kavramının sektörde kullanımı da göreceli olarak yenidir. Türkiye'de ulusal kalkınma planları veya ulusal B-T politikalarının gelişimi incelendiğinde, gerçekleşmelerin hedeflerin altında kalması nedeniyle hedef değerlerin düşürülmesiyle zaman ekseninde ötelendiği görülmektedir. BTI sisteminin performansını arttırmak, çeviklik kazandırmak için zamanında karar alınmasını sağlayacak politikalar geliştirilmesi gerekmektedir.

Teknoloji Öngörüsünün etkisini ölçmek geliştirilen ölçek maddelerinin altında toplandığı faktörlerin (etki tipleri) hepsini eşit ağırlıklı almak yerine, odak grup temsilcileri tarafından ağurlıklarının belirlenmesi istenmiştir. Katılımcıların verdiği puanların aritmetik ortalaması alınmış ve 100'e normalize edilmiştir. Odak grup çalışmasının son bölümünde etkinin arttırılması ile ilgili öneriler geliştirilmiştir. Teknoloji öngörüsü veri analizi, veri yönetiminde yeni bir kavram olan "Büyük Veri" yaklaşımı, veri kalitesinin sağlanması, teknoloji öngörüsünün 5 yılda bir tekrarlanması önerilmiştir.

Etki Değerlendirme Ölçeğinin Geliştirilmesi ve Etkinin Ölçülmesi

Bütün teknoloji öngörü çalışmalarına uygulanabilecek genel bir etki değerlendirme ölçeği uygulamada mevcut değildir. Her değerlendirme, değerlendirmesi yapılacak teknoloji öngörü çalışmasının amaçları, rasyoneli, kapsamı göz önüne alınarak yapılmalıdır. Teknoloji öngörüsünün uzun vadeli olası etkilerinin neler olabileceği, beklenen etkileri, araştırmanın başında uzman görüşleri ile belirlenmiştir. literatürde var olan bütün etki değerlendirme çerçeve modelleri incelenmiştir. Bu çerçeve modelleri hiç uygulanmamış veya sınırlı sayıda pilot uygulamaya dayandırılmıştır. Uzman görüşleri ve genel etki değerlendirme çerçeve modelleri ve etki göstergeleri kullanılarak taslak bir etki değerlendirme ölçeği geliştirilmiştir. Geliştirilen taslak ölçeğe, kapsam geçerliliği, Keşfedici Faktör Analizi (KFA), iç tutarlılık ve güvenirlik testleri uygulanmıştır. Etki değerlendirme ölçeğinin geliştirilmesi ve etkinin ölçülmesi bu araştırmada önemli bir yer tutmuştur.

Her bir teknoloji öngörüsü etki fonksiyonunu ölçmek için 74 maddeden oluşan ölçek taslağı geliştirilmiştir. Maddeler etki sınıflandırmasında ortaya çıkan 10 boyut altında gruplandırılmıştır. Ölçek maddelerinin uygunluğu kapsam geçerliliği ile test edilmiştir. Anket maddelerinin ölçülmek istenen değişkeni, özelliği kapsama ve ölçme yeterliliği kapsam geçerliliği ile sınanmıştır. Taslak ölçek kapsam geçerliliği için 15 uzmana gönderilmiş ve ölçekteki maddelerin istenilen etkiyi ölçüp ölçmediklerini değerlendirmeleri istenmiştir. Uzmanlar stratejik yönetim, teknoloji yönetimi, teknoloji öngörüsü alanlarında uzman, ağırlıklı olarak savunma sektöründe çalışmış ve Vizyon 2023 Teknoloji Öngörü projesinde görev almış kişilerden seçilmiştir. 8 kişiden yanıt alınmıştır.

Hazırlanan taslak ölçek kurumlarında yönetici pozisyonlarında görev yapmış, V2023 Teknoloji Öngörüsünde çalışmış veya konu hakkında bilgisi olan kişilerle pilot uygulama ile ön test yapılmıştır.

Anketin tanımlayıcı istatistik değişkenleri kapsamında, kişilerin konu hakkında bilgi seviyeleri, çalıştıkları kurumlar, yaş ve şirketin sermaye yapısı bilgileri istenmiştir. Teknoloji öngörüsü hakkında bilgisi olmayan kişilerin anketi yanıtlaması engellenmiştir. Taslak ölçek (anket) SurveyMonkey yazılım programına aktarılmış ve internette erişime açılmıştır.

Araştırma evreni Vizyon 2023 Teknoloji Öngörüsü Savunma Uzay Havacılık paneli çalışmasına katılanlar ve bu konuda bilgi sahibi kişilerden oluşmaktadır. Panele katılanların sayısı 793 olarak verilmiştir (TÜBİTAK, 2004). Ancak panel üyeleri dışında bulunan bu kişilerin erişim bilgilerine ulaşılamamıştır. Panel çalışmalarına katılan kişiler aynı zamanda savunma sektörünün çalışanları, yöneticileri, bu konu ile ilgilenen uzmanlar ve bilim insanlarıdır. Teknoloji öngörü çalışmasında yer almayıp sonradan bilgi sahibi olanlar da araştırma evreni kapsamındadır. Sonuç olarak araştırma evreni savunma sanayi şirketleri, TÜBİTAK, TSK, kamu kurumları (özellikle MSB, SSM), üst düzey yöneticileri, Ar-Ge, teknoloji, strateji, pazarlama, İK yöneticileri ve çalışanlarından ve üniversite bilim insanlarından oluşmaktadır. Bu kişilerle anket uygulaması yapılması amaçlanmıştır. Tüm araştırma evrenine ulaşmak için anket savunma profesyonellerinin internette haberleşme platformları, Bilim, Teknoloji ve Yenilik (BTY) sosyal medya platformlarında yayınlanmıştır. Savunma sektöründe çalışmış veya çalışan ve 'Vizyon 2023 Teknoloji Öngörüsü' hakkında bilgi sahibi olabilecek kişilere ulaşılmaya çalışılmış, e-posta ve sosyal medya aracılığıyla ile anket gönderilmiştir. Örneklem büyüklüğünün arttırılmasında çekirdek grubun iletişim ağından yayrlanılmıştır. Toplamda 239 kişiye erişilerek, örneklem araştırma evrenine yaklaştırılmaya çalışılmıştır.

Anket yanıtları, veri özeti ve detay verileri SPSS istatistik programına aktarılmıştır. SPSS programına aktarma sırasında 'Bilmiyorum' seçeneğini işaretleyen yanıtlar filtrelenmiştir. Ölçeğin faktör yapısını belirlemek için Keşfedici Faktör Analizi (KFA) yapılmıştır. KFA geliştirilen ölçeğin yapı geçerliliğini test etmek için kullanılmaktadır. Yapı geçerliliği ölçekte yer alan maddelerin araştırılan özellikleri ölçüp ölçmediğini göstermektedir. KFA yöntemi için örneklem büyüklüğü ölçekteki madde sayısının en az 2 veya 3 katı, tercihen 10 katı olması gerekmektedir. Analizlere başlamadan önce eksik veri ve rasgelelik kontrolu yapılmıştır. Faktörleşme analizi için Temel Bileşenler Analizi (Principle Component) ve Varimax Eksen Döndürme teknikleri uygulanmıştır. Geliştirilen ölçeğin sonuçlarının anlamlı olması, yapı geçerliliğinin sağlanması için güvenirlilik ve geçerlik testleri yapılmıştır. Faktör yapısının belirlenmesinde; Öz değer yaklaşımı (Kaiser ölçütü): Öz değeri>1 olan faktörler; Yamaç serpinti grafiği; Toplam varyansa en fazla katkıda bulunan faktörler dikkate alınmıştır. Her bir boyut altında toplanan maddelerin faktör yükleri incelenmiştir.

Faktör maddelerinin belirlenmesinde, bu çalışma bir ölçek geliştirme çalışması olduğundan ve faktörlerin mümkün olduğunca güçlü maddelerden oluşturulması hedeflendiğinden faktör yükü, $q \geq 0,5$ seçilmiştir; Çapraz yüklenme olmamasına dikkat edilmiştir. KFA için örneklem büyüklüğü kriteri yanında, KMO değeri (>0.6) örneklem yeterlilik değeri ölçülmüştür. Örneklem büyüklüğünün faktör analizi için yeterli olduğu tespit edilmiştir. Bartlett Küresellik Testi'nin anlamlı olması maddeler arasındaki korelasyon ilişkilerinin faktör analizi için uygun olduğunu göstermiştir.

KFA analizi sonucunda 53 madde ve 5 faktörlü yapıda; faktörlerin toplam varyansın % 75,23'ünü açıkladığı ve faktör yükleri 0,5'in üzerinde olan Teknoloji Öngörüsü Etki Değerlendirme ölçeği elde edilmiştir. Ölçek faktörleri maddelerin taşıdığı anlamları kapsayacak şekilde isimlendirilmiştir:

- 'Etkileme' tesir tipi en yüksek ağrılık katsayısına sahiptir. BTY politikaları, teknoloji alanları, Ar-Ge projeleri ve yatırımların belirlenmesi ve önceliklendirilmesi, yetkin Ar-Ge personeli, teknoloji transfer mekanizmaları, Ar-Ge ve yeniliğe talep, savunma projelerinde kamu-üniversite-sanayi işbirliğine katkısı ile ilgili maddeleri kapsamaktadır.
- 'Etkileme ve Kolaylaştırma' tesir tipi teknoloji öngörüsünün uzun vadeli BTY politika ve planların geliştirlmesinde bir araç olarak kullanılmasına katkısı ile ilgili maddeleri kapsamaktadır.
- 'Farkındalık Arttırma ve Bilgilendirme' tesir tipi BTY, teknoloji öngörüsü, Ar-Ge personeli ve teknoloji yönetimi farkındalığının artması ve öngörü çıktılarının politika ve kararlarda kaynak olarak kullanılmasına katkısı ile ilgili maddeleri kapsamaktadır.
- 'Kamu-Üniversite-Sanayi işbirliği' tesir tipi üçlü yapı arasındaki işbirliğinin artmasına katkısı ile ilgili maddeleri kapsamaktdır.
- 'Öngörü Kültürü' tesir tipi öngörü kültürü, uzun vadeli ve katılımcı planlama, geniş katılım, ortak akıl ile vizyon belirleme kültürünün geliştirlmesine katkısı ile ilgili maddeleri kapsamaktadır.

Yapısal geçerliliği KFA ile test edilen ölçeğin tutarlı ölçüm yapıp yapmadığı, ölçek maddeleri arasında tutarlılık olup olmadığı güvenirlik analizi ile sınanmıştır. Bu çalışmada iç tutarlılık güvenilirliği kullanılmıştır. İç tutarlılık güvenilirliği ölçme aracını oluşturan maddeleri kendi aralarında tutarlılık gösterip göstermediğine bakılmıştır. Teknoloji öngörüsü etki değerlendirmesi ölçeğinin her bir alt faktörüne ait güvenirlik katsayısı Cranbach Alfa tekniği ile hesaplanmıştır. Etki ölçeğini oluşturan alt boyutların Cronbach Alfa (α) güvenilirlik katsayısının 0.70'den yüksek olduğu görülmüştür.

Faktör yükleri belirlenen değerin (q<0.5) altında kalan maddeler kurumların yaptığı planlara duyulan güveni; planlar arasında tutarlılığı, uyumu; disiplinler arası çalışmayı, çalışanların yeni beceriler kazanması gibi konuları kapsamaktadır. Bu maddeler teknoloji öngörüsünün amaçlanmamış veya dolaylı etkileri olabilir. Bu maddeler, faktör yükü 0.5'ten daha düşük bir değer seçilerek ölçeğe dahil edilebilir. Dolayısı ile kapsam geçerliliğini sağlayan ancak seçilen faktör yükü değeri sebebiyle KFA sonucunda ölçek dışında kalan maddeler, teknoloji öngörüsü etki değerlendirme çerçeve ölçeği kapsamında korunması değerlendirilmiştir.

Geliştirilen ölçekte katılımcıların Vizyon 2023 SHU TÖ Etki'sine dair algı ve tutumlarının istatistiksel analizler sonucu elde edilen bulgular hakkında yorum yapılabilmesi için ortalamaların belli bir aralığa dönüştürülmesi gerekmektedir. Ölçekte 5'li Likert tipi seçenekler 1-5 arasında bir değer ve katkı sınıfı aralığına dönüştürülmüştür. 1- Kesinlikle Katılmıyorum, 2-Katılmıyorum, 3-Kısmen Katılıyorum, 4-Katılıyorum, 5-Kesinlikle Katılıyorum. 5'li Likert ölçeği doğrusal olarak 5 eşit aralığa dönüştürülmüştür. Etki seviyeleri "Etkisiz" (1,00-1,79), "Az Etki" (1,80-2,59), "Kısmi Etki (2,60-3,39), "Önemli Etki" (3,40-4,19) ve "Çok Etki" (4,20-5,00).

SPSS ile yapılan hesaplama sonucunda, Vizyon 2023 Teknoloji Öngörüsünün savunma sektöründe etki seviyesi 2.92 ile "Biraz Katkı" düzeyindedir. Etki seviyesi odak grup çalışmasında belirlenen faktör ağırlık puanları ile yeniden hesaplanması sonucunda 3,04 ile 'Biraz Katkı' düzeyinin değişmediği görülmüştür. Vizyon 2023 Teknoloji Öngörüsünün savunma sektöründe toplam etkisi ve her bir faktör bazında etki puanı artış göstermekle birlikte "Biraz Etki" düzeyi değişmemiştir.

Vizyon 2023 teknoloji öngörüsünün savunma sektöründe etkisine dair algının, katılımcıların teknoloji öngörüsüyle ilgili bilgi seviyesine, çalıştıkları kurum türüne, şirket türüne ve katılımcının yaş grubuna göre farklılık gösterip göstermediği analiz edilmiştir.

Örneklemden elde edilen verilerin istatiksel sonuçlarının, örneklemi oluşturan gruplara göre farklılık gösterip göstermediğini sınamak için parametrik olmayan Kruskall-Wallis (3den fazla grup arasında) ve Mann-Whitney U (2 grup arasında) testleri yapılmıştır.

Katılımcıların Vizyon 2023 Teknoloji Öngörüsünün etki değerlendirmeleri, sahip oldukları bilgi seviyelerine göre farklılık göstermektedir. Farkın hangi gruplar arasında olduğu, ikili gruplar arasında Mann-Whitney U testi ile sınanmıştır. Vizyon 2023 Teknoloji Öngörüsü hakkında çok az bilgi sahibi olanlarla, iyi ve çok iyi bilenlerin etki değerlendirmeleri arasında $p=0.05$ düzeyinde anlamlı bir farklılık vardır. Benzer bir sonuç derin görüşme analizlerinde de çıkmıştır. Vizyon 2023 teknoloji öngörü çalışmasına katılmayan uzman görüşlerinde daha olumsuz değerlendirmeler yer almıştır.

Katlımcıların Vizyon 2023 Teknoloji Öngörüsünün etkisine dair değerlendirmelerinde, çalıştıkları kurum kategorisine (kamu kurumları, TSK, üniversite, şirket) göre anlamlı bir fark yoktur.

Katılımcıların Vizyon 2023 Teknoloji Öngörüsünün etkisine dair değerlendirmelerinde, çalıştıkları şirketin sermaye yapısına (kamu veya özel şirket) göre anlamlı bir farkın varlığı Mann-Whitney U testi ile sınanmıştır. Sınama sonucu, katılımcıların etki değerlendirmelerinde çalıştıkları şirketin sermaye yapısına göre $p=0.05$ düzeyinde anlamlı bir fark yoktur. Katılımcıların Vizyon 2023 Teknoloji Öngörüsünün etkisine dair değerlendirmelerinde, yaş gruplarına göre de anlamlı bir fark yoktur.

Etki değerlendirmesinde uygulanan bütün yöntemlerde neticeye bakılarak, teknoloji öngörüsünün bu sonuçlara, neticeye katkısı araştırılmıştır. Bu çalışma kapsamında ayrıca, neticeye katkı yapan teknoloji öngörüsü çıktılarından hangilerinden ne kadar faydalanıldığı da analiz edilmiştir. Etki Değerlendirme Ölçeğini uygulama anketinde, öngörü çıktılarından ne derece faydalanıldığı, öncelikli teknoloji alanlarında gelişmeye etkisi, teknoloji yönetim araçlarının kullanımına etkisi, teknoloji olgunluğu ölçme araçlarının kullanımına etkisi, yenilik çeşitlerine etkisi, politika alanlarına etkisini ölçmeye dair maddeler eklenmiştir. Ankete öngörü etkisi hakkında daha kapsamlı bilgi edinmek için eklenen maddelerin istatistiki sonuçları ayrıca değerlendirilmiştir.

- Teknoloji öngörü çıktılarından faydalanılması: En çok faydalanılan, etkili olan teknoloji öngörü çıktıları BTY Yol Haritaları, BTY politika Yol Haritaları, Analiz Raporları, Teknoloji Taksonomisi ve Kritik Teknoloji Ağacı çıktılarıdır ve etki düzeyleri "Orta Etki".
- Öncelikli teknoloji alanlarında gelişmeye etkisi: Gelişmeye etkisinin en yüksek olduğu öncelikli teknoloji alanları, "Sensör, Elektronik, Haberleşme ve Bilgi Teknolojileri", "Hava-Kara-Deniz Platform Teknolojileri" ve "Modelleme ve Simülasyon Teknolojileridir", "Orta Etki" düzeyindedir.
- Kullanılmasında en çok etkili olduğu öngörü teknikleri: Beyin fırtınası, SWOT analizi, Yol Haritaları, çalıştaylar ve kritik teknolojilerdir.
- Teknoloji yönetim araçları: Kullanılmasında en fazla etkili olduğu teknoloji yönetim aracı Teknoloji Yol Haritaları. "Orta Etki".
- Teknoloji Olgunluğu Ölçme Araçları: Kullanılmasında en fazla etkili olduğu teknoloji olgunluğu ölçme araçları TRL-Donanım, TRL-Sistem ve TRL-Yazılımdır. Etki düzeyi "Orta Etki".
- Yenilik çeşitleri: En fazla etkili olduğu yenilik çeşitleri ürün yeniliği ve süreç yeniliği. "Orta Etki"
- Politika Alanları: En fazla etkili olduğu politika alanları, teknoloji yönetimi, teknoloji-ürün geliştirme, teknoloji edinimi, AR-GE ve yenilik. "Orta Etki".

Öngörünün etkisiz olduğu veya daha düşük oranda da olsa çok etkili olduğu değerlendirmeleri de anket sonuçlarından elde edilmiştir. Bu gözlenen değişkenler, aynı zamanda birer göstergedir. Teknoloji öngörüsünün etkisini izlemek için kullanılabilecek anahtar göstergeler olarak önerilmiştir.

4 Araştırma yönteminden elde edilen leri bulgularının karşılaştırılması

Farklı araştırma yöntemlerinden (görüşme, odak grup, doküman analiz ve anket) elde edilen bulguların hepsi Vizyon 2023 teknoloji öngörüsünün uzun vadede savunma sektöründe biraz etkili olduğunu, sonuç / neticeye biraz katkısı olduğunu göstermektedir. Farklı metodlarla birbirini destekleyen, tamamlayıcı kanıtlar elde edilmiştir. BTY sisteminin ‘çevik’ olması ve sistemin iyileştirme önerileri olarak izleme ve değerlendirmelerin somut göstergelerle yapılması için yeni anahtar göstergeler tanımlanmıştır. Önerilen anahtar göstergeler: Öngörü çıktılarından yararlanma oranı; Stratejik teknoloji alanlarındaki gelişmenin, teknolojik seviyenin Teknoloji Olgunluk Düzeyi (TRL) araçları ile ölçülmesi; Teknoloji yönetim araçları ve Teknoloji öngörü araçlarının kullanılması ve yetkinlik artışı; Yenilikçilik artışı.

Etki Değerlendirme Modeli

Etki değerlendirme modeli bu tez kapsamında geliştirilen Etki Değerlendirme Ölçeği, etki değerlendirme süreç alanları, öngörü süreçlerinden sorumlu organizasyonel yapı ve somut göstergelerden oluşmaktadır. Tez çalışması kapsamında gerçekleştirilen faaliyetler gözden geçirilmiş ve CMM/CMMI süreç alanları kapsamındaki genel faaliyetleri ile benzerliklerine odaklanılmıştır. Teknoloji öngörü döngüsü tekrarlayan süreçler olduğundan CMM/CMMI modelinin tanımsız süreçlerden yönetilen süreçlere doğru gelişmeyi sağlayan, ölçmeye dayalı 5 aşamalı süreç iyileştirme özelliklerinden yararlanılması hedeflenmiştir. CMM/CMMI süreç alanı yaklaşımı ile teknoloji öngörüsü etki değerlendirme süreçlerinin ölçme, analiz ve geliştirilmesi için yeni bir yaklaşım önerilmiştir. Literatürde CMM/CMMI modelini mikro seviyede şirket teknoloji öngörüsüne uyarlayan çalışmalar olmakla birlikte, bu çalışma onlardan makro düzeyde uygulama olması ile ayrışmaktadır. Etki değerlendirme modelinde CMMI süreç alanları yaklaşımı, sistem ve proje yönetimi ile birleştirilmiştir. Model, süreç alanlarının bir sistem içinde birbiri ile girdi çıktılarının tanımlandığı akışı göstermektedir.

Süreç alanları çerçevesi: Süreç alanının amacı, faaliyetlerin planlanması, kaynak ve paydaşların tanımlanması, görev ve sorumlulukların verilmesi, eğitim, izleme ve kontrol, değerlendirme (assessment and evaluation), üst yönetim gözden geçirmesi, konfigürasyon yönetimi ve geliştirme, kaynaklar, ölçüm ve doğrulama faaliyetlerini kapsamaktadır. Etki değerlendirme süreç alanları ise planlama, bilgi toplama, uzmanlarla danışma, KBF ve değerlendirmedir.

Proje Planlama süreç alanının amacı etki değerlendirme faaliyetlerini tanımlamak ve planlamaktır. Bilgi Toplama süreç alanının amacı teknoloji öngörüsü bağlamında veri ve bilgi toplamaktır. Uzmanlara danışma süreç alanı teknoloji öngörüsünün farklı boyutları hakkında uzmanlardan görüşlerini derlemektir. KBF ve Kararlar süreç alanının amacı teknoloji önörüsünün başarılı olmsı için KBF'nin belirlenmesi ve başarı, başarısızlık, sebep-sonuç bağlantıları hakkında kararların alınmasıdır. Etki Değerlendirme süreç alanının amacı ise etkinin ölçülmesidir. KBF, başarı, başarısızlık, sebep-sonuç ilişkileri, ölçülen etki seviyeleri ve bu bilgilerden üretilecek öneriler raporlanarak teknoloji öngörüsünün tasarım sürecine girdi oluşturacaktır. Her süreç alanı için sistematik olarak veri toplanabilecek ve öğrenme ve süreç iyileştirme için güvenilir, geçerli veri, bilgi toplanabilecektir.

Aşamalı CMMI modelinin teknoloji öngörü döngü ve süreçlerine uygulanması savunma sektöründe ve ülkede öngörü kapasitesinin geliştirilmesi ve olgunluk seviyesinin artmasına yardımcı olacaktır. Faaliyetlerin sorumlulara bağlanması ve SMART hedeflerin belirlenmesini, izlenmesini ve değerlendirilmesini kolaylaştıracaktır. CMMI süreç alanları çerçevesi bu tez kapsamında yalnızca etki değerlendirmesi için geliştirilmiştir. Model teknoloji öngörüsünün tüm yaşam döngüsünü kapsayacak şekilde genişletilebilir.

Sponsor kurum: Teknoloji öngörüsünden sorumlu kurumların, birimlerin, yapıların açıkça tanımlanması KBF'dür. Teknoloji öngörüsünü talep eden, sponsor olan kurumun açıkça tanımlanmasıdır. Talep eden ve sponsor olan yapı için Savunma Sanayi İcra Kurulu (SSİK) benzeri bir yapı önerilmiştir. Bu kurul, MSB/SSM ve Bilim, Sanayi ve Ticaret Bakanlığı üst düzey yöneticilerinden, bakanlardan oluşabilir. Kurul öngörü programının yapılması için görevlendirme yapar, SSM ve TÜBİTAK'ı görevlendirir.

Müşteri: SSM, teknoloji öngörü sonuçlarının müşterisidir, öngörünün başarısından sorumludur. TÜBİTAK teknoloji öngörüsünün 2nci derece müşterisidir. Öngörü projesinin gerçekleştirilmesinden ve öngörü döngüsünün işletilmesinden sorumludur. Teknoloji öngörü merkezi olarak görev yapar. SSM ile koordinasyon içinde çalışır.

Akademik alıcı: Üniversite (ODTÜ) teknoloji öngörüsünün akademik kapasitesini oluşturmaktan sorumludur. Geleceğe ilişkin politikalar hakkında fikirler üretir, sürekli bilginin kaynağıdır ve eğitim verir.

B-T bilgisinin üretilmesi: Teknoloji panelleri, asker-iş insanı, bilim insanı, kamu temsilcilerinin birlikte çalışarak, AR-GE proje fikirlerinin üretilmesi, savunma ihtiyaçlarının karşılanması, ekonomi ve topluma etkisini araştırmak için bağımsız, özgür platformlar sunar.

Politika Önerileri:

Savunma sektörüde teknoloji öngörü döngüsünün başarıyla uygulanması ve etkisinin artması için politikalar ve politika araçları önerilmiştir.

Teknoloji panelleri ve askeri AR-GE merkezlerinin BTY sistemine bilgi üreten yapılar olarak dahil edilmesi, savunma sektöründe BTY sisteminin performansını arttıracaktır. Askeri AR-GE merkezlerinin işleyişi asker-sivil bilim insanlarının birlikte çalışmasını destekleyecek şekilde düzenlenmeleridir. Askeri AR-GE merkezleri ve teknoloji panllerinden sanayiye bilgi ve teknoloji transferi BTY sistemi için performans göstergesi olabilir.

Savunma sektörü için teknoloji öngörüsünde üretilen bilgiye dayalı B-T strateji belgesinin hazırlanması, sektörün ortak vizyonu sahiplenmesini ve gerçekleştirilmesini kolaylaştırabilir. Araştırma merkezleri ve sanayinin Ar-Ge ve ürün geliştirme programları ile TRL ölçeğine göre konulandırılmaları B-T yetkinliğin artması ve kaynakların uygun kullanımını arttırabilir. Prototip geliştirmeyi kolaylaştıracak politikaların oluşturulması teknolojik gelişmeyi arttıracaktır.

Teknoloji öngörü süreçlerini ve döngüsünün başarıyla uygulandığı ülkelerin avantajı öngörü çıktılarının politika geliştirme sürecine dahil edilmesi için kanunların varlığı ve uygulanmasıdır. Hükümetlerin, kurumların öngörü sonuçlarını sahiplenmeleri için katılımcı teknoloji öngörü programlarının uygulanması ve sonuçların politikalara yansıtılması, izlenmesi ve değerlendirilmesi için kanunlar çıkarılabilir. Performans göstergelerinin, Delphi tekniklerinin kullanılması teknoloji öngörüsü, izleme ve değerlendirme politikalarının uygulanabilirliğini ve doğruluğunu, güvenilirliğini arttıracak politika araçlarıdır.

Teknoloji öngörüsünün sponsorluğunu yapacak, talep edecek yapı olarak SSİK benzeri bir yüksek kurulun kurulması, üyelerinin Bilim Sanayi ve Teknoloji Bakanlığı ve Milli Savunma Bakanlığı'ndan oluşturulması; Savunma Sanayi Müsteşarlığının teknoloji öngörüsü ve neticelerinden sorumlu kurum olarak görevlendirilmesi önerilmiştir.

TEZ FOTOKOPİSİ İZİN FORMU

<u>ENSTİTÜ</u>

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<u>YAZARIN</u>

Soyadı : Burhan
Adı : Mukaddes
Bölümü : Bilim ve Teknoloji Politika Çalışmaları

<u>TEZİN ADI</u> (İngilizce) : Impact Assessment of Vision 2023 Technology Foresight in Defense Sector

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