DETERMINATION OF PROGRAM MANAGEMENT METHODS AND PRACTICES TO BE APPLIED IN THE NATIONAL COMBAT AIRCRAFT DEVELOPMENT (TFX) PROGRAM BY USING THE EXPERIENCE FROM THE F-35 JOINT STRIKE FIGHTER (JSF) PROGRAM

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

BY

MUHAMMED ALİ YİĞİT

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

DECEMBER 2019

Approval of the Graduate School of Social Sciences

Prof. Dr. Yaşar KONDAKÇI
Director

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

Prof. Dr. M. Teoman PAMUKÇU
Head of Department

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

Dr. E. Serdar GÖKPINAR
Co-Supervisor

Prof. Dr. M. Teoman PAMUKÇU
Supervisor

Examining Committee Members

Prof. Dr. Serkan ÖZGEN (METU, AE) ______________________

Prof. Dr. M. Teoman PAMUKÇU (METU, STPS) ______________________

Assist. Prof. Dr. Mehmet ERDEM (Atılım Uni., IE) ______________________

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

Name, Last name :

Signature :

ABSTRACT

DETERMINATION OF PROGRAM MANAGEMENT METHODS AND PRACTICES TO BE APPLIED IN THE NATIONAL COMBAT AIRCRAFT DEVELOPMENT (TFX) PROGRAM BY USING THE EXPERIENCE FROM THE F-35 JOINT STRIKE FIGHTER (JSF) PROGRAM

Yiğit, Muhammed Ali
M.S., Science and Technology Policy Studies
Supervisor: Prof. Dr. M. Teoman Pamukçu
Co-Supervisor: Dr. E. Serdar Gökpınar

December 2019, 160 pages

Following World War II, the air power was clearly accepted as the most critical power to have for all nations. The military theorists focused on the air power since the air supremacy was seen the key for victory. Hence, the fighter aircraft technology has grown aggressively in the second half of last century and triggered the development of five types of aircraft generations until the beginning of the 1990s.

The F-35 Lightning-II is a fifth-generation aircraft that has thrust vector, stealth airframe, advanced radar and sensors and integrated avionics with fusion technology, and it was developed and manufactured under the F-35 Joint Strike Fighter (JSF) Program which is one of the largest single defense programs in the world history. Turkey has been a partner of JSF Program with the international memorandum and under this memorandum and

Turkey will procure the F-35 Lightning-II. Furthermore, Turkey independently decided to start the local development of fifth generation fighter aircraft and named it as 'National Combat Aircraft Development (TFX) Program'. The conceptual design phase has been completed under the TFX Program and currently the preliminary design phase of the aircraft is ongoing.

In the development of the large-scale programs such as JSF, TFX i.e., each project process and each phase should be designed and each decision have to be taken with great scrutiny as the results of each action can have tremendous effects on the program, not only limited to technical, but also financial matters. Any unnecessary application can cause waste of time, money and other resources. Therefore, it is important to apply the best practices from all the past experiences made out, lessons-learnt encountered the other programs in TFX Program. At that point, the JSF Program seems as a cut out for TFX Program.

In this thesis, program management methods and applicable best practices are investigated and presented by utilizing the experiences gained in the JSF Program in order to make the best use of time, money and efforts and increase the efficiency of the TFX Program.

Keywords: F-35 Joint Strike Fighter (JSF) Program, National Combat Aircraft Development / Turkish Fighter Development (TFX) Program, Project Management, Key Performance Indicators, Turkish Defense Industry

ÖZ

MİLLİ MUHARİP UÇAK GELİŞTİRME (TFX) PROGRAMINDA UYGULANABİLECEK PROGRAM YÖNETİMİ METOTLARI VE PRATİKLERİNİN F-35 MÜŞTEREK TAARRUZ UÇAĞI (JSF) PROGRAMININ TECRÜBESİ KULLANILARAK BELİRLENMESİ

Yiğit, Muhammed Ali
Yüksek Lisans, Bilim ve Teknoloji Politikası Çalışmaları
Tez Danışmanı: Prof. Dr. Mehmet Teoman Pamukçu
Ortak Tez Danışmanı: Dr. Eyüp Serdar Gökpınar

Aralık 2019, 160 Sayfa

İkinci Dünya Savaşı'ndan sonra hava gücünün kritik öneme haiz olduğu birçok ülke tarafından daha net anlaşıldı. Hava üstünlüğünün muharebelerde başarı getiren önemli bir unsur olması askeri teorisyenlerin dikkatini hava gücü üzerine yoğunlaştırmasına sebep oldu. Bu durum, savaş uçağı teknolojisinin son yarım yüzyıldaki gelişimini çok hızlandırdı ve 90'lı yılların başlarına kadar beş farklı tip savaş uçağı nesli geliştirildi.

F-35, vektörel itki sistemi, düşük görünürlük özelliğine sahip gövdesi, ileri seviye radar ve algılayıcıları yanı sıra füzyon teknolojisiyle donatılmış entegre aviyonik mimarisi ile V. Nesil bir savaş uçağı olup tüm zamanların en geniş ölçekli savunma programından biri olan Müşterek Taarruz Uçağı (JSF) Programı kapsamında geliştirilip üretilmektedir. Türkiye, JSF Programı'na uluslararası mutabakat ile üye olmuştur ve hâlihazırdaki mutabakata göre

F-35 uçağı tedarik edecektir. Bunun yanı sıra Türkiye kendi milli V. Nesil savaş uçağını geliştirme kararı almış ve Milli Muharip Uçak Geliştirme (TFX) Programı'nı başlatmıştır. TFX Programı'nda kavramsal tasarım evresi tamamlanmış olup ön tasarım evresi şu an için devam etmektedir.

JSF ve TFX gibi büyük ölçekli programların geliştirilmesinde atılacak her adım çok önemlidir. Bu sebeple program adımlarının büyük bir hassasiyetle belirlenmesi ve programa ilişkin alınacak kararların ince elenip sık dokunması gerekmektedir. TFX Programı içerisinde yapılacak her verimsiz uygulama programda zaman, para ve kaynak israfına yol açacaktır. Bu sebeple geçmiş programlardan öğrenilen derslerin, birikmiş tecrübelerin ve iyi uygulamaların süzülerek çıkarılması ve TFX Programı'na aktarılarak uygulamaya konulması önem arz etmektedir. Bu noktadan bakılınca JSF Programı, TFX Programı için biçilmiş kaftan gibi görünmektedir.

Bu tezde, TFX Programı'nda zaman, maliyet ve efor kaybını en aza indirmek ve verimliliği artırmak adına JSF Programı'nın tecrübeleri kullanılarak uygulanacak program yönetim metotlarının ve pratiklerinin analizi ve uygulaması anlatılmıştır.

Anahtar Kelimeler: Müşterek Taarruz Uçağı (JSF) Programı, Milli Muharip Uçak Geliştirme (TFX) Programı, Proje Yönetimi, Anahtar Performans Göstergeleri, Türk Savunma Sanayii

to my wife and my family

ACKNOWLEDGMENTS

I want to express my gratitude to my supervisor Prof. Dr. Mehmet Teoman PAMUKÇU and co-supervisor Dr. Eyüp Serdar GÖKPINAR, for their precious contributions, criticisms and guidance during my thesis.

I am indebted to my wife Hacer, who is a strong woman always behind me, and patiently encourage me to accomplish this thesis, my mother Gülseren and father Erol, for inspiring me with their sincere support from the beginning and even before, and my dear brothers Ömer Faruk and Abdullah Harun, for their continuous support and belief in me.

I want to express my gratitude to my colleagues and my office mates. I am grateful to my executive managers in Presidency of Defense Industries (SSB). I would like to thank my manager Semra ÖZTÜRK for always being helpful when I need. I want to thank Abdurrahman Şeref CAN, the Head of Aircraft Department, for his mind-opening assessments and attitudes motivating me.

Lastly, I would like to thank Serdar DEMİREL, SSB's Vice President, for sparing time and answering my questions voluntarily with valuable contributions. I want to thank Prof. Dr. İsmail DEMİR, SSB President, for his high permission and support.

This thesis has only "Unclassified" information and was officially approved on January 22, 2020 with the reference number 33531258-100-E.2020-O-3090 by the Presidency of Defense Industries (SSB).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CDP	Conceptual Design Phase
CDP	Critical Design Phase
CDR	Critical Design Reviews
CPF	Cost-Plus-Fee
CTOL	Conventional Take-Off and Landing
CV	Carrier Variant
DoD	Department of Defense
FFP	Firm-Fixed Price
FMS	Foreign Military Sales
FOC	Final Operating Capability
IOC	Initial Operating Capability
IOT&E	Initial Operational Test and Evaluation
IPT	Integrated Project Team
JAST	Joint Advanced Strike Technology
JDL	Joint Data Library
JPO	JSF Program Office
JSF	Joint Strike Fighter Program
KPI	Key Performance Indicator
LRIP	Low Rate Initial Production
MOU	Memorandum of Understanding

MRO	Maintenance Repair and Overhaul
NCW	Network Centric Warfare
PDP	Preliminary Design Phase
PDR	Preliminary Design Review
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PSFD	Production, Sustainment, and Follow-On Development
RFP	Request for Proposal
SDD	System Development and Demonstration
SOW	Statement of Work
SSB	Presidency of Defense Industries
SSİK	Defense Industries Executive Committee
STOVL	Short Takeoff and Vertical Landing
TAI	Turkish Aerospace
TBMM	The Grand National Assembly of Turkey
TFX	Turkish Fighter Development Program
TFX	National Combat Aircraft Development Program
TurAF	Turkish Air Force
UK	United Kingdom
US	United States
USAF	United States Air Force

CHAPTER 1

INTRODUCTION

1.1. Background

In modern geopolitical studies, there exists many theories related to the power of states. Many of them are about the sea power (Mackinder, 1904). After the World War II, however, the air power was clearly accepted as the most critical power. The military theorists focused on the air power, indeed, the air supremacy was seen the key of victory (Douhet, 1942). During the Cold War, countries' race of developing fighter aircraft capability accelerated which resulted in the development of aerospace industry (Meilinger, 1997). Hence, the fighter technology has grown rapidly causing the development of five types of aircraft generations until the beginning of the twenty-first century.

1.1.1. Overview

Each fighter aircraft generation has its own unique capabilities. The latest one being the fifth generation fighter aircraft comprise new technologies such as thrust vectoring, stealth airframe, advanced radar and sensors, composite materials, and integrated avionics with fusion technology to increase the pilot's situational awareness (Gertler, 2018). The early fifth generation studies started in 1980s (Hehs, 1998). Many types of fifth generation aircraft were designed by the countries which had solid industrial infrastructure and in-depth knowledge that enables them to further improve fighter capabilities.

Despite not having super-cruise capability, the F-35 Lightning-II was conceived as a relatively affordable fifth-generation aircraft (Gertler, 2018). It was designed, developed and manufactured and sustained under the F-35 Joint Strike Fighter (JSF) Program.

The JSF Program is deemed the largest single defense program in the world history. It is estimated that the overall procurement and the sustainment cost is approximately 1,12 trillion U.S. dollars[1] for the United States alone (GAO Report, 2019).

The JSF Program is as complex as it is large. That means, it requires the coordination of numerous agencies and also the management of collaborative efforts of the hundreds of international subcontractors while meeting the expectations of JSF Program partners. Turkey is the partner of JSF Program with the international agreement (TBMM Law No.5425, 2005). Turkey will procure F-35 fighter aircraft under JSF Program (TBMM Law No.5764, 2008).

Furthermore, Turkey independently decided to start the development of fifth generation aircraft in 2010 (Akşam, 2010). The program was named as National Combat Aircraft Development (TFX) Program (or Turkish Fighter Development Program). The TFX Program has completed the conceptual design phase and currently progresses with the preliminary design phase.

1.1.2. History

Turkey participated the JSF Program with a Letter of Acceptance and it became a partner of Concept Development Phase on June 16, 1999 (SSB, 2019). After the concept phase, System Development and Demonstration Memorandum of Understanding (MOU) was signed on July 11, 2002 (Schrock, 2002). And, Turkey's participation strengthened with the signature

[1] This estimate is reported in "then year" dollars (that is, dollars that reflect the impact of inflation over time).

of the Production, Sustainment, and Follow-On Development (PSFD) MOU on January 25, 2007 (PSFD MOU, 2007). As a result, Turkey has been a member of Joint Strike Fighter Program for 20 years.

On the other hand, Turkey launched her National Combat Aircraft Development Program/Turkish Fighter Development (TFX) Program with the decision of Defense Industries Executive Committee (SSİK) on December 15, 2010 (SSB, 2019). Following the initiation of the Program, Conceptual Design Phase (CDP) was completed on September 29, 2013 and then SSİK decided the commencement of the TFX Program on January 7, 2015.

Presidency of Defense Industries (SSB) has selected the Turkish Aerospace (TAI) as a Main Contractor of the TFX Program. After that, the Technology Development Projects Contract was signed between TAI and ASELSAN (Bloomberg HT, 2018). Therefore, the TFX Program is not a stand-alone defense program; however, it interests and incorporates many companies that constitutes the big part of Turkish defense industries. Nowadays, the TFX Program is in the progress at full steam. The first TFX fighter aircraft mock-up was demonstrated in Paris Air Show in June 17, 2019 (Anadolu Agency, 2019).

1.2. Purpose and Motivation of Thesis

The management of the large-scale defense programs are required to be tackled in a comprehensive way. Any misleading or short-sightedness cause a waste of the money and effort irreversibly.

During the implementation of the extensive defense programs such as JSF, TFX etc. each step, process and decision should be attached importance to in a more attentive way than smaller ones. Therefore, there is an increased need to contemplate the best practices and outcomes retrieved from all the past programs experience.

It can be theoretically assumed that if the past experiences and management practices of JSF Program are duly adopted by SSB in order to apply the similar practices in TFX Program, the TFX Program would be managed in an effective and efficient manner.

1.2.1. Statement of the Problem

How can the best project management practices be determined to apply in the National Combat Aircraft Development Program by using the experience from the Joint Strike Fighter Program?

1.2.2. Purpose of Thesis

In this thesis, Joint Strike Fighter Program was used as a case study for the National Combat Aircraft Development Program. It is expected that the transferring of the JSF Program experience to the TFX Program result in cost and time saving in addition to considerable gain in public funding and effort.

This thesis aims to determine the practices and methods that can be applied in the management and development of the TFX Program by using the experience obtained from the JSF Program.

1.2.3. Significance of Thesis

The TFX Program is the largest defense development program in Turkish defense history. It represents a significant challenge for Turkish defense industry companies in terms of technological and economical capabilities. For the time being, TFX Program cost estimation studies are on-going in both government and industry side. Having said that, it requires great effort to be able to manage such a program in an efficient manner given all the challenges affecting the program.

As a researcher, it is very important to contribute to the National Combat Aircraft Development Program through a master' thesis.

As known, Turkey has limited resources, in terms of money and technological capabilities; therefore, it is needed to think down to a gnat's eyebrow in each pace of TFX Program. The more comprehensive and adaptive project management methods and practices are applied in TFX Program, the smoother and well-aligned processes are established. The smoother processes are established, the better decisions are made. The better decisions are made, the more efficiently the program is managed. The more efficiently is the program managed, the lower the program cost becomes, and more savings are created in the public funds of Turkey.

1.3. Methodology

The methodology of the thesis is explained with all details in following chapters. The Key Performance Indicators (KPIs) are determined to analyze the JSF Program. The methodology of this thesis is based on the qualitative and quantitative research methods. After research completion, the qualitative content analysis and descriptive Likert-type data analysis methods are used.

1.3.1. Structure of the Study

The structure of the study is demonstrated on the flowchart. Each chapter and the relevant contents are presented briefly on Figure 1 below.

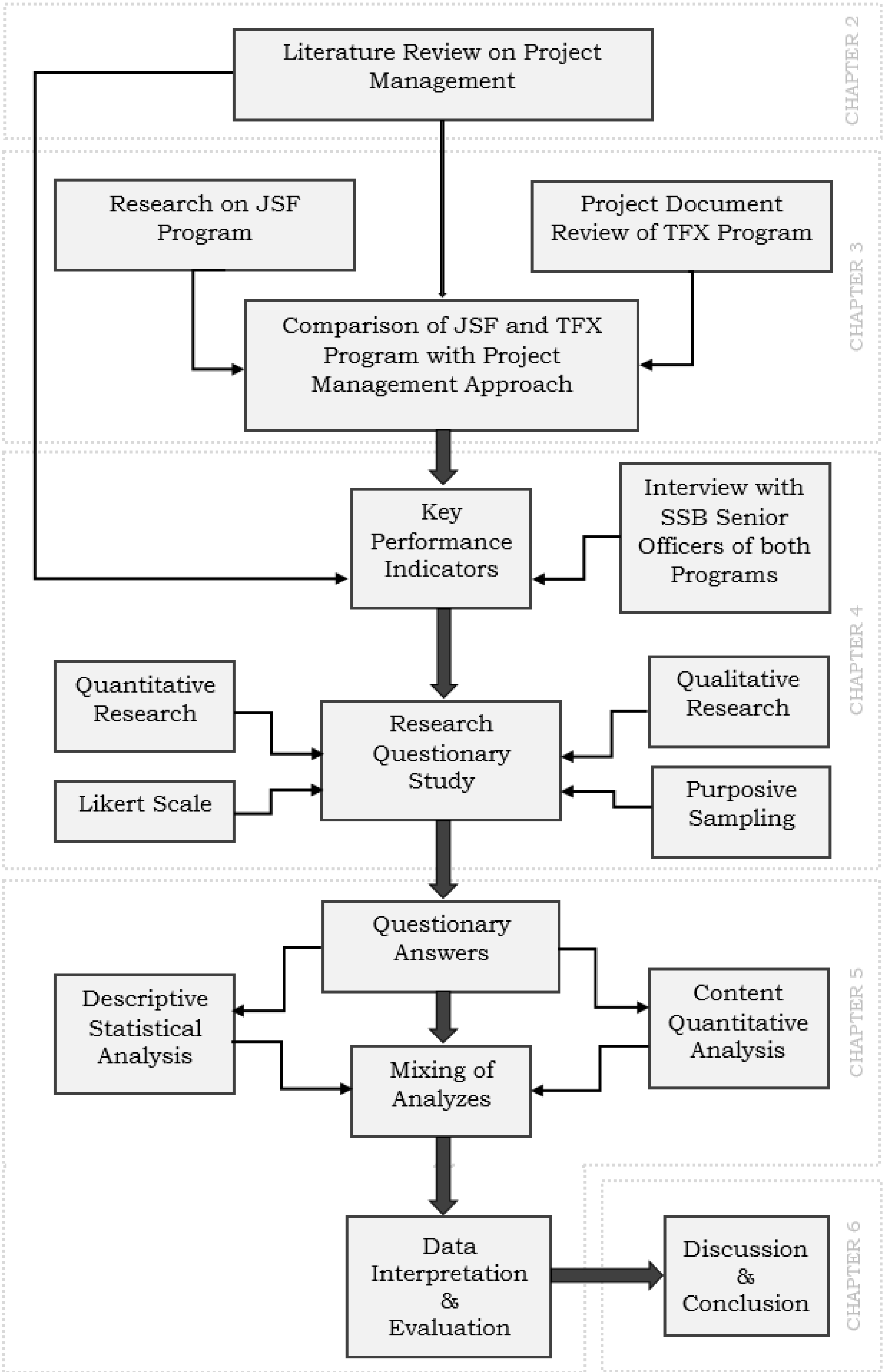


Figure 1: The Structure of Study

1.3.2. Research Methods

The quantitative and qualitative research methodologies are used together in order to understand the main paradigm of program management and to determine the crucial parameters of each step of development process of JSF Program. Firstly, a set of Key Performance Indicators (KPIs) was prepared by interviewing with the SSB's senior officers and executives in order to understand the JSF Program management clearly.

The KPI set was prepared as the main constituent of this research. Then, a questionnaire study was performed comprising 18+5 (the total is 23) questions. The half of the 18 questions were qualitative type of questions the other ones being quantitative type with Likert Scale. Due to the specific subject of the research, it is needed to make purposive sampling in the small group of sample population. The questionnaire was carried out for 24 personnel who performed and still performs in the JSF Program. The remaining 5 questions are about the character traits of the respondents.

1.3.3. Analysis Methods

The data collected through the survey have been analyzed and interpreted through comparing and incorporating both qualitative and quantitative analysis methods. The answers of the qualitative questions have been analyzed by using the content analysis, being one of the most beneficial data interpretation techniques in the qualitative data analysis method.

The answers of the Likert-Type quantitative questions have been analyzed by using the descriptive statistical analysis method with the Likert scale. The Likert scale composed of 5 levels from “Strongly Agree” to “Strongly Disagree”. According to respondents' choice of answer, a bar chart has been plotted. The plotted bar chart helped us to interpret the qualitative answer clearly.

1.3.4. Limitation of Study

As a partner of JSF Program, there exist three main stakeholders in Turkey which are Presidency of Defense Industries (SSB) as a procurement agency in the government side, Turkish Air Force (TurAF) as a user in the military side and the defense companies as suppliers of JSF Program in the industry side.

All studies have some limitations. No study is fully flawless or involves all possible aspects of the research subject. In this study, I have conducted the questionnaire and interview with the SSB's personnel and put the emphasis particularly on SSB's JSF Program perspective. Therefore, any program management perspective in the military (TurAF) or industry (Turkish Defense Companies) side is the out of scope of this study.

1.4. Discussion

All Joint Strike Fighter Program KPIs are investigated and analyzed in the following chapters. With the help of KPIs approach, the useful and efficient project management practices and methods are revealed.

The above methods and practices are adopted in order to contribute to the management of the National Combat Aircraft Development Program.

CHAPTER 2

LITERATURE REVIEW

In this chapter, it is focused on the project management discipline and the system engineering methodology. Several renowned project management and system engineering approaches and practices are investigated according to the literature.

2.1. Project Management

Before defining of project management, it is needed to describe the notion of 'management'. According to Cambridge Dictionary, the management is the control and organization of something. There are many types of definitions about management, however Drucker's definition included six elements of management (Drucker, 2011) which are;

- Managing the objectives,
- Calculating the risks,
- Making strategic decision,
- Building the integrated team,
- Communicating fast and clearly,
- And seeing the business as a whole.

After Drucker defined the six elements of management in 1950s, many researchers made the re-assessment of his definition. Having said that, these six elements seem to be still valid in the management philosophy.

On the other hand, the project management is a specific type of the management phenomenon. For example, Burke (1999) considers project management to be a specialized management technique, to plan and control projects under a strong single point of responsibility. According to Oisen's (1971) views, which was one of the early attempts on defining project management,

> Project Management is the application of a collection of tools and techniques to direct the use of diverse resources toward the accomplishment of a unique, complex, one-time task within time, cost and quality constraints. Each task requires a particular mix of these tools and techniques structured to fit the task environment and life cycle (from conception to completion) of the task.

Managing a project requires a delicate equilibrium of technical, managerial and administrative aspects considering time, cost, human and other resources, all harmonized together to accomplish the desired goal (Cleland & King, 1988). The British Standard defined project management as:

> The planning, monitoring and control of all aspects of a project and the motivation of all those involved in it to achieve the project objectives on time and to the specified cost, quality and performance (BS 6079, 2000).

A few of researchers consider the project management from a different perspective. For example, Reiss has defined project management as all human activities achieving the pre-determined and clear targets in the constraint of time (Reiss, 1993).

After touching upon several different definitions about project management, the most universal consent of definition was finally made by the Project Management Institute (PMI). PMI defines the project management as an application of knowledge, skills, tools and techniques to project activities to meet the requirements. Project management is accomplished through the use of processes such as; initiating, planning, executing, controlling, and closing with in the binding constraints such as; scope, time, cost, risk and quality and also stakeholders' expectations and demands (PMBOK, 2000).

2.1.1. History of Project Management

Indeed, inventing of project management discipline is not arrogated to any individual sector or industry. The appearance of project management as a discipline is often assumed to lie somewhere in the space programs of the late 1960s and early 1970s (Wallace, 2014). In fact, the beginning of project management goes back earlier than this. The 1950's is generally regarded as the time at which project management arose as a distinct management discipline based on an engineering model (Cleland & King, 1988). The project management has developed by the need to improve project effectivity and complexity through technology using the rational tools.

According to Wallace, who has dated back the project management to old times like Roman and ancient Egyptian times, claims that Roman Roads and Egyptian Pyramids were the large projects, but they were not the complex project. He says that;

> It was not until the Industrial Revolution that there was a significant increase in the complexity of projects as more and more manufacturing processes became industrialized. Project interdependency increased steadily and so the need for a combined planning and control tool increased. The failure of any component from tens of thousands of possibilities could result in disaster (Wallace, 2014).

When the complexity of the project has increased after the second half of twentieth century with the beginning of the space program, the importance of program management as an alone independent discipline has enhanced. It was increased the need of ground rules and assumptions framework for the project management.

In 1969, the Project Management Institute (PMI) was found to develop the standards, research, education, publication and regulations under project management discipline. And then, PMI Board of Directors authorized the development of what has become The Guide to the Project Management Body of Knowledge including the standards and guidelines of practice that are widely used throughout the profession. Nowadays, there are many guide books and standards for project management.

2.1.2. Project versus Program

Before stating what is a project is in more detail, ‘project’ as term is required to be distinguished from ‘program’ in order to understand clearly. Generally, the expression of ‘program management’ and ‘project management’ are used incorrectly and interchangeably, and the program does not have the same meaning as the project.

The program is a set of pre-determined projects targeted to achieve some objectives (Jaafari, 2007). Typically, a program has a longer time-span than any individual project. According to Wallace, programs indeed are not supposed to have any specified end date and may run until a decision is taken to stop or replace them. In many ways the demands of program management are similar to those of project management, only on a larger scale (Wallace, 2014).

2.1.3. Basic Principles of the Project Management

According to Atkinson, the project management principles can be described by the Iron Triangle shown below. He uses the word of ‘quality’ to express the performance of project (Atkinson, 1999). But, the main paradigm of project management is the same with other researchers.

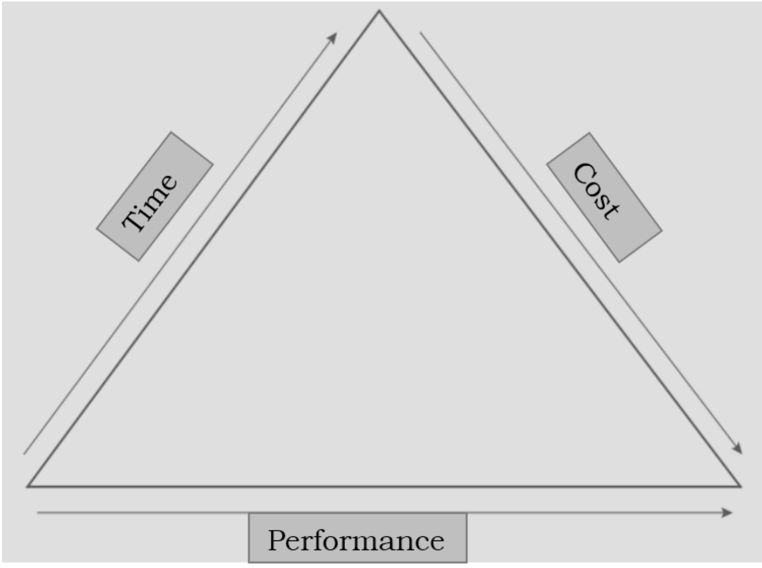


Figure 2: The Iron Triangle of Project Management

The Iron Triangle of Project Management shown in Figure 2 (Atkinson, 1999) is a commonly used practice by project managers to best capture the project status. For example, the shaded area on Figure 3 below (Wallace, 2014) represents the range of acceptable outcomes. The outcomes are defined in the range of which are below the cost limit, below the time limit and above the minimum performance limit.

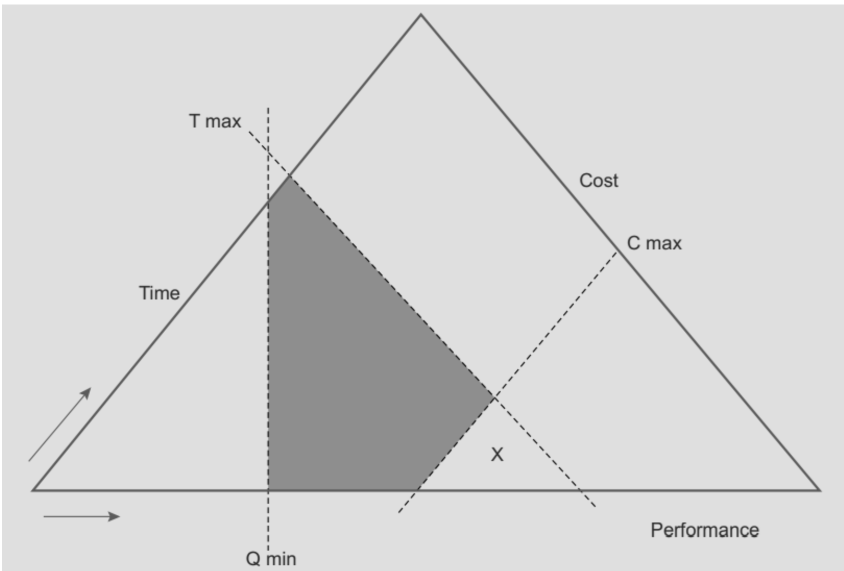


Figure 3: Typical Range of Acceptable Outcomes

There are some trade-offs in all projects between the performance, cost, and the schedule, considering the project priorities (Dvir, Shenhar, & Alkaher, 2003). The range of acceptable outcomes depends on the trade-off perspective of the project manager. Hence, the shaded area of the project may exceed the limit line in some cases. The project manager has to make an optimization in that times by exploiting the project management knowledge areas.

2.1.4. Project Management Knowledge Areas

The project management is divided into ten subsidiary processes by PMI (PMBOK, 2000). All subsidiary processes complement each other. The processes are required to ensure the coordination among the project component. The Figure 4 (PMBOK, 2000) below shows the subsidiary processes of the project management.

Figure 4: Knowledge Areas of Project Management

These ten subsidiary processes shown above have the sub-items. When symbolized the subsidiary processes and their sub-items in the Mind Mapping diagram (Buzan, 2006), it looks like the below structure on Figure 5 (Srinivasan, 2013).

Figure 5: Knowledge Areas Demonstrated in Mind Mapping

Each sub-process feeds the project management similar to blood vessels. Any vascular occlusion in the vessels may cause a heart attack in the project. There is a famous expression about the aviation regulations that “aviation regulations are written in blood”. It is somewhat similar in the project management. All the project management knowledge, process and rules are created due to bad practices applied in the unsuccessful projects.

2.1.5. Project Management in Complex and High-Tech Projects

Project management is a broad activity. It has been focused on the general project management procedures so far. These procedures are accepted as the fundamental applications in project, and they have wide-spread usage in project management organizations pursuing the PMBOK and other standards. However, the projects may change significantly in some aspects like scale, time-span, complexity, industry, customers, and technology. The project orientation may vary from case to case for example; some projects incorporate well-established technologies, while others employ new ones. There are significant differences between projects.

In large and high-tech projects, the project requires a management style that is more diligent and sensitive. These projects can be attached special attention to. Especially, the experimental technological projects involve enormous uncertainties and risks. To manage these types of projects effectively, it is needed to select an appropriate concept and adopt that concept with a right attitude specified in the next.

Considering all the differences between projects, it is recommended to divide the entire spectrum of projects into four categories based on their levels of technological uncertainty. According to Shenhar (1993), the technological uncertainty in the projects ranges from those employing well-established and known technologies to the most sophisticated high technologies. In particular, high-tech projects can be treated with the special interest (Shenhar, 1993); because, the high-tech projects may have a great impact on achieving competitive edge in today's rapidly changing industrial world, if they are well executed and completed successfully (Rosenbloom & Cusumano, 1987).

Shenhar (1993) classified a project according to its complexity level. The Table 1 is shown below.

Table 1: The Four Type Model of Project Classification

Project Type	Level of Technology	Typical Project Examples	Development Work Design Freeze Risk Involved	Managerial Style, Strategy and Attitude Communication Pattern Required
Type-A Low-Tech	No new technology is utilized	Construction Installation, Rebuilding a product. Bridges, Telephones	No development needed. Specifications set before initiation. Limited risks due to weak planning, human errors or "acts of God"	Firm style. Build to 'print.' Stick to the initial plan. Formal communication at predetermined periods.
Type-B Medium Tech	Some new technology is utilized	Additional commercial model. Improvement of a product. Autos, TV	Some development and testing needed. Early design freeze. Additional risks due to the utilization of some new technology.	Moderately firm style. Build to Specs'. Accept some changes. Additional communication needed; some informal interaction.

Table 1: (continued)

Type-C High- Tech	Integration of new, but existing technologies	New military system. New commercial family.	Considerable development, integration and testing. Late design freeze. Additional risks of integrating new technologies for the first time and due to wrong tradeoff decisions.	Moderately flexible style. Build to state of-the-art. Expect many changes. High levels of communication needed - multiple channels; extensive informal interaction.
		F-16, First VCR, Macintosh.		
Type-D Super High-Tech	Key technologies do not exist at project's initiation	New system concept.	Enormous development work needed. Very late design freeze. Extensive risks in unknown technologies and integration.	Flexible style. Build to advanced need. Live with continuous change and 'look for trouble.' Enormous levels of communication are essential - must enhance
		Sidewinder, SR-71, Eagle computer		

Source: Shenhar, A. J. (1993, 3 23). From Low to High-Tech Project Management. *R&D Management*, pp. 199-214.

According to Shenhar's classification, the communication is basically maintained in each of the project types at least at a minimal level. However, this level gradually increases with the level of technological uncertainty.

A-types of projects are classified as low-tech projects; and, they have the lowest level of uncertainty shown on the table. Their main managerial factors are planning and coordination. The more careful and exact the planning is, the higher the chances are to be completed on time, with a limited budget. Success in these projects is assessed by how low the cost was and how closely the project was finished according to schedule. The technological level increases gradually from type-A to the type-D. The aerospace and defense projects are classified as D-type of project due to having high technology.

In this study, the Joint Strike Fighter (JSF) Program and the National Combat Aircraft Development (TFX) Program will be analyzed as D-type projects; because, both JSF and TFX Program have the internalization of somehow new, state-of-the-art technologies. D-Type of projects crate the difference in the sequential technology steps. They offer more areas for trade-offs with having additional risks; therefore, the total amount of uncertainties increases substantially in these types of projects. Shenhar says;

> To manage a D type project effectively, one needs a very wide range of managerial capabilities, skills and tools. There is a need to manage long periods of uncertainty, maintain open, and for most of the time, flexible specifications, and continuously cope with undefined technologies and enormous tradeoffs. Managers of such projects should be aware that problems and difficulties are commonplace in D type projects and they should therefore continuously 'look for trouble' (Shenhar, 1993).

As seen on the Table-1, there are significant differences between managing type-D and other type of projects. Any failing to realize these differences may result in unimaginable issues. The fact that additional flexibility is needed in type-D projects is just one of these differences. However, the extra flexibility in handling these projects may cause some ambiguities over a long period of time and this is another challenge to tackle. For this reason, project flexibility has to be carefully defined within the limits.

In addition, the staff working on both JSF and TFX programs are usually scientists or senior engineers with a high level of expertise in their fields (Etzkowitz, 1983). Therefore, the project manager can face additional difficulties of managing these professionals as well as communicating with them, motivating them and, most importantly, coordinating their efforts, and balancing the right trade-offs among different disciplines (Katz, 1988). Project managers monitor the communication of the project people more carefully and introspectively, according to the required volume or frequency (Bart, 1993).

After all the considerations above to summarize, the high-level technological projects are required to be managed like new-born babies, with special attention, care and extra scrutiny.

2.2. System Engineering in Projects

The definitions, principles, classifications and applications of the project management are stated so far. In this part, it is emphasized the product development in projects with the system engineering approach.

The primary meaning of systems engineering is the design of a system defined by a program's requirements or operational needs within the available resources. It is a disciplined learning process that translates capability requirements into specific design features and thus identifies key risks to be resolved. In addition, system engineering can be defined as a logical sequence of activities and decisions converting the operational needs into the description of system design within a preferred system configuration (DAU, 2001). The International Consul of System Engineering defines the systems engineering as a transdisciplinary, integrative and iterative approach to make successful engineered systems by using systems principles and concepts, and scientific, technological, and management methods (INCOSE, 2019).

According to Defense Acquisition Guidebook established the rules and principles of system engineering;

> The systems engineering is a methodical and disciplined approach for the specification, design, development, realization, technical management, operations and retirement of a system. Systems engineering applies critical thinking to the acquisition of a capability. It is a holistic, integrative discipline, whereby the contributions occur across engineering disciplines (Defense Acquisition Guidebook, 2010).

For the product development, the system engineer exactly does what project manager does for the project management. There is a similarity between the system engineering and project management in terms of handling the problems and mitigating the risks.

To develop a seamless engineered system without encountering any significant problem, it is needed to validate the system performance by analyzing the logical interactions between the system components. Therefore, the system engineering includes many subsidiary processes as shown below in Figure 6 (Microgenesis, 2019).

Figure 6: System Engineering Processes

There are many subsidiary processes in the system engineering life cycle; however, in this thesis, it is only focused on the design phase of system engineering. The definition of two levels about design phases is explained below.

The most critical phase in system engineering is the design phase. Design phases are considered the core of product development. There is not a formal agreed definition for level of design among researchers. Nevertheless, most commonly, two main terms about the design levels of system are described; preliminary design phase and critical design phase.

2.2.1. Preliminary Design Phase in System Engineering

The Preliminary Design Phase (PDP) provides enough confidence to continue with detailed design. In Preliminary Design Phase, it is ensured that the preliminary design and basic system structure are completed within cost and schedule goals so, there is technical confidence in the ability.

According to Military Standards, the PDP is the best time to evaluate the progress, technical adequacy, and risk resolution of the selected design approach and assess the degree of definition of technical risk associated with the selected manufacturing methods/processes (MIL-STD-1521B, 1985).

The space envelope for all sub-components are described, with preferably a high-level design for each sub-component; but, the full design of system components is not required at this stage.

2.2.2. Critical Design Phase in System Engineering

The Critical Design Phase (CDP) confirms the system design is stable and is expected to meet system performance requirements. The CDP ensures that the system is on track to achieve affordability, and it establishes the detailed design documentation for the initial product baseline. (Defense Acquisition Guidebook, 2010).

Another function of Critical Design is to describe in full detail how the system will be built and what the final hurdle which needs to be overcome before construction has started is. The critical design phase is the time to assess the results of the productivity analyses conducted on system hardware, and review the preliminary hardware product specifications (MIL-STD-1521B, 1985).

2.3. Project Management and System Engineering in High-Tech Projects

The uncertainties always exist in all types of projects but especially, in the high technological projects called type-D, the level of uncertainty is considerably high, due to having the high-technological system.

The high technology systems generally involve many sub-systems. When the number of sub-systems goes up arithmetically, the number of interactions between the systems increases exponentially. As expected, this is just a basic rule of mathematics. Consequently, the high technology systems have more uncertainty and complexity than ordinary ones. This situation gives rise to risks in projects. For example, the initial misconception regarding a product, whose integration process is successfully completed at the laboratory, can cause project staffs and executives to believe that the risks are lower than they actually are.

On the other hand, some risks appear only when a product implementation starts on the actual platform. When the problems start to accumulate, new measures have to be taken in order to control and mitigate the associated risks. In order to mitigate the risk in this type of systems and projects, Dvir *et. al.* (2003) have set a model as named UCP and they have shown the risk vectors analytically as the combination of uncertainty, complexity and pace of the project.

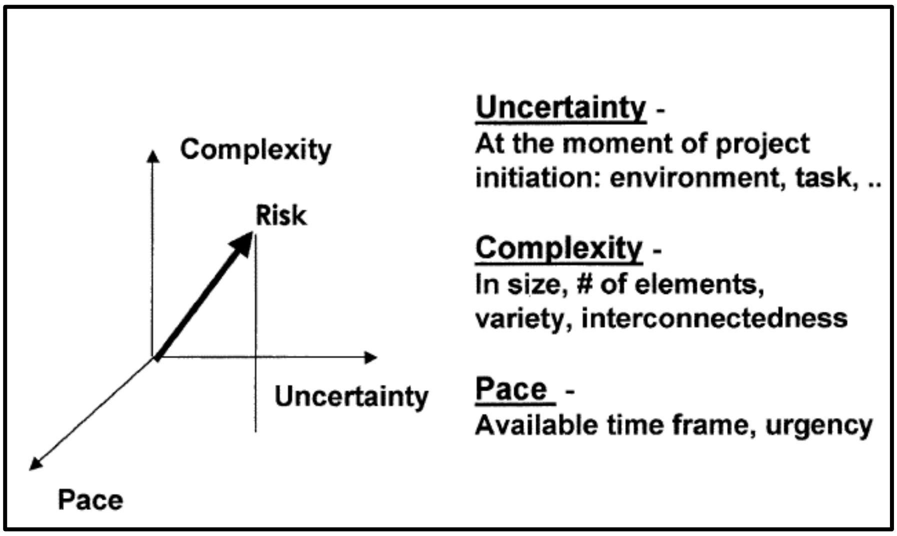


Figure 7: Uncertainty, Pace and Complexity Vector

The risk vector and its components are shown in Figure 7 above (Dvir, Shenhar, & Alkaher, 2003). In type-D projects having high technological systems, following actions required to mitigate the risks;

- it is needed to maintain an extensive level of communication among the project managers and system engineers, much of this in a casual and informal way (Shenhar & Bonen, 1997).
- it is needed to give extra ample time to the project managers and system engineers so that,
    - the system engineer allocates the system engineering activities,
    - the project manager makes the corrective actions when required without slippage in schedule and without unnecessary pressures on the development team (Dvir, Shenhar, & Alkaher, 2003).

2.4. Summary of Chapter

In this chapter, it is focused on the project management and system engineering methodology in the projects. Several renowned project Management and system engineering approaches and practices are investigated according to the literature. The project types are classified according to their level technology. It is emphasized that the aerospace and defense projects are grouped as type-D projects. Therefore, it is expressed that the development of high technological projects requires unique system engineering skills and a thorough understanding of the system's complexity, technological uncertainty, and scope. Furthermore, the risk is modeled with its components which are the uncertainty, pace and complexity.

There exists a system life cycle in system engineering approach; similarly, the project life cycle exists in project management approach. As a result, there is a similarity between the system engineering and project management in terms of handling the problems and mitigating the risks. For the product development, the system engineer exactly does what project manager does for the project management. Therefore, both project managers and systems engineers aim to balance the conflict of constraints among the cost, schedule, and performance while manipulating an acceptable level of risk. Both of them are designed to solve problems using a multidiscipline approach. The similarity between two concepts is impressive.

All mentioned above is used to analyze the Joint Strike Fighter and the National Combat Aircraft Development Program in terms of project management approach in the following chapters.

CHAPTER 3

FIGHTER PROGRAMS

The JSF Program and TFX Program are explained respectively and detailly in this chapter, and it is stated the comparability of both programs. After constituting the comparable fields of both programs, the JSF Program is easily used as a case study for the TFX Program in the next chapter.

3.1. Joint Strike Fighter Program

After the first Gulf War, United States Department of Defense (US DoD) change its warfare paradigm. The new warfare paradigm is composed of two types of essential concepts which were Network Centric Warfare and Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (Ruhlman, 2000) abbreviated as NCW and C4ISR. And then, a new program model for designing a new generation aircraft was thought about and in early stages of 1990s, the F-35 aircraft was envisaged by US DoD within a new program model later on will be named as the Joint Strike Fighter Program.

The F-35 aircraft was designed taking into account both NCW and C4ISR; and, it was developed in conformity with the four pillars: affordability, lethality, survivability and supportability (Counts, Kiger, Hoffschwelle, Houtman, & Henderson, 2018). It was created to meet the demand of an affordable, multirole, multi-service, multi-national fighter aircraft.

3.1.1. History of Joint Strike Fighter Program

Since the end of 1980s, the assumptions in defense planning of United States had been changed significantly. The F-22 program was initiated largely to deal with the continued numerical inferiority and to counter two new Soviet fighters. With the demise of the Soviet threat in addition to political and financial difficulties within the independent Russian states, the threat initially caused the design of F-22 to change substantially (Rodrigues, 1994).

The F-22, as a fighter aircraft, has no capability to operate from the carriers. The fighter aircraft designed and procured for land-based operations; in addition, it has not been successfully converted to be capable of operating from the aircraft carriers (Davis, 1997). Despite these unaligned capabilities, DoD planned to replace its F-15s with F-22 fighters; but at the same time DoD has intend to develop multi-role fighter.

In October 1993, the US DoD presented the results of its "bottom-up review" and concluded that its goal was to develop a common combat aircraft whose components were same or close to same. Indeed, the US DoD's aircraft commonality target was 80 percent. That is why the US started the joint advance strike aircraft technology program (Rodrigues, 1994). The US DoD's effort to make common components for the common use among the services, but still, the F-22 appeared to be included in this initiative. Therefore, it can be stated that F-22 seems as a pioneer of the F-35 (Evans & Gibbons, 2008). Furthermore, the JSF Program has been already started with a bang. Glathar stated in his thesis that;

> Joint Advanced Strike Technology (JAST) effort created by DoD for affordable development of the next-generation strike weapons system. A short Concept Exploration phase kicked off the technology studies. After a review of the program in August 1995, Department of Defense (DoD) changed the program name to JSF (Glathar, 2005).

In March 1996, a Request for Proposal (RFP) was released. Boeing and Lockheed Martin started to compete for the Concept Demonstration Aircraft.

Both companies have designed and built aircraft to prove their concepts and to reduce development risks. The photos of Boeing's X-32 are shown in Figure 8 (Counts, Kiger, Hoffschwelle, Houtman, & Henderson, 2018).

Figure 8: Boeing's Aircraft X-32 (the left photo is illustrated and the right is real aircraft)

On October 26, 2001, the US DoD announced that Lockheed Martin's X-35 won the Joint Strike Fighter contest over Boeing's X-32 and selected the LM Company as contractor for the JSF Program (Rogoway, 2018).

3.1.2. Joint Strike Fighter Program from Turkey's Perspective

In the JSF Program, there are three US Services, eight Partner Nations and four Foreign Military Sales (FMS) countries. Their aircraft number and F-35 variants are indicated on Figure 9 (Nelson & Friedman, 2019) below.

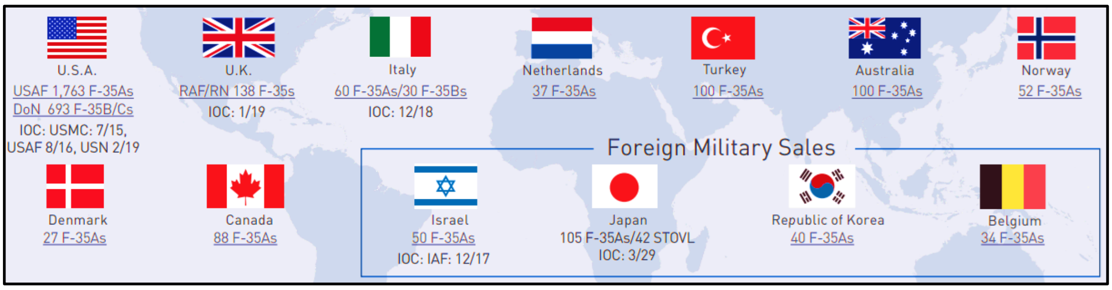


Figure 9: The JSF Program Partners and FMS Countries

Three F-35 variants were developed which are the conventional take-off (F-35A), the short take-off and vertical landing (F-35B) and the carrier version (F-35C). Turkey, the US Air Force and some of the partners plans to procure F-35As. All variants are shown in Figure 10 (Counts, Kiger, Hoffschwelle, Houtman, & Henderson, 2018).

Figure 10: The three F-35 variants: F-35C (left), F-35B (center) and F-35A (right)

Turkey participated the JSF Program on June 16, 1999 with a Letter of Acceptance and became a member of Concept Development Phase. Turkey's participation got strong with the sign of Memorandum of Understanding (MOU) for the System Development and Demonstration (SDD) phase in July 11, 2002 (TBMM Law No.5425, 2005).

After the signature of SDD MoU, Presidency of Defense Industries (SSB) initiated a feasibility study regarding Turkish defense companies. Within this time frame, SSB examined and assessed various defense companies based on certain criteria and concluded that they had sufficient capability in order to produce the F-35 components. After that, Turkey convinced the US Government in order for Turkish companies to produce some parts of F-35.

While the development F-35 was still in progress, the Production, Sustainment, and Follow-On Development Memorandum of Understanding was signed by Turkey on January 25, 2007 with all partnering countries and US. Accordingly, Turkey became the third level partner or the informed partner of the JSF Program (TBMM Law No.5764, 2008). After the United Kingdom who declared that it had plans to procure 134 F-35 aircraft, Turkey became the second biggest procuring partner who declared its intention to procure F-35 aircraft. In Figure 11, the delivery of the first F-35A to Turkey in June 2018 is shown (Leone, 2018).

Figure 11: The First Turkish F-35

By September 2019, Turkey is a part of F-35 production supply chain (Nelson & Friedman, 2019). According to The Presidency of Republic of Turkey Investment Office Report (2018), Turkish companies supporting the development and/or production of JSF Program as follow:

- **Alp Aviation** has been supporting the program since 2004 and currently manufactures F-35 production airframe structure and assemblies,
- **Ayesas** currently is the sole source supplier for two major F-35 components which are missile remote interface unit and the panoramic cockpit display,
- **Havelsan** has been supporting the F-35 training systems since 2005,
- **Kale Aerospace** has been supporting the F-35 since 2005. In conjunction with Turkish Aerospace Industries, they manufacture and produce F-35 airframe structures and assemblies,

- **Roketsan** and **TUBITAK-SAGE** are the Turkish joint leadership team who strategically manage the development, integration, and production of the advanced precision-guided Stand-off Missile (SOM) which will be carried internally on the 5th Generation F-35 aircraft. Additionally, Lockheed Martin Missiles and Fire Control has partnered with Roketsan, through a teaming agreement, to jointly develop, produce, market and sell the advanced, precision guided JSF Stand-off Missile (SOM-J),
- **Turkish Aerospace Industries (TAI)** has been strategically supporting the F-35 Program since 2008. The company currently supplies production hardware that goes into every F-35 production aircraft. TAI manufactures and assembles the center fuselages, produces composite skins and weapon bay doors, and manufactures fiber placement composite air inlet ducts (Investment Office Report, 2018).

3.1.3. Project Management in Joint Strike Fighter Program

The F-35 has been the largest US DoD acquisition program, and is uniquely structured to manage the size, scope, and international aspects of the program. For this reason, it was required to establish a specific program management office named “JSF Program Office” (Gertler, 2018). The JSF Program Office (JPO) is jointly staffed and managed by the US Air Force and the US Navy (Bolkcom, 2009).

The JPO manages the design, development, production, and sustainment of the JSF Program on behalf of US Services, eight partner countries, and a growing number of FMS countries around the globe. The JPO collects requirements from users and prioritizes those requirements in coordination with users. It also manages all contracting activities in order to meet the requirements defined by all these groups, and monitors F-35 fighter performance accordingly (PSFD MOU, 2007).

As stated in the previous chapter, there are three basic components of the project management shown as the Iron Triangle, which being the cost, time and performance/quality (Atkinson, 1999). All components of the project management in the JSF Program will be analyzed in accordance with Atkinson's paper.

3.1.3.1. Cost Management in Joint Strike Fighter Program

The US DoD stated that "The Joint Strike Fighter Program is the largest acquisition program in the world. In terms of US DoD, with total acquisition costs are expected to exceed $406 billion dollars." Currently, US DoD plans to acquire a total of 2,470 aircraft through fiscal year 2044 (GAO Report, 2019).United States Government Accountability Office (2019) reported that

> Since the development program began in 2001, the cost and schedule estimation has been revised three times. The most recent restructuring was initiated in 2010 when the program's cost estimates exceeded certain thresholds established by Joint Program Office. In addition, the program's sustainment costs to operate and maintain the F-35 fleet over the next 52 years are estimated to be $1.12 trillion. (GAO Report, 2019).

The aircraft numbers and their cost through the years is shown on Table 2 below (GAO Report, 2019).

Table 2: JSF Program Cost and Quantity, 2001-2017

CATEGORIES	2001	2012	2017
Developmental Aircraft	14	14	14
Procurement Aircraft	2852	2443	2456
Total Aircraft	2886	2457	2470
Total Cost for Development	34.4 B$	55.2 B$	55.5 B$

Table 2: (continued)

Total Cost for Procurement	196.6 B$	335.7 B$	345.4 B$
Total Cost estimates for Military Construction	2.0 B$	4.8 B$	5.3 B$
Total Program Acquisition Cost	233.0 B$	395.7 B$	406.1 B$

Source: GAO Report (2019, 4 25). F-35 Aircraft Sustainment: DOD Needs to Address Substantial Supply Chain Challenges. *United States Government Accountability Office Report, GAO-19-321*, pp. 3-33.

The Low Rate Initial Production Contract-11 (Lot/LRIP-11) has been recently signed between the JSF Program Office and the main contractor Lockheed Martin. According to Lot-11 contract, 131 aircraft will be manufactured by Lockheed Martin and the unit price of F-35 aircraft will be in between 89 and 108 million dollars (Nelson & Friedman, 2019) as shown in Figure 12.

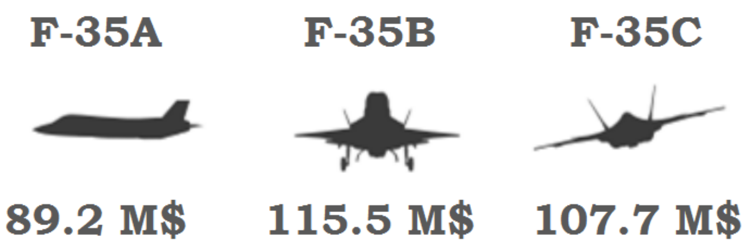


Figure 12: Unit Price of F-35 for Lot-11 Contract

However, it is estimated that the price of the F-35s will decrease in future contracts. The estimated prices are shown below Table 3 (Nelson, 2019).

Table 3: Estimated Unit Price of F-35 in Lot 12-14 Contracts

F-35	Lot/LRIP 12	Lot/LRIP 13	Lot/LRIP 14	% Reduction from Lot/LRIP 11
F-35 A	82.4 M$	79.2 M$	77.9 M$	%12.8
F-35 B	108.0 M$	104.8 M$	101.3 M$	%12.3
F-35 C	103.1 M$	98.1 M$	94.4 M$	%13.4

Source: Nelson, C. (2019, 11 7). *F-35 Lightning II Program Status and Fast Facts.* F-35 Lightning II Program Status and Fast Facts, pp. 1-2.

The F-35 was both developed and produced at the same time. For this reason, the cost planning and controlling are very difficult for JSF Program Office (JPO). However, the unit cost has started to decrease recently. According to Lockheed Martin's Report (2019), the cost reduction is greater than 70% since Lot-1 contract (Nelson, 2019). This shows that production learning curve shifts to bottom and causes to decrease in unit price.

3.1.3.2. Time Management in Joint Strike Fighter Program

Like some other aviation procurement programs, the JSF has experienced cost growth, schedule slippage, and a reduction in the production rates. To better understand the time management, it is needed to divide the project time into the development and production schedules.

3.1.3.2.1. Development Schedule

The JSF Program milestones has started with the Concept Development in November 1996. From 1999 through 2001, it continued the evolution to a fully integrated program with executed the Concept Demonstration Phase (CDP) of JSF Program.

In October 2001, the US DoD held the Milestone B review. The JSF Program has successfully demonstrated the sufficient technical maturity to complete the concept demonstration phase. Just after, the US DoD has selected Lockheed Martin as main contractor, and with SDD contracts awarded, the JSF Program entered the system development and demonstration phase. All millstones are shown in Figure 13 below (Bolkcom, 2009).

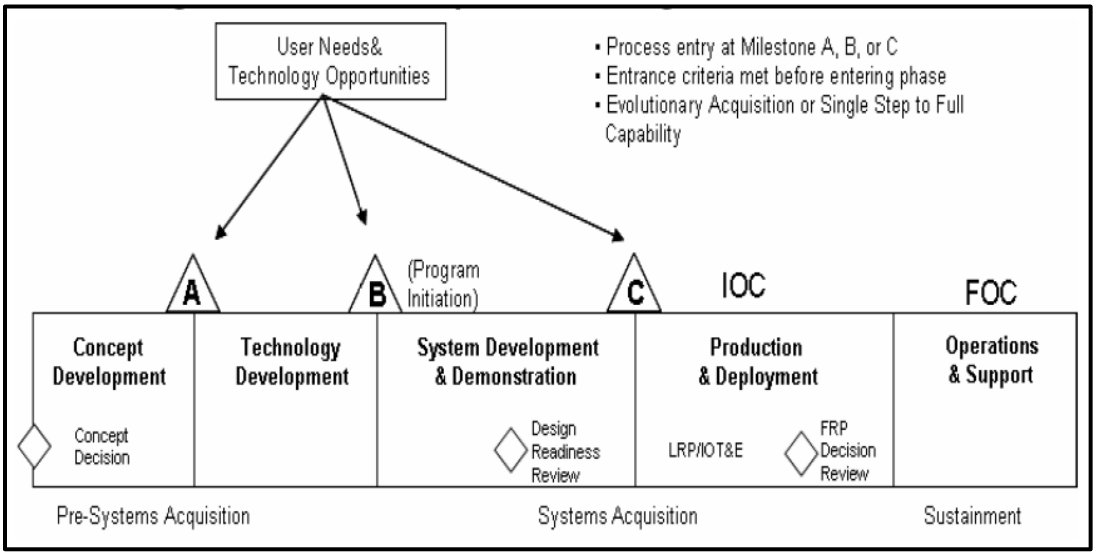


Figure 13: Milestones of JSF Program

A Preliminary Design Review (PDR) for the JSF Program was conducted in April 2003. The Critical Design Reviews (CDR) were held in February 2006 for F-35A and F-35B but for F-35C held in June 2007. The schedule for first flight is shown in Table 4 (Gertler, 2018) below.

Table 4: First Flights Dates of F-35

F-35	First Flown
F-35 A	December 15, 2006
F-35 B	June 11, 2008 First Hover: March 17, 2010
F-35 C	June 6, 2010

Source: Gertler, J. (2018, 4 23). F-35 Joint Strike Fighter Program. *Congressional Research Service Report for Congress*, pp. 1-29.

The JSF Program's SDD phase did not complete in planned time. After 17-years, SDD efforts completed in April 2018. The developmental flight team has executed more than 9,200 sorties, accumulated 17,000 flight (Gertler, 2018). But still, the end of the flight test effort does not mark the actual end of SDD, though; that will occur at Milestone C, following the completion of Initial Operational Test and Evaluation (IOT&E).

3.1.3.2.2. Production Schedule

After the CDR for the F-35A and F-35B variants were completed in February 2006, the US DoD approved to start the work on Low Rate Initial Production (LRIP) in March 2006. However, the beginning of low-rate initial production shifted from 2006 to 2007.

In 2007, the Production Sustainment and Follow on Development (PSFD) Memorandum of Understanding (MOU) was signed among the partner countries and US Services (PSFD MOU, 2007). After the signature of the PSFD MOU, the low rate serial production of F-35s has started.

It has been delivered a total of 455+ aircraft to the users by September 2019. And it will deliver more aircraft year by year. The delivery planning of F-35s is shown in Figure 14 (Nelson & Friedman, 2019).

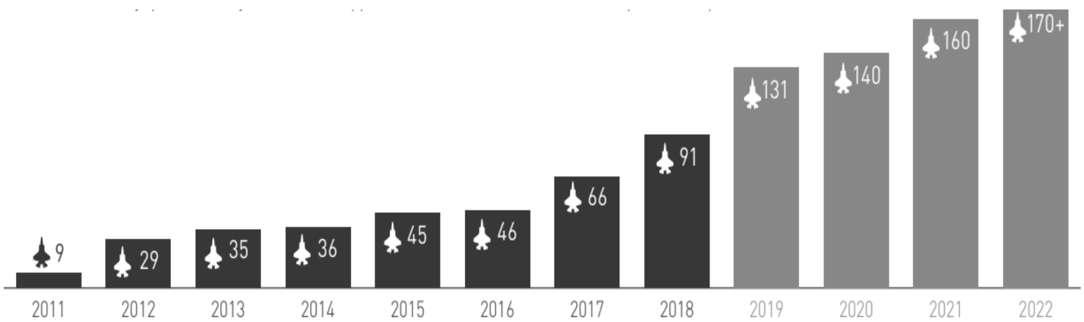


Figure 14: F-35 Production Extending up to 2022

3.1.3.3. Performance Management in Joint Strike Fighter Program

Performance management can be considered in two points. The first is the performance of the JSF Program and the second is the performance of the F-35 fighter aircraft.

3.1.3.3.1. Performance of the Joint Strike Fighter Program

The JSF Program managed by the Joint Program Office (JPO). The JSF Program Office reflects the users' commitment to make the changes required. The JPO provides a strategic focus on affordability at the top. And then, it concentrates to develop and refine a sound basis for the JSF Program execution. This provides faster feedback, reduce development cycle time, and enable an environment for improved fighter concepts.

The JPO tries to achieve the new paradigm named as 'agile management', which is mentioned at previous part of this chapter, in program management. This new paradigm manifest itself in the production rate number. Table 5 (GAO Report, 2018) shows improvements of the capability in production metrics in terms of the labor hour since 2012 and over the past year. These improvements in airframe manufacturing efficiency indicate that manufacturing processes are stabilizing and coming under control.

The JSF Program leverages the existing military and industrial national defense capabilities throughout the entire supply chain to maximize the effectiveness.

Table 5: F-35 Airframe in 2012, 2016, and 2017 Deliveries and Labor Hours

Average Labour Hours	**2012**	**2016**	**2017**
Average labor hours per F-35A delivered	108 355	47 269	41 541
Average labor hours per F-35B delivered	107 998	61 928	57 152
Average labor hours per F-35C delivered	0	65 187	60 121

Source: GAO Report. (2018, 6 13). Development Is Nearly Complete, but Deficiencies Found in Testing Need to Be Resolved. *United States Government Accountability Office Report, GAO-18-321*, pp. 4-19.

The JPO also embraces the 'block approach strategy'. The block approach is a type of incremental advance in the program management and is defined detailly in the following chapters. The F-35 has been developed using a building block approach, with each block providing low level of risk, solid foundation for the next (Gertler, 2018). In production phase, the aircraft is still manufactured as "Lot by Lot" by making the Lot Contracts. This is considered as block approach strategy in the production phase of JSF Program.

3.1.3.3.2. Performance of F-35 Product

According to JPO perspective, each variant of F-35 has developed in line with the necessity of handling the differing requirements. The F-35's key capabilities include low-observable, or stealth technology combined with advanced sensors and computer networking capabilities (GAO Report, 2019). The F-35 is not as stealthy nor as capable in air-to- air combat as the F-22, but it is designed to be more capable in air-to-ground combat than the F22, and stealthier than the F 16 (Perrett, 2009).

The F-35 was developed as three variants. The Conventional Take-Off and Landing (CTOL) variant is called F-35A. Turkey, the US Air Force and some of the partners plans to procure F-35As. F-35As has been planned to replace F-16 fighters and A-10 attack aircraft and possibly F-15 fighters in US Air Force (Trimble, 2019). The F-35A is intended to be a more affordable complement to the Air Force's F-22 Raptor air superiority fighter (Gertler, 2013). Below, Table 6 (Nelson & Friedman, 2019) shows the technical performance of all variants of F-35:

Table 6: The Specifications of F-35A, F-35B and F-35C

F-35 Lightning II Specs	F-35A	F-35B	F-35C
Length	51.4 ft / 15.7 m	51.2 ft / 15.6 m	51.5 ft / 15.7 m
Height	14.4 ft / 4.38 m	14.3 ft / 4.36 m	14.7 ft / 4.48 m
Wingspan	35 ft / 10.7 m	35 ft / 10.7 m	43 ft / 13.1 m
Wing area	460 ft2 / 42.7 m2	460 ft2 / 42.7 m2	668 ft2 / 62.1 m2
Horizontal tail span	22.5 ft / 6.86 m	21.8 ft / 6.65 m	26.3 ft / 8.02 m
Weight empty	29,300 lb	32,300 lb	34,800 lb
Internal fuel capacity	18,250 lb / 8278 kg	13,500 lb / 6,125 kg	19,750 lb / 8,960kg
Weapons payload	18,000 lb / 8,160 kg	15,000 lb / 6,800kg	18,000 lb / 8,160 kg
Standard internal weapons load	• 25 mm GAU-22/A cannon • Two AIM-120C/D air-to-air missiles • Two 2,000-pound GBU-31 JDAM guided bombs	• Two AIM-120C/D air-to-air missiles • Two 1,000-pound GBU-32 JDAM guided bombs	• Two AIM-120C/D air-to-air missiles • Two 2,000-pound GBU-31 JDAM guided bombs
Maximum weight	70,000 lb class	60,000 lb class	70,000 lb class
Propulsion* (uninstalled thrust ratings)	F135-PW-100 40,000 lb Max. 25,000 lb Mil. Vertical N/A	F135-PW-600 40,000 lb Max. 25,000 lb Mil. 40,500 lb Vertical	F135-PW-100 40,000 lb Max. 25,000 lb Mil. Vertical N/A
Speed (full internal weapons load)	Mach 1.6 (~1,200 mph)	Mach 1.6 (~1,200 mph)	Mach 1.6 (~1,200 mph)
Combat radius (internal fuel)	>590 nm / 1,093 km (USAF profile)	>450 nm / 833 km (USMC profile)	>600 nm / 1,100 km (USN profile)
Range (internal fuel)	>1,200 nm / 2,200 km (USAF profile)	>900 nm / 1,667 km (USMC profile)	>1,200 nm / 2,200 km (USN profile)
Max g-rating	9.0	7.0	7.5

Source: Nelson, C., & Friedman, M. (2019, 4 17). F-35 Lightning II Program Status and Fast Facts. *F-35 Lightning II Fast Facts*, pp. 1-2.

The Short Takeoff and Vertical Landing (STOVL) variant is called F-35B. The UK and US Marine Corps plans to procure F-35Bs. It is intended to support the concept of marine air ground task force. And, the Carrier-Suitable CTOL (CV) variant is called F-35C. The F-35C known as Carrier Variant is the naval designation for aircraft carrier (Gertler, 2009). Only the US Navy and Marines plans to procure F-35Cs.

As mentioned above, the F-35 has the Network Centric Warfare (NCW) capability. The NCW was stated in 1996 when Admiral William Owens introduced the concept of a "System of Systems" in a paper published by the Institute for the National Security Studies (Owens, 1996). Beyond being a fighter aircraft, the F-35 was designed as a flying 'electronic battle platform' combining all these features and it was called the fifth-generation aircraft (Gruetzmacher, 2003). According to Frey et.al. (2008),

> The F-35 fusion technology is the software module at the heart of the integrated mission systems capability on the aircraft. Fusion involves constructing an integrated description and interpretation of the tactical situation surrounding ownship. (Frey, Aguilar, Engebretson, Faulk, & Lenning, 2018).

The mission technology of F-35 is designed as a fifth-generation aircraft concept (Cahoon, 2019). The prominent features (Lemons, Carrington, Frey, & Ledyard, 2018) (Calvello, Olin, Hess, & Frith, 2007) of F-35 are shown in Table 7.

Table 7: Prominent Features of F-35 Aircraft

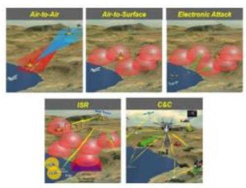
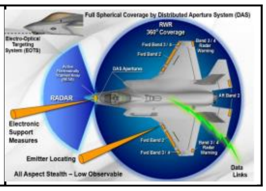
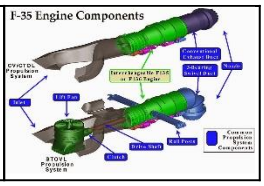
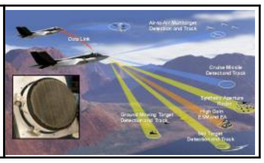
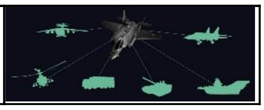
Air to Air Air to Ground Electronic Battle, Intelligence, Surveillance and Reconnaissance Command & Control	

Table 7 (continued)

Stealth	
Vertical Landing Propulsion System	
Active Electronically Scanned Array Radar	
Electro-Optical Distributed Aperture System Electro-Optical Targeting Sensor	
Network-centric warfare with Communications, Navigation, Identification System	
Electronic Warfare	
Next-Generation Cockpit	
Autonomic Logistics Information System	

Source-1: Lemons, G., Carrington, K., Frey, D. T., & Ledyard, J. (2018). F-35 Mission Systems Design, Development, and Verification. *Aviation Technology, Integration, and Operations Conference* (pp. 4-10). Atlanta, Georgia: AIAA AVIATION Forum.

Source-2: Calvello, G., Olin, S., Hess, A., & Frith, P. (2007, April 11). PHM and Corrosion Control on the Joint Strike Fighter. *Corrosion Reviews*, pp. 51-80.

3.2. National Combat Aircraft Development Program [2]

The aim of National Combat Aircraft Development Program also named as Turkish Fighter Development Program (TFX) is to have an indigenous fighter aircraft that befits Turkey's dignity and compete with the world in order to reach the operational sovereignty of Turkey. The mission of TFX Program is to develop and produce an indigenous fifth-generation fighter aircraft using national capabilities and providing necessary technological developments to meet Turkey's defense requirements (SSB, 2019).

3.2.1. History of National Combat Aircraft Development Program

The history of the TFX Program extends to Defense Industries Executive Committee (DIEC) Decision in December 2010 (Akşam, 2010). The summary of program history is shown below Table 8 (SSB Official Record, 2019).

Table 8: Milestones of TFX Program

Date	Events Occurred
15.12.2010	DIEC Decision: Conceptual Design of TFX
29.09.2011	Start of Conceptual Design Phase of TFX
29.09.2013	End of Conceptual Design Phase of TFX
07.01.2015	DIEC Decision: Commencement of Turkish Fighter Development Program; Phase-I, Stage-I
27.04.2015	DIEC Decision: Turkish Aerospace announced as Main Contractor for Phase-I, Stage-I
05.08.2016	Phase-I, Stage-I Contract Signature between SSB and Turkish Aerospace

Source: SSB Official Record. (2019). The National Combat Aircraft Development Program. Ankara: Presidency of Defence Industries.

[2] All information about the Turkish Fighter Program was written as "Unclassified Level".

As per DIEC decision dated 27 April 2015, Turkish Aerospace (TAI) has been assigned as main contractor against SSB for the execution of Phase-I, Stage-I. Contract was signed between SSB and Turkish Aerospace on 5 August 2016 (TAI, 2019).

3.2.2. Overview on National Combat Aircraft Development Program

The National Combat Aircraft Development Program includes design, development, production and qualification of indigenous fighter where SSB aims to acquire a fighter aircraft that fulfills Turkish Air Force (TurAF) operational needs beyond 2030s (Hurriyet, 2013). The TFX fighter aircraft is expected to be operational in the TurAF inventory until 2070s and operable with other critical assets of TurAF (TAI, 2019).

Figure 15: TFX Fighter Aircraft Mock-up in Paris Air Show

In Figure 15 below, the first TFX aircraft mock-up was demonstrated in Paris Air Show in June 17, 2019 (Anadolu Agency, 2019).

3.2.3. Project Management in National Combat Aircraft Development Program

SSB is responsible for the overall TFX Program management, like JPO in the JSF Program. TurAF is the end-user of the TFX fighter aircraft. SSB and main contractor TAI work in harmony in order to drive TFX Program towards a common goal of delivering the most effective and affordable product. SSB assumes a level of independent observation/analysis role through the participation in design and development phase in order to ensure an effective project management.

Here, it is needed to clarify the roles and responsibility of both side which are Customer side (SSB and TurAF) and Contractor (TAI/Aselsan etc.) side. SSB has a critical role for performing two key actions ensuring that:

- The systems and services developed by main contractor and its subcontractors meet the operational requirements and are fit for purpose.
- The management direction being set by main contractor team leads is consistent with SSB and user's expectations and in accordance with the scope, time and budget requirements in accordance with the quality constraints.

The project management is analyzed in three items which are cost, time and performance.

3.2.3.1. Cost Management in National Combat Aircraft Development Program

There are many factors which may affect the total cost of development of aircraft. The TFX Program is divided into phases and stages and SSB releases budgets separately for each stage and/or phase in accordance with the contract upon successful completion of such phase and/or stage in order to provide the cost control. The first contract covers the stage-I under phase-I period. The stage-I of phase-I period of TFX Program contract has signed with not-to-exceed prices as 1.2 Billion US Dollars (Bloomberg HT, 2018).

The subcontracts have been modelled differently to support the overall schedule and budget constraints (SSB Official Record, 2019). The SSB and main contractor authorize the budgets to each Integrated Project Team (IPT). Each task in the schedule was assigned an amount of resource and resource type, covering the budget needed for the entire scope of the program.

3.2.3.2. Time Management in National Combat Aircraft Development Program

The basic assumption is seamless transition between phases and stages. The TFX Program is planned to be executed in the following three phases.

3.2.3.2.1. Design and Prototype Qualification (Phase-I)

The Stage-I involves design and development activities including related certification packages up to preliminary design acceptance with the optional provisions for the full development, qualification, certification, production and life cycle support etc. activities to cover as much as possible all future stage and phases of the TFX Program. The Program Phase-I, Stage-I PDR completion is scheduled as T0+48 months as shown in Figure 16 below (SSB Official Record, 2019).

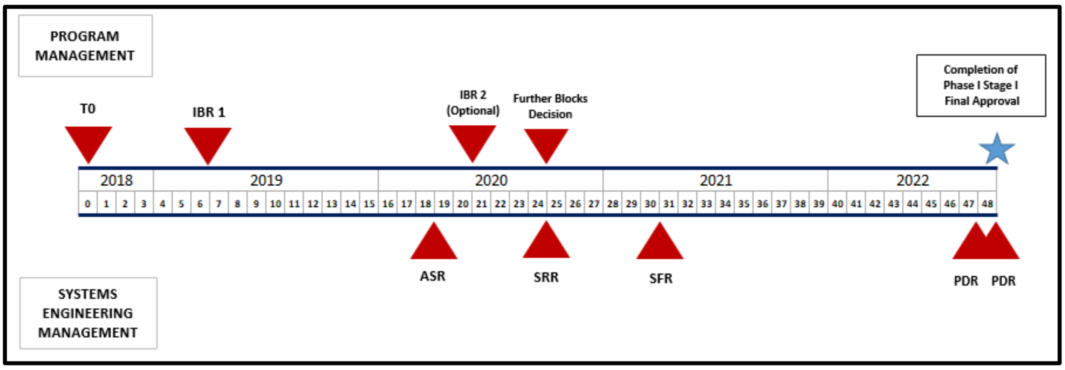


Figure 16: Phase-I Stage-I of TFX Program

The Stage-II involves the rest of the design, development, test, qualification, certification etc. activities for production of prototype TFX fighter aircraft and other test items with the optional provisions for Phase-II and Phase-III. The Figure 17 (SSB Official Record, 2019) shows the phases of TFX program.

<table>
<tr><td>Stage I
Preliminary Design</td><td>Stage II
Detailed Design and Prototype Qualification</td><td rowspan="2">Phase II
INITIAL AND FINAL OPERATING CAPABILITY (IOC & FOC)</td><td rowspan="2">Phase III
SERIAL PRODUCTION</td><td rowspan="2">Operations and Sustainment Phase</td></tr>
<tr><td colspan="2">Phase I
DESIGN AND PROTOTYPE QUALIFICATION</td></tr>
</table>

Figure 17: Phases of TFX Program

3.2.3.2.2. Initial and Final Operating Capability (Phase-II)

The Phase-II involves the development, qualification, certification, logistics support, …etc. activities for Initial Operating Capability (IOC) and Final Operating Capability (FOC).

3.2.3.2.3. Serial Production (Phase-III)

The Phase-III involves serial production and may involve logistics support agreements, establishment of Maintenance Repair and Overhaul (MRO) facilities for serial production of TFX fighter aircraft.

3.2.3.3. Performance Management in National Combat Aircraft Development Program

Within the scope of TFX Program, SSB and Main contractor collaborate with each other in the design and development activities by sharing overall responsibility and being part of the decision cycle. The collaboration activities include the best practices and experience on a wide range of supplier information in order to support the design, development, test and certification tasks of the TFX Program development activities.

3.2.3.3.1. Performance of the Program

SSB is expected to identify concerns and reservations as early as possible. SSB is party to review of trade off studies, equipment and supplier selections, as well as status and reporting reviews. SSB has the authorize to access the technical and management metrics showing the picture of the overall technical performance of the design as well as cost and schedule information.

The main contractor has to receive commitments of major subcontractors for following stages and phases of the TFX Program and it needs to establish an appropriate and possible mechanism in the subcontracts in order to minimize the risks of the TFX Program.

3.2.3.3.2. Performance of TFX Fighter Aircraft

In order to meet Turkish Air Force (TurAF) requirements beyond 2030s, the TFX Program purposes designing, developing, producing and sustaining a fifth-generation fighter aircraft which will have the multirole optimized for air-to-air, super-cruise, the extended range with highly maneuverable, the low observable with internal weapon bays, the advanced sensor capabilities and high degree of situational awareness.

The TFX fighter aircraft is planned to be kept operational in the TurAF's inventory until 2070s and will be interoperable with other critical assets of TurAF such as F-35As. The main systems of TFX fighter aircraft demonstrated in Figure 18 (TAI, 2019).

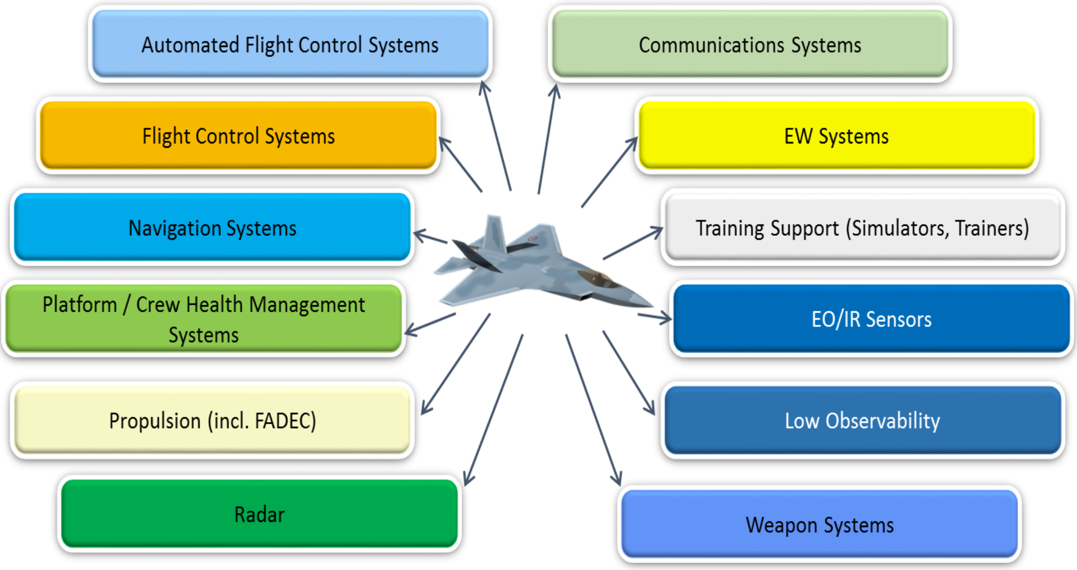


Figure 18: Main Systems of TFX Fighter Aircraft

According to Defense Turkey Magazine some of the main requirements can be listed (Defence Turkey, 2017) as follows.

- Multi Role
- Extended Combat Radius
- Low Observable
- Precise Targeting Capability
- Internal Air to Air Missiles
- External Weapon Carriage
- Super-cruise capability
- Interoperability
- Advanced avionics for sensor fusion
- High Maneuverability
- Independently Operations Capability
- High Engine Thrust

3.3. Comparison of Programs

As discussed above, the JSF and TFX programs are different from each other in terms of program models. Each program is idiosyncratic and unique, so it should be evaluated given these facts.

The National Combat Aircraft Development Program is a program involving only two parts; one customer (SSB) and main contractor (TAI). Hence, the TFX program can be defined as a two-sided program.

On the other hand, the JSF Program has many program partners. It is basically a consortium program. The US is the sole leading country in the JSF Program, and its services are composed of huge stakeholders. Furthermore, the partner countries are not at equal levels in the program. They have different rights depend on their participation levels to the JSF Program.

The program structures of JSF and TFX program are different, the TFX is not a consortium program; at least for now. Therefore, in order to better analyze the project management approaches of both programs, we need to compare the Joint Strike Fighter Program and the National Combat Aircraft Program in terms of cost, time and performance management.

3.3.1. Comparison of Cost Management in JSF and TFX Programs

Currently, there is no official announced records regarding the cost for the development and production of TFX fighter aircraft. However, some defense specialists make estimations by using the program data of other fifth-generation fighter aircraft.

According to some defense specialists, the total cost of TFX Program is expected to be 50-80 Billion US Dollars (Kılıç, 2018) including the development and the production of 300 aircraft (Star, 2013). Having said that, this cost will not be paid in one go. It will be extending over 20 years given the development and production period. Below, Table 9 shows the comparison of the TFX (Kılıç, 2018) and JSF (GAO Report, 2019) Program in terms of program cost.

Table 9: Cost Comparison of JSF and TFX Program

Compared Items	TFX Program	JSF Program
Contract Type	Firm-Fix Price	Cost Plus Fee
Total Cost for Development	There is no official cost estimation about the TFX Program. However, according to defence specialists, the total development and production cost of 300 TFX Fighter Aircraft approximately is 50 B$.	55.5 B$
Total Cost for Procurement		345.4 B$
Total Cost for Infrastructure		5.3 B$
Approximate Unit Price	Expected as F-35 Unit Price	80-110 M$

Source-1: GAO Report. (2019, 4 25). F-35 Aircraft Sustainment: DOD Needs to Address Substantial Supply Chain Challenges. *United States Government Accountability Office Report, GAO-19-321*, pp. 3-33.

Source-2: Kılıç, H. (2018, 3 26). *Türkiye'nin "Gerçek Çılgın Projesi" TF-X Uçağı.* Retrieved from Kokpit Aero: http://www.kokpit.aero/hakan-kilic-cevapliyor-tfx-projesi?writer=23

3.3.2. Comparison of Time Management in JSF and TFX Programs

The time-span of the JSF Program from the starting point till the serial production point is 11 years (Bolkcom, 2009). The Figure 19 (Gertler, 2018) below shows the timeline of the JSF Program.

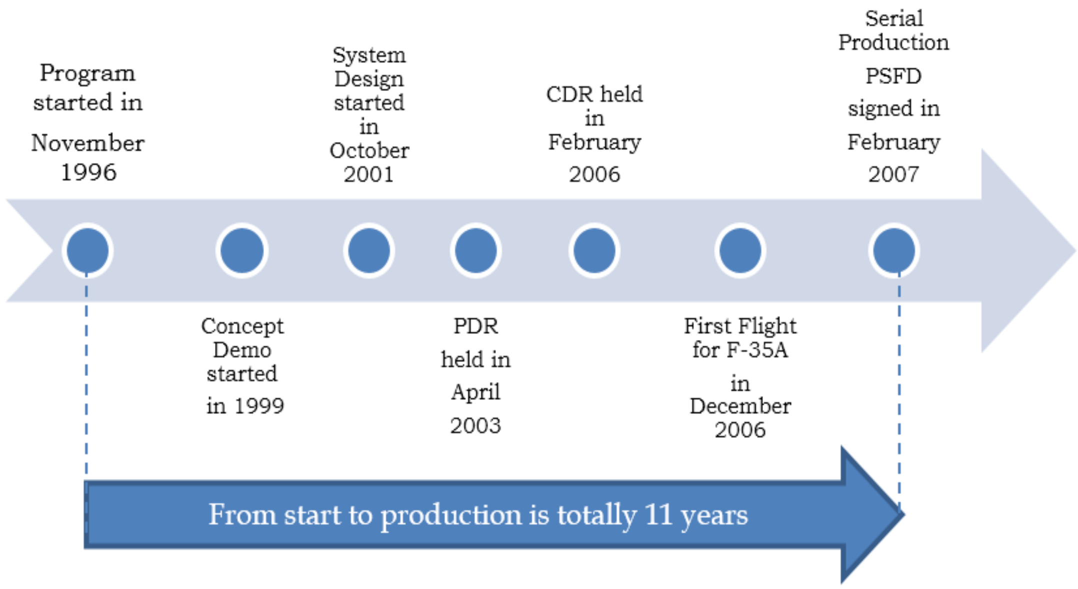


Figure 19: Timeline of the JSF Program

The time-span of the TFX Program from the starting point to the preliminary design completion point is totally 12 years. The timeline of the TFX Program is shown in Figure 20 (SSB Official Record, 2019) below.

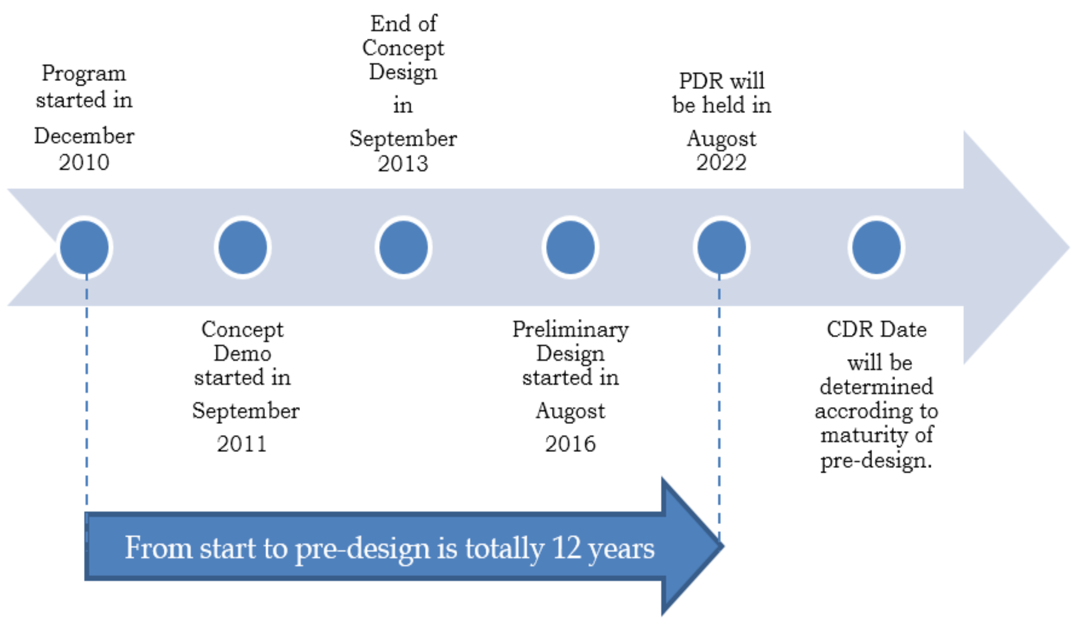


Figure 20: Timeline of TFX Program

To make a better schedule comparison regarding both programs, it is needed to concentrate on the completion dates of system engineering phases. These respectively are the conceptual design phase, the preliminary design phase and the critical design phase.

Considering the above figures, it can be thought that the USA has designed and developed so many types of aircraft since the beginning of the 20th century (Maurer, 1987). Hence, it has an in-depth defense and aerospace industry capabilities (Koonce, 1984) that have an aptitude to design and develop advanced technologies whilst incorporation some in existing systems. Having the industrial depth provides great convenience for development of new types of fighter. Therefore, it is not a considerable challenge to design and develop a new generation aircraft. As a result, the JSF Program completed its system engineering phases in a short time compared to TFX Program.

Turkey's aviation is one of the pioneering aviation in the world and dates back to 1909 when studies into aviation by the Turkish military began (TurAF, 2019). It showed a marked improvement in a very short time (Leiser, 1990) and, stood on the shoulders of giants who established the aviation infrastructures (Demirağ, 1938) and manufactured the aircraft (Hürkuş, 1942) at the first half of 20th century.

After the first successful half, the second half of 20th century was more actless compared to first one. But nowadays, Turkey has recently entered the modern aerospace industry and became one of the new players in the global aerospace industry with broad horizons to develop more advanced systems.

3.3.3. Comparison of Performance Management in JSF and TFX Programs

Whilst comparing the performance of JSF and TFX Programs, the main goal of the programs is to design and develop a fifth-generation aircraft. Therefore, it can be assumed that the performance and operational capabilities of both aircraft are close to each other.

Table 10: Comparison of Specifications of TFX and JSF Fighters

Compared Specs	TFX Program	JSF Program (F-35A)
Wingspan	14 m	10.7 m
Lenght	21 m	15.7 m
Height	6 m	4.38 m
Thrust	2 x 27 000 lb	40 000 lb
Service Ceiling	55 000 ft	50 000 ft
Maximum Speed	1.8 Mach	1.6 Mach

Source-1: Nelson, C., & Friedman, M. (2019, 4 17). F-35 Lightning II Program Status and Fast Facts. *F-35 Lightning II Fast Facts*, pp. 1-2.

Source-2: TAI. (2019, 10 10). TF. Turkish Aerospace Industries: Retrieved from https://www.tusas.com.tr/en/product/milli-muharip-ucak

Nevertheless, to better analyze both aircrafts, some specs can be compared as indicated in Table 10 (Nelson, 2019) below. When considered both aircraft specifications, the super-cruise specification of TFX fighter aircraft (TAI, 2019) seems to be close to the F-22 Raptor (Gertler, 2013) rather than F-35 Lightning II.

3.4. Summary of Chapter

In this chapter, the JSF and TFX Programs are presented covering almost all aspects. As known from previous chapter, there are three basic components of the project management defined as the Iron Triangle, which are the cost, time and performance (Atkinson, 1999). In order to show the comparability of the JSF and the TFX Program, the project management approaches of the both programs were compared in terms of cost, time and performance.

From the point of aircraft, both programs aim to design and develop a fifth-generation fighter aircraft. The specification and operational capability of both aircraft is close to each other. So, they are comparable.

From the point of program model, the JSF Program is a consortium model, but the TFX is not a consortium. However, the difference between the two models does not affect the comparability of the project management approach; because three parties exist in both programs, which are the project managers, the users and the contractors. The relationship among these parties can be compared with the project management approach.

From the point of program cost, the budget of programs is different due to the difference in program's scale. But still, they are comparable.

From the point of program schedule, both programs have the same system engineering phases in terms of conceptual design, preliminary design and critical design phases. So, they are comparable. And, it seems that the JSF Program is faster than TFX Program.

CHAPTER 4

METHODOLOGY

The thesis methodological approach is explained in this chapter. The research methods, data collection methods, research analysis methods and data interpretation methods are explained respectively.

4.1. Methodological Approach

The methodological approach of this thesis and its relationship with the other chapters is indicated in Figure 21. Here, the diagram is shown again to clarify the structure of study.

4.2. Assumptions and Limitations

This study is based on interviewers' stated opinions. It is assumed that each respondent answered in an honest manner. And, it is assumed that each interviewer has told their opinions free-heartedly.

In Turkey's JSF Program, there are main three parties/stakeholders which are Presidency of Defense Industries (SSB) as a procurement agency, Turkish Air Force (TurAF) as a user and the defense industry companies as suppliers.

No study is fully flawless or involves all possible aspects of the research subject. All studies have some limitations. This study focuses only on SSB's JSF Program perspective. Therefore, any program management perspective in military or industry side are the out of scope of this study.

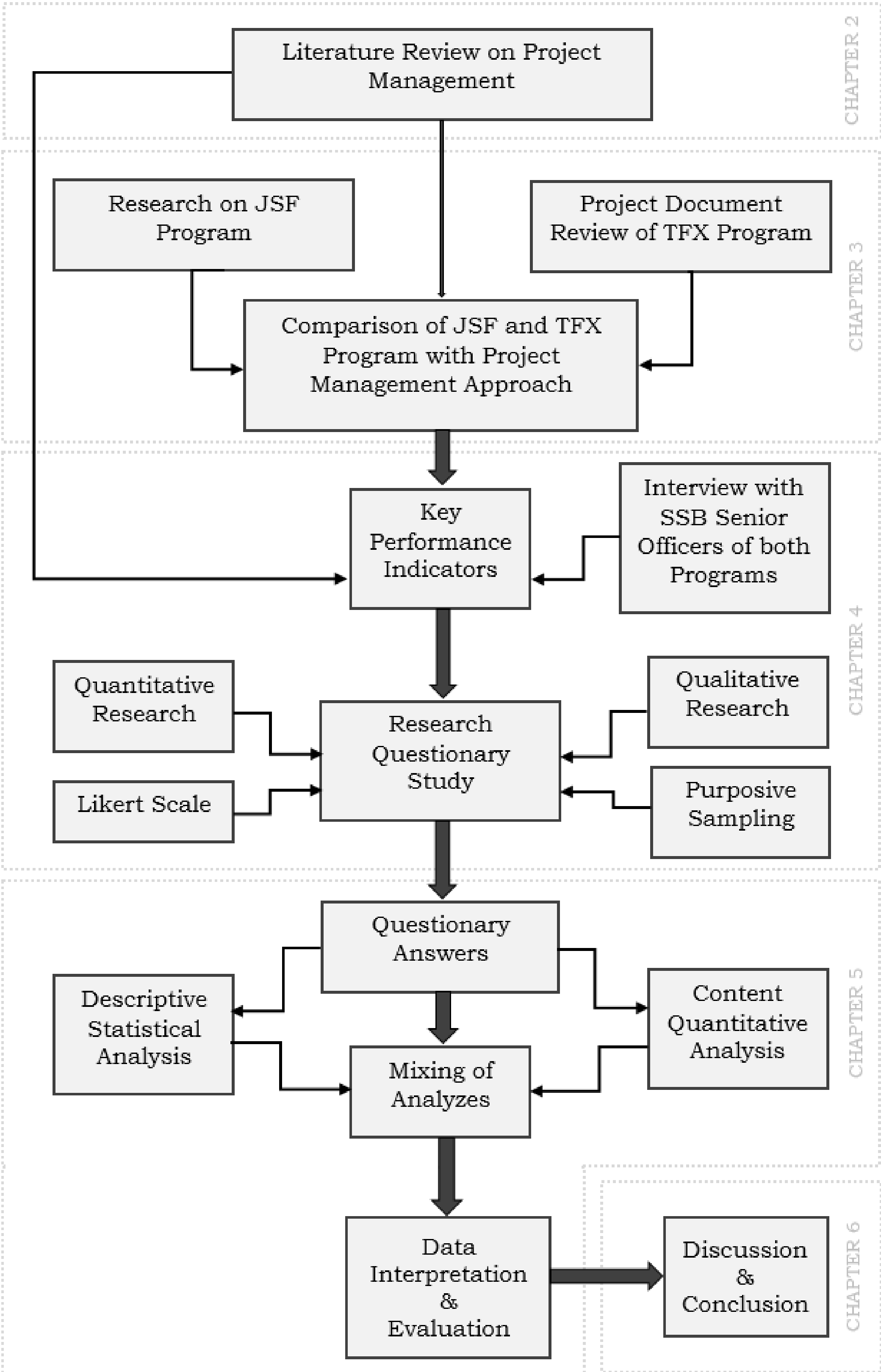


Figure 21: Structure of Research Study

4.3. Key Performance Indicators

A Key Performance Indicator (KPI) is a measurable value that is designed to demonstrate how effectively an organization is achieving certain key business objectives it defined. The KPIs help project manager to assess how the organization is performing based on certain criteria that describes ‘success’ and, by observing the KPIs, project managers are able to increase performance (Parmenter, 2015). The KPIs are expected to be measurable proving how effectively the goals are achieved. According to Oxford Dictionary, KPI is a quantifiable measure used to evaluate the success of an organization, employee, etc. in meeting objectives for performance.

The KPIs are used at multiple levels to assess the level of success while achieving the goals. In terms of developing a strategy for formulating KPIs, it is needed to start with the basics, understand what organizational objectives are and how it is planned on achieving these objectives. Therefore, defining and designing KPIs is an iterative and interactive process that involves feedback from analysts, department heads and managers. Further, the KPIs are specified with an appropriate level of detail, according to the precisely adapted to the measurable processes (Kueng, 2000). There are many defined KPI standards in the sectors, including industry, medicine, education, and services so they are designed almost for any domain of our life (Roubtsova & Michell, 2013).

4.3.1. Implementation of Key Performance Indicators to the Projects

As mentioned above, KPIs are used in various fields including project management. There are many researchers examined the different types of KPIs to measure project management (Kerzner, 2017). The important matter is the definition of success criteria in project management. The definition of the success criteria in project management is still discussed, there are countless number of success criteria from Oisen’s Iron Triangle analogy to new edition PMBOK’s approach.

Success criteria have also been defined and summarized in some research studies. For example, in one of these studies, 15 project success factors classified as four COMs (Nguyen, Ogunlana, & Lan, 2004). The COMs list is follows as;

- comfort,
- competence,
- commitment and
- communication

However, each project should be assessed individually since they are different from each other and each success criteria should be assessed in project's own terms and characteristics. Many researchers have thought over the success parameters/dimensions of an ideal project management. For example, Shenhar has analyzed the success of projects in a holistic perspective. According to Shenhar (1993),

> Projects may differ considerably in various aspects like size, time-span, complexity, industry, customers, and of course, technology. The technology used in projects should receive special attention, since there are great differences among projects. Some projects incorporate well established technologies, while others employ new, and sometimes even experimental technologies that involve enormous uncertainties and risks (p. 200)

Shenhar (1993). has grouped four types of t projects according to their technology and complexity. Type-A is low level of technology and type-D is the highest one. However apart from the technologic complexity of the project, there are four elements for measuring project success which are;

- Project efficiency,
- Impact on customer,
- Business success,
- Preparing for the future.

Below, the schematic demonstration of the project success indicators is in Figure 22 (Shenhar, Levy, & Dvir, 1997).

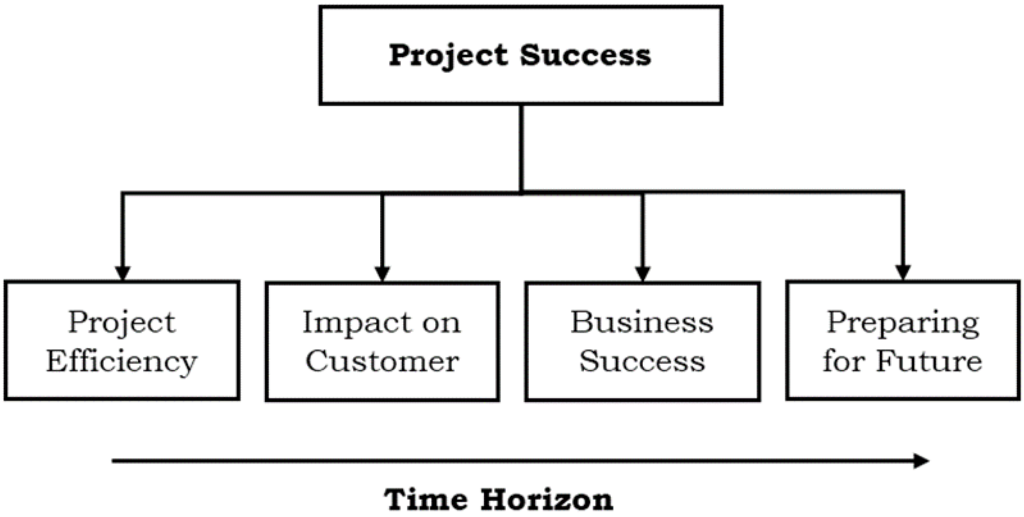


Figure 22: Four Dimension of Project Success

All the project success dimensions can be traceable with the KPIs. Nevertheless, these success dimensions are not evaluated with the same level of significance. Here, the time horizon is appeared as a determinant factor. According to Shenhar overall project success dimensions have the relatively importance in terms of time function. (Shenhar, Levy, & Dvir, 1997). Figure 23 shows the project success dimensions from the point of project completion time.

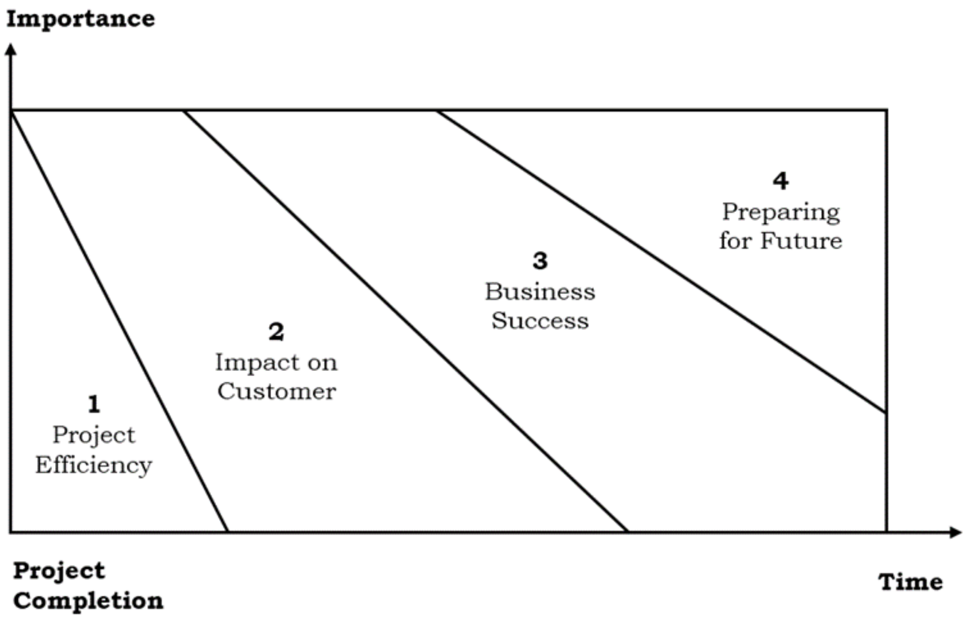


Figure 23: Relative Importance of Success Dimensions

Drucker clearly revealed the success factors (Drucker, 2011). He has determined a simple SMART criteria set which are;

- Specific
- Measurable
- Achievable
- Relevant
- Time sensitive

SMART criteria help us to define the KPIs. Furthermore, Parmenter re-defined the KPIs by using the success factors of the based-on Drucker's SMART criteria set (Parmenter, 2015). Consequently, the KPIs used in this thesis are defined considering the SMART approaches.

4.3.2. Key Performance Indicators in Joint Strike Fighter Program

The definition of an appropriate KPIs framework plays a key role in executing a comprehensive study. Too many KPIs can be unmanageable to analyze, so it is needed to choose appropriate KPIs for each objective in project management (Roubtsova & Michell, 2013). The KPIs should be in a quantifiable form and be presented as a quantification predicate of first-order logic (Andrews, 2002).

Some of KPIs were firstly inspired from the literature review of previous studies on KPIs/success criteria. Oisen's Iron Triangle is still the fundamental project management approach (Oisen, 1971). Furthermore, Atkinson and some other researchers added new criteria and re-evaluated them again (Atkinson, 1999). For example, DeLone, having the great influence of the Atkinson's study, proposed six new success factors which are;

- System quality
- Information quality
- Information Use
- Users satisfaction
- Individual impact
- Organizational impact (DeLone & McLean, 1992).

As a result, all previous studies are considered good guides for us to constitute the JSF Program KPIs. They were used as a framework JSF Program KPIs.

The specific KPIs set for JSF Program was constituted by interviewing with SSB's executives and senior officers who performs/performed in Joint Strike Fighter Program. After the interviews with the SSB's senior officers, a preliminary set of KPIs was identified in accordance with JSF Program management. After all, the preliminary set of KPIs was refined to an applicable set. The refined set of JSF Program KPIs is tabulated in Table 11 below.

Table 11: Preliminary Set of JSF Program KPIs

Code	KPIs	Evaluation
KPI-1	JSF Cost Performance	including the budget and financial management
KPI-2	JSF Time Performance	including schedule and baseline management
KPI-4	JSF Quality Management	including certification process , quality procedures, quality standardization in the contractors
KPI-5	JPO Team Performance	including JSF Program Office management team attitudes to the program, their responsive management approaches to solve the problems and the partner countries participation to the JSF Program Office
KPI-6	JSF Development Management	including all SDD and PSFD and ongoing modernization phases, conducting the development and production phases together
KPI-7	JSF Risk Management	including all type of risks which are financial / managerial /political / industrial etc.
KPI-8	JSF Technological Management	including technological baseline, technological objectives and technological tendency in the next future

Table 11 (continued)

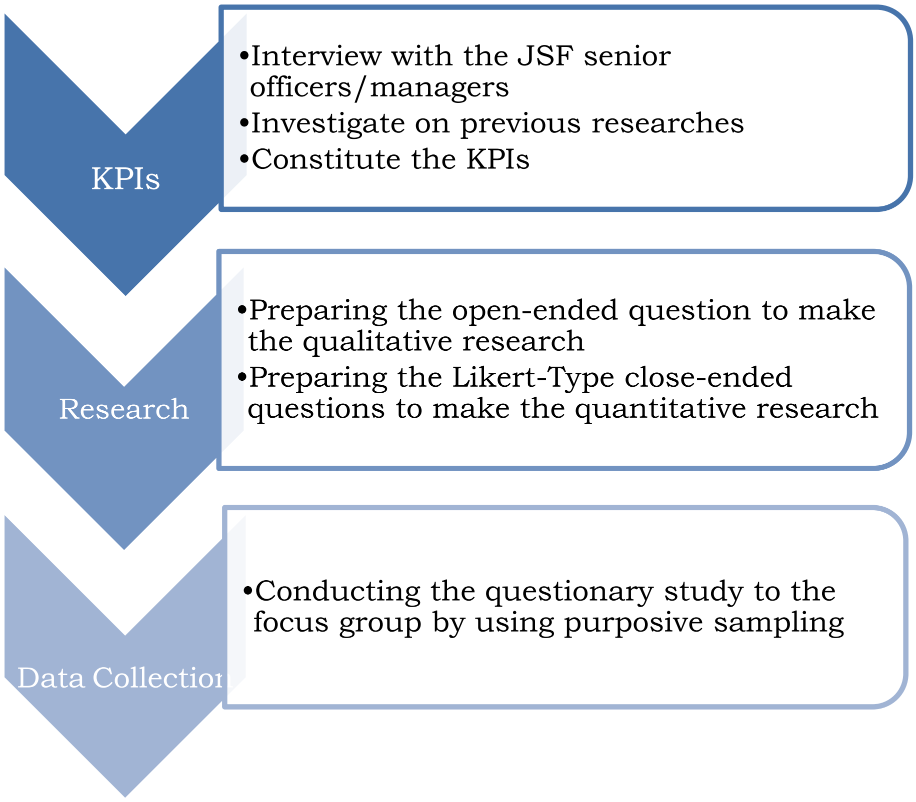
KPI-9	JSF Contractual Performance	including all contract type cost-plus or firm fixes price, large and long-term contracts in addition contract numbers and their complexity
KPI-10	JSF Resource Management Performance	including all types of resource human, material, information facilities, etc.

As previously known, the KPIs should be specific, measurable, achievable, relative and time-sensitive (Drucker, 2011). Therefore, the KPIs for JSF Program were classified as specific to the JSF program management topics. Each KPIs was relatively and measurable. And they were achievable in the pre-determined time-span. So, the basic specifications of the KPIs were provided as mentioned in Drucker's approach. After the definition of the JSF Program KPIs, they are converted to the questions to use in questionnaire study.

4.4. Research Strategy

The project management is not only an engineering, a financial or a managerial issue but also it is a social issue due to the interdisciplinarity (Drucker, 2011). In order to understand the project management in an explicit way, it is needed to establish an appropriate research strategy. From this point, the research strategy should involve the imagination, the creativity, the comprehensibility and the stability (O'Leary, 2009). In the methodology of this thesis, it is decided that the qualitative and quantitative research methods are used together to better understand the JSF Program management approach from different aspects. The simple schematic demonstration of the research strategy is shown in Table 12 below.

Table 12: Research Flowchart



4.4.1. Qualitative Research Method

The qualitative research method involves qualitative data in order to understand and explain a social phenomenon. The qualitative research is especially effective in obtaining specific information about opinions, behaviors, ideas and methods etc. According to Yin (1994), the findings from qualitative data are often be extended to people with experiences similar to those in the study population, gaining a rich and complex understanding of a specific problems typically take precedence over eliciting data that can be generalized to other problematic issues (Yin, 1994).

The relationship between the researcher and the respondent was often less formal with the qualitative research. The respondents have the opportunity to respond more elaborately. Hence, the use of qualitative method and analysis are extended almost to every research field and area (Lee, Liebenau, & DeGross, 1997).

The qualitative research provides a whole description and analysis in the scope of researched subject by using the participant's state of nature (Collis & Hussey, 2003). The key difference between quantitative and qualitative research is their flexibility. Generally, the quantitative research is fairly inflexible.

The three most common qualitative methods are the participant observation, in-depth interviews, and focus groups (Gill, Stewart, Treasure, & Chadwick, 2008). Each method is particularly suited for obtaining a specific type of data.

- **Participant observation** is appropriate for collecting data on naturally occurring behaviors in their usual contexts.

- **In-depth interviews** are optimal for collecting data on individuals' personal histories, perspectives, and experiences, particularly when sensitive topics are being explored.

- **Focus groups** are effective in eliciting data on the specific group and in generating broad overviews of issues.

It is used the focus group method and concentrated on the specific group of SSB's personnel whilst conducting the research of this thesis.

4.4.2. Quantitative Research Method

The quantitative research makes the subjected issue be quantifiable value by generating some numerical data and that data can be converted to the usable statistics (Oflazoğlu, 2017). It provides measurable data to uncover the patterns statistically structured facts (Corbetta, 2003). According to Mack *et. al.* (2011),

> The response categories from which participants may choose are 'closed-ended' or fixed. The advantage of this inflexibility is that it allows for meaningful comparison of responses across participants and study sites (p. 3).

The quantitative research is used to quantify attitudes, opinions, behaviors, and other defined variables. The most common quantitative research method is the questionnaire type of surveys with the Likert-Type questions (Likert, 1932). The typical Likert scale is a 5 or 7 point ordinal scale used by respondents to rate the degree to which they agree or disagree with a statement (Sullivan & Artino Jr., 2013). The Likert-Type questions have been used in quantitative research of this thesis. And then, the questions were adopted five-point Likert scales which is listed as follows;

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree,

the answers of all questions were assigned to respondents' rating.

4.4.3. Population and Sample

It is not necessary to collect data from everyone in JSF Program in order to get valid findings, even if, it is possible to make a wide range of research study with all parties in Turkey. In this qualitative and quantitative research, only a sample (that is, a subset) of a population is selected, and, it provides sufficient data in the limitation of the research study.

Normally, the most common sampling methods used in qualitative researches (Mack et al., 2011), which are;

- Purposive Sampling
- Quota Sampling
- Snowball Sampling

Purposive sampling is selected in this study because SSB's staff is a small specific group performing or who performed in many various positions in JSF Program. Therefore, they were able to give all details of the JSF Program clearly. Additionally, some SSB staff are involved in both TFX and JSF Program at the same time.

As a consequence, the sample population or focus group of this questionnaire study was SSB's personnel who performs or performed in JSF Program.

4.4.4. Data Collection Methods

There are many forms of data collection for the purposes of research study. In this thesis, two types of data collection methods were applied which are the interview and questionnaire study.

4.4.4.1. Interview

The primary advantage of personal interviews is that they provide the direct contact between interviewers and interviewees and eliminate the non-response rates (Fisher & Geiselman, 1992). According to Harrell and Bradley (2009), "The interviews are discussions, usually one-on-one between an interviewer and an individual, meant to gather information on a specific set of topics". For constituting the project management KPIs in order to evaluate the JSF Program and observe the effective methods used in, the interviews with SSB's senior officers and executives were conducted.

4.4.4.2. Questionnaire

The questionnaire is the fixed sets of questions that can be administered by paper and pencil (Harrell & Bradley, 2009). In this thesis, the questionnaire is composed of two types of questions that are qualitative (or open-ended questions) and quantitative (close-ended or Likert-Type questions).

In order to evaluate the project management KPIs of the JSF Program, the questionnaire was conducted with SSB's personnel performing or performed in many various positions in JSF Program.

4.5. Data Analysis Strategy

Since two types of research methods are used in research strategy, the data analysis has been divided into two parts; qualitative data analysis and quantitative data analysis. Both analyses are used simultaneously.

4.5.1. Qualitative Data Analysis

The qualitative data analysis aims to find the description of general statements about interrelations between the main idea and the offered data. The analysis, as a term, includes three basic elements which are the description, the analysis and the interpretation (Wolcott, 1994). In qualitative research, the data analysis differs from the quantitative. The qualitative data analysis usually starts with data collection (Marshall & Rossman, 2006).

The most common analysis methods in the qualitative researches is the content analysis. The content analysis enables analysis of 'open-ended' data and, it is used to capture the true diagnosis in the research. It has been applied to diverse fields of research, including psychology, economy, education, management and history (Stemler, 2001). The main advantage of the content analysis is that collected data can easily be reduced and simplified when generating the results (Moore & McCabe, 2005).

In this thesis, the collected JSF Program data was categorized in themes and sub-themes in order to compare them by content analysis. Moreover, the content analysis is useful as part of multi-method analysis, for example for triangulation or mixing of the analysis (Harwood & Garry, 2003). The collected data of JSF Program is analyzed with a mix analysis method within project management KPIs' framework.

4.5.2. Quantitative Data Analysis

The quantitative data analysis converts the quantitative data to useful information to assess them properly. The statistics helps us to summarize data and to describe the patterns, the relationships and the connection of the response. Therefore, statistical methods are used when analyzing the quantitative data.

The statistical analysis is divided into the descriptive and inferential statistics (Sprinthall & Fisk, 1990). The descriptive statistical analysis summarizes and describes the collected data. However, the inferential statistical analysis determines the differences between the groups of data (Lowry, 2014).

Typically, the descriptive statistical analysis is the first level of analysis. It easily summarizes and classifies the data and finds patterns. In this thesis, therefore, we will use the descriptive statistical method rather than inferential statistics.

The descriptive analysis is considered more useful when the research is limited to a small group of samples not to be generalized to a larger population (Peatman, 1947). To properly analyze Likert-type data, it is needed to be clear that Likert-type questions express a "greater than" relationship among the answers in ordinal scale. Using the ordinal measurement scale in Likert-type questions is more appropriate to find the median for the tendency and frequencies for variability (Boone, Jr. & Boone, 2012).

Although, the descriptive analysis provides data numbers and some percentage, it does not explain the reasoning behind those findings. Therefore, it is not used as a stand-alone analysis method for interpreting the data; instead, both analysis methods were used.

4.5.3. Mixed Model of Analysis

The descriptive analysis of quantitative data contributes to the body of knowledge in the qualitative data worked on (Treiman, 2009). Having said that, still, the qualitative studies have been used to 'salvage' quantitative studies (Weinholtz, Kacer, & Rocklin, 1995).

The mixing of quantitative and qualitative methods leads to strengthen the validity and increases the utility of the research. According to Sandelowski (2000), "Mixed-method studies dramatize the artfulness and versatility of research design".

To establish our research on a solid basis, therefore, both quantitative and qualitative data were collected and analyzed together. The results of analysis were then compared while interpreting the collected data. As a result, the combination of quantitative and qualitative analysis created more comprehensive and grounded findings about the JSF Program management methods and practices.

4.6. Ethical Considerations

This thesis seeks only the information about the specified research subject. The participation of respondents in this research was on completely voluntary basis. The respondents were assured in advance regarding the research and how it is intended to be used, so that any negative consequences were eliminated to perform this research study.

The data was collected anonymously, and all information given by respondents was kept confidential. The respondent's personal data and their responses were retained only until the completion of this thesis and then, they all destroyed.

4.7. Summary of Chapter

In this chapter, the methodology of the thesis is explained with mist significant details. The KPIs used in JSF Program are determined. In addition, the research, data collection and data analysis methods are defined in order to be utilized in the next chapter.

CHAPTER 5

ANALYSIS & EVALUATION

The questionnaire was conducted in the Presidency of Defense Industries (SSB) with 24 SSB's personnel. It has been asked two types of questions to the respondents, which were;

- Likert-Type Questions,
- Open-Ended Qualitative Questions.

The questionnaire study helped us to understand the project management practices in JSF Program. All the respondents are from SSB.

5.1. Specification of Population

The age of the respondents is shown in the pie chart in Figure 25, and listed below;

- 57% of the respondents was between 40 and 49 years old.
- 17% of the respondents was between 30 and 34 years old.
- 13% of the respondents was older than 50 and the 13% was in between 35-39.
- The rest of respondents were younger than 30.

88% of the respondents was male and the 12% was female as shown in pie charts in Figure 26.

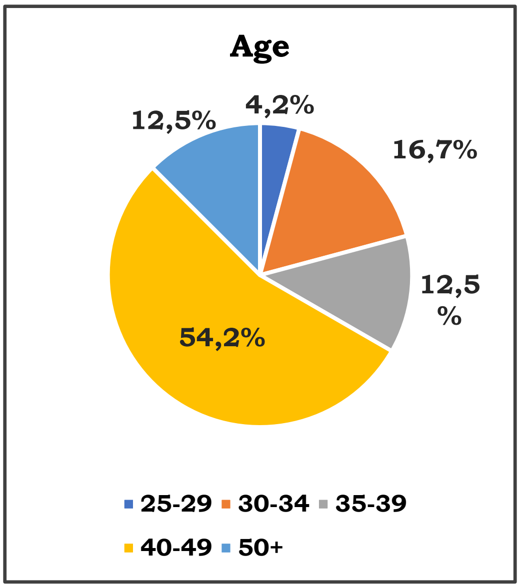


Figure 25: Respondents' Age

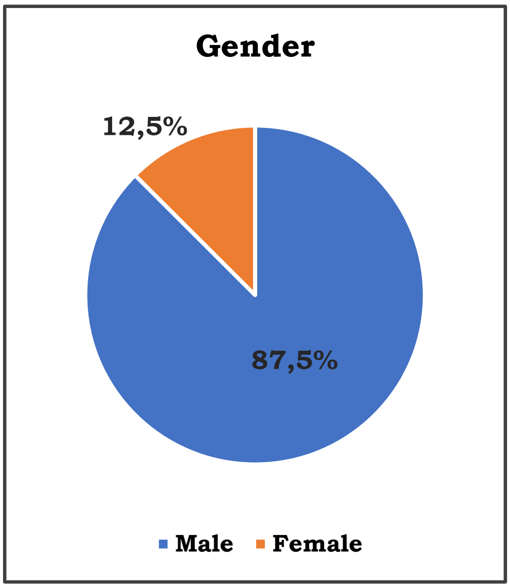


Figure 24: Respondents' Gender

All the respondents are SSB's staff, but their origin is different from each other. The origin the respondents are shown in the pie chart in Figure 27 and are explained as follow;

- 83% of the respondents was civilian personnel/civil servants.
- The 4% has military origin and they are retired from TurAF.
- The 13% has industry origin and they are retired from private sector.

The job titles of the respondents are shown in the pie chart Figure 27 below and are classified as follow;

- % 46 of the respondents was Senior Project Associate.
- % 17 of the respondents were Project Engineers.
- % 17 of the respondents were Project Consultant.
- % 17 of the respondents were Project Manager.
- The rest was Project Assistants.

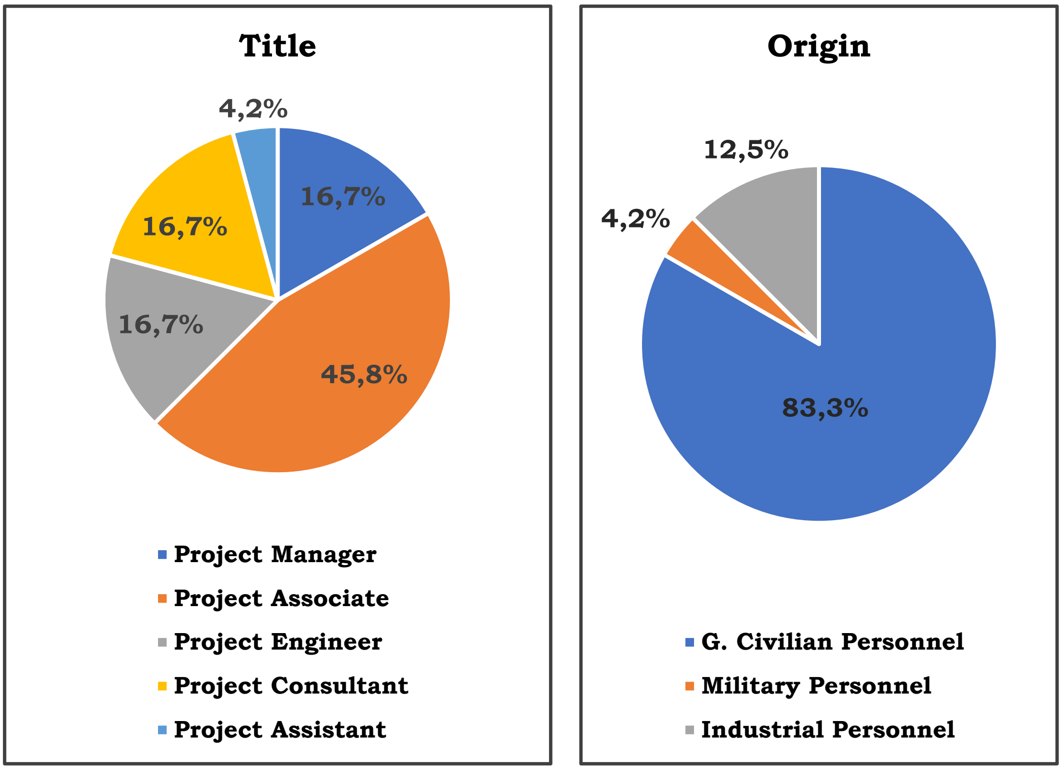


Figure 26: Respondents' Title and Origin

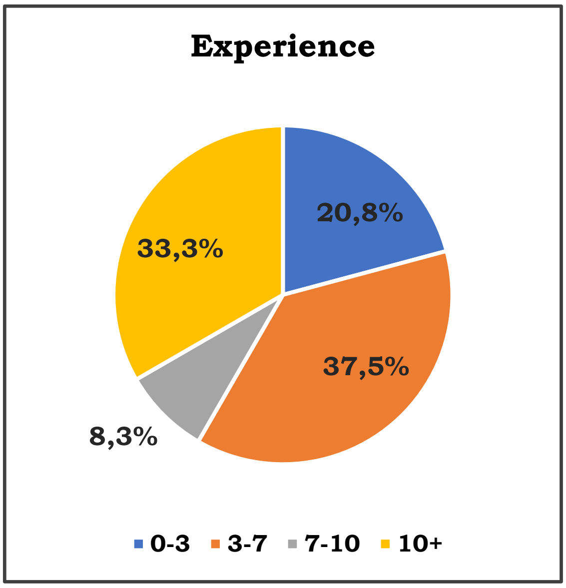


Figure 27: Respondents' Experience (years)

The project management experience of the respondents as working year is shown in the pie chart in Figure 28. 38% of the respondents has work experience in between 3 and 7 years. 33% of the respondents has higher than 10-year work experience. 21% of the respondents has lower than 3-year experience. The rest of respondents has experience in between 7 and 10 years.

5.2. Analysis and Evaluation of the Questionnaire Study

A questionnaire form template was prepared for the research study; and, each question in the study was written on both sides, in order to make the qualitative and quantitative research together.

The questionnaire form included 9 (nine) coupled questions set, totally 18 (eighteen). Each coupled question set was created by using KPI's subjects mentioned in the previous chapter. The coupled questions consist of two types, which are A-type and B-type. A-type questions were prepared for the qualitative research and B-type questions were prepared for the quantitative one.

The answers of the qualitative questions were analyzed by using the content analysis, commonly used data interpretation technique in the qualitative data analysis method. In spite of existing many specific types of computer programs for content analysis, all answers in this study were interpreted manually not using computer programs. Each written response is grouped according to the content codes stated in the respondents' answers. These codes are determined by intersecting and cross-cutting the respondents' answers. Then, all answers are listed and classified within same content code group in order to summarize as one sentence. As a result, the answers having the same meaning are epitomized to represent the results. The content codes were tabulated in the evaluation of each question.

The answers of the Likert-Type quantitative questions were analyzed by using the descriptive statistical analysis method with the Likert scale. The Likert scale was composed of 5 levels. According to respondents' choice of answer, a bar chart was plotted. The plotted bar chart helped us to interpret clearly the qualitative answers.

All nine KPIs and their coupled question set are presented respectively. Both methods of analysis are specified. The responses regarding each coupled question were analyzed in both ways.

5.2.1. Cost Performance in JSF Program

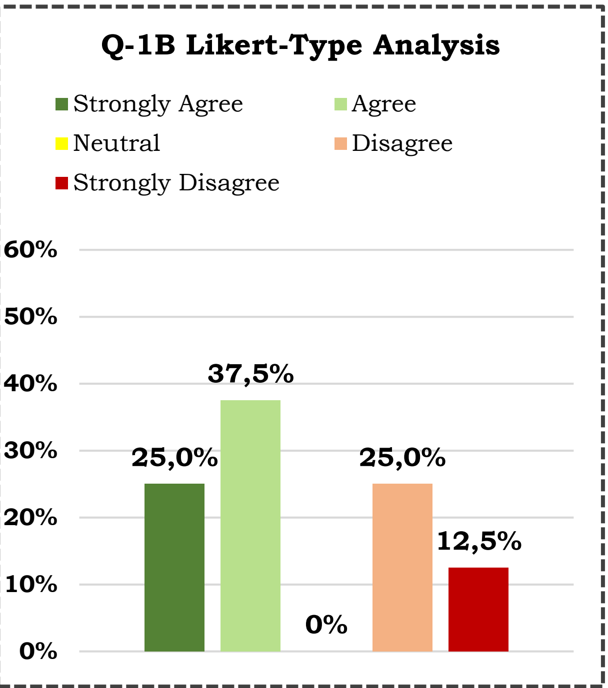
KPI-1: JSF Cost Performance

Q-1A: What is the financial management approach that you find very useful within Joint Strike Fighter (JSF) Program?
Please specify:

Q-1B: Do you agree that a comprehensive financial management exist in Joint Strike Fighter (JSF) Program?

a. strongly agree
b. agree
c. neutral
d. disagree
e. strongly disagree

5.2.1.1. Analysis of Q-1A and Q-1B



Q-1A Codes of Content Analysis

- cost break-down structure
- work packages and invoices
- price properly
- payments
- financial risk
- cost share ratio

5.2.1.2. Evaluation of KPI-1

Due to the JSF Program being a large-scale program, the financial management of the JSF Program is one of the biggest controversial topics in this study. 38% of the respondents answered the question as 'disagree' or 'strongly disagree'. The underlying causes are determined as follow:

- It is hard to pursue all the financial items of the program easily. The traceability between the project work packages and their invoices is so week
- The cost break-down structure of the project work package has not enough details.
- The cost items of the JSF Program are not determined properly in order to be able to address cost-effective solutions.

However, the other 62% of the respondents answered 'agree' and 'strongly agree'. The underlying causes of this result are determined as follows:

- JSF Program conveys the planned cost to contracts and gets the price properly. Also, they report each case of the financial process to the partner country.
- JSF Program provides related payments to contractor on time and then it gives the partners extra time for the payments.
- JSF Program Office sometimes loads the financial risk on behalf of the partners.
- JSF Program shares the cost as equitably for the partners.

As a result, the financial issues are thought to be the most critical part of the project management. It is not easy to control all the work packages and their associated price effectiveness in large programs like the JSF Program. However, as stated in the previous chapters, the development cost of the JSF Program exceeded the initially planned cost. In addition, one of the most famous mottos in this program is 'the affordability' however, the unit cost was considered too high for many users. Therefore, it is not easy to say that the cost management is very successful in the JSF Program given the circumstances stated above.

5.2.2. Time Performance in JSF Program

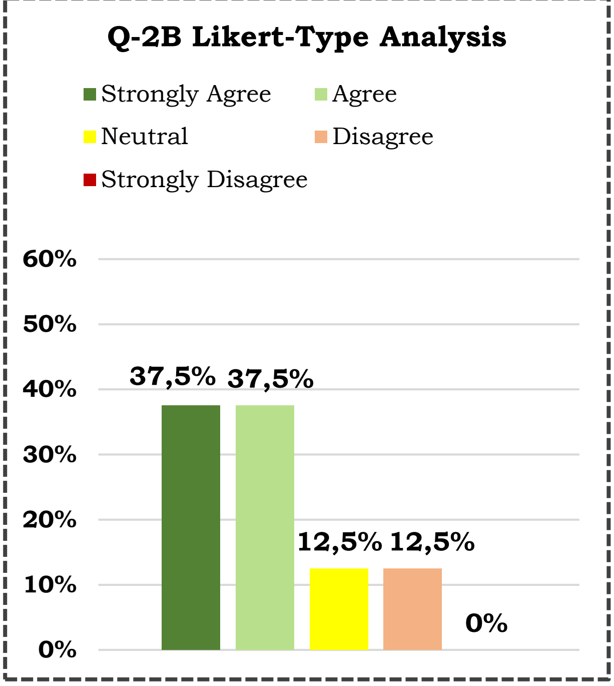
KPI-2: JSF Time Performance

Q-2A: What is the schedule management approach that you find very useful within Joint Strike Fighter (JSF) Program?
Please specify:

Q-2B: Do you agree that a comprehensive schedule management exists in Joint Strike Fighter (JSF) Program?

a. strongly agree
b. agree
c. neutral
d. disagree
e. strongly disagree

5.2.2.1. Analysis of Q-2A and Q-2B



Q-2A Codes of Content Analysis

- Delivery
- Planning
- Schedule
- Monthly and quarterly meetings
- Program activities

5.2.2.2. Evaluation of KPI-2

Except 13%, the rest of the respondents answered the question as 'agree', 'disagree' or 'neutral'. The evaluation is defined as follows:

- JSF Program Office (JPO) uses the Joint Data Library (JDL). This digital library is open to all partners. As is known to all program personnel, the delivery and correspondence of documentation is very important in programs. JSF documents are delivered to partners by sharing them in the JDL.
- All program activities are planned in an integrated master schedule. This schedule covers ten years and updated yearly periods with the approval of partners.
- JPO is not the only organization that is responsible of the schedule of JSF Program, but also each partner has its own responsibility. Each partner must keep up with the JSF Program's schedule.
- JPO manages the program schedule through monthly and quarterly meetings with the partners.
- Acceptance of F-35 system deliverables, the certification and accreditation of the F-35 bases are in JPO's responsibility zone. These affect the program schedule directly.
- To manage the schedule efficiently, JSF Program welcomes any opportunities to save the time by shifting the program activities to the left on the timeline.

As a result, despite the fact that there are certain delays in the planned agenda of the JSF Program as touched upon in the previous chapters, it can be said that the JSF Program is recently on the crest of a wave.

5.2.3. Program Team Management Performance in JSF Program

KPI-3: JSF Program Team Management Performance

Q-3A: Which of the project management practices, that you find very useful and efficient, are used by Joint Strike Fighter Program management team in JPO?

Please specify:

Q-3B: Do you agree that a comprehensive project management approach is being systematically used by the Joint Strike Fighter Program management team in JPO?

a. strongly agree

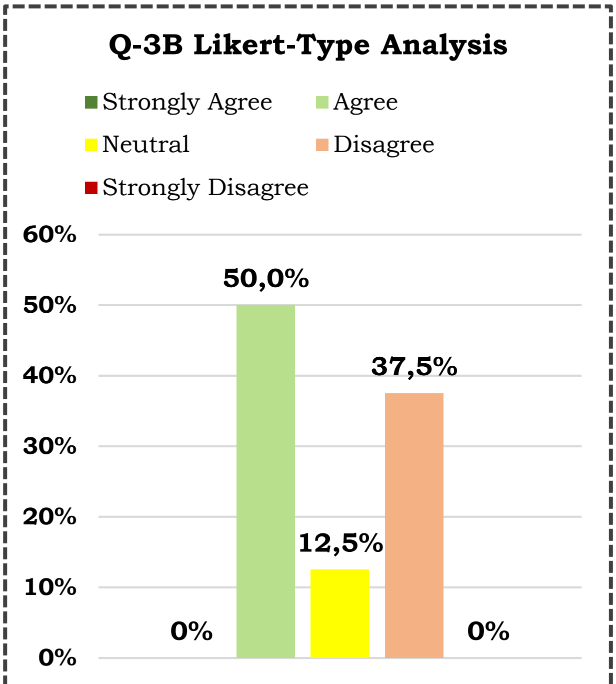
b. agree

c. neutral

d. disagree

e. strongly disagree

5.2.3.1. Analysis of Q-3A and Q-3B



Q-3A Codes of Content Analysis

- Common good
- Transparent
- Informative
- Political issues
- Inter-discipline approach

5.2.3.2. Evaluation of KPI-3

This is another biggest controversial topic in the questionnaire study. There is a relative balance between the positive and negative answers. Most of the respondents answered as ‘agree this question using the same words. The reasons can be stated briefly as follows,

- JSF Program is not a fighter development program, it is beyond that. Therefore, many political issues affect the JSF Program. For the common good, JSF Program Office (JPO) and the Partners are required to be result-oriented.
- The JSF Program Office uses the well-established expert working groups and decision-making boards with partner nation’s involvement to make a quick decision about the program.

On the other hand, the JPO falls in a faint in some cases; namely;

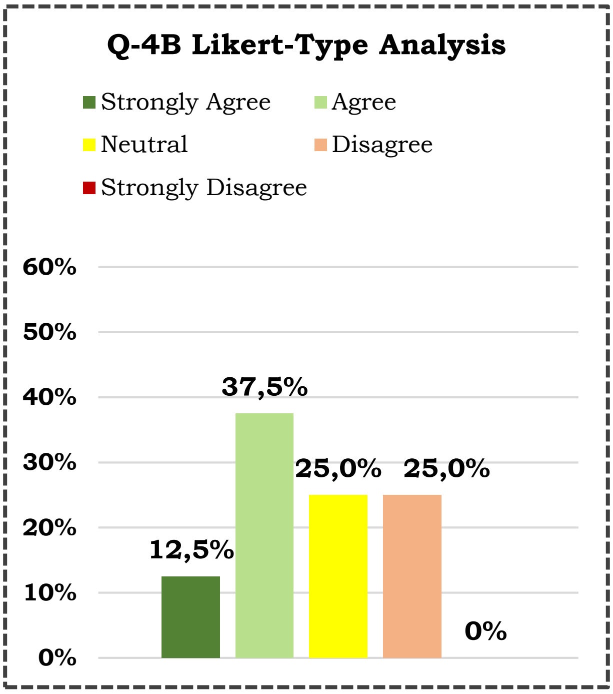
- The JPO is needed to be more transparent and collaborative in terms of sharing of information with the JSF Program Partners.
- The JPO is needed to improve cost determination stages.
- The JPO’s Integrated Project Team (IPT) personnel and budgeting personnel should make plans cooperatively. It is needed to deal with the program matters with an inter-disciplinary approach.

As a result, the JPO cannot be described as a very successful project management organization. Nonetheless, the JPO constitutes a common organization structure composed of all partners’ personnel. If we take into consideration the fact that the staff coming from different countries and cultural background, it may be difficult to catch an ideal team spirit given the differences between people. But here, another problem is the conflict of interest sometimes arose between JSF Program’s stakeholders. In that period of time, the JPO cannot satisfy every parties in the program.

5.2.4. Development Management in JSF Program

KPI-4: JSF Development Management
Q-4A: What is the development management approach that you find very useful within Joint Strike Fighter (JSF) Program? Please specify:
Q-4B: Do you agree that a comprehensive development management exists in Joint Strike Fighter (JSF) Program? a. strongly agree b. agree c. neutral d. disagree e. strongly disagree

5.2.4.1. Analysis of Q-4A and Q-4B



Q-4A Codes of Content Analysis

- Concept design
- Demonstration
- Follow-on Development
- Continuous Capability

5.2.4.2. Evaluation of KPI-4

75% of the respondents answered the question as ‘strongly agree’, ‘agree’ or ‘neutral’. The assessment of these results can be found below:

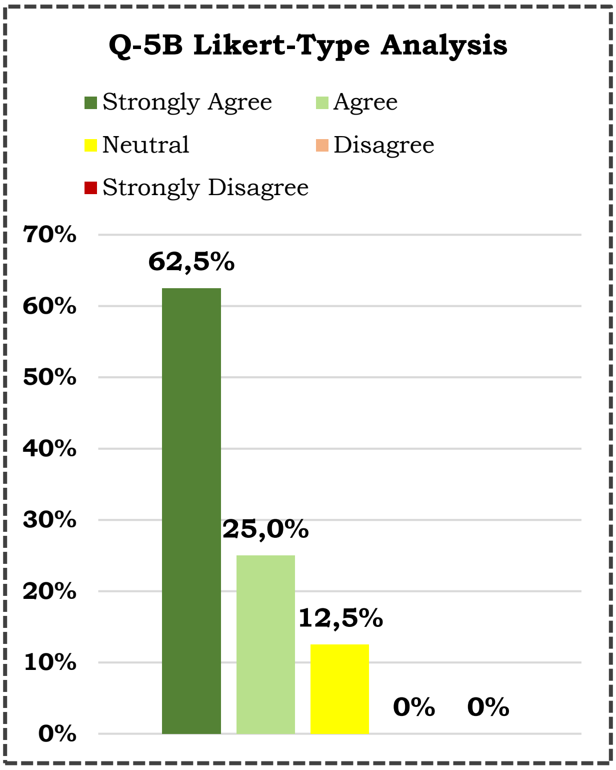
- In the JSF Program, the developmental and production activities are handled together. It is very challenging to be able to control and not easy to manage the both development and production activities in terms of configuration management.
- Although the JSF Program was divided into SDD and PSFD phases, the development unfortunately overlapped with the production serial phase and resulted in unprecedented delays and cost overruns in capability development.
- The JSF Program uses an evolving aircraft development based on the open system architecture by phasing the capabilities of the aircraft according to block phase approach. The block development approach minimizes risk in developing the operational capability. Each phase is targeted to employ certain capabilities prioritized with the users’ requirements.
- Development management is mainly focused on the end user’s needs. And also, the additional developed capabilities can be deployed through block upgrades with the user’s decision.
- The configuration of each fighter batch can be different from the others. To provide the similarity between the batches, it is needed to make retrofit plans.

As a result, the JSF Program uses an evolving aircraft development based on the block phase approach by scheduling the capabilities of aircraft. Moreover, the development plan of the F-35s has been driven based on the user’s requirements. It is important to maintain close dialogue with the users by providing an environment for discussion. The JSF Program tries to accumulate the cumulative knowledge and choose the best solutions for the Program’s future.

5.2.5. Risk and Opportunity Management in JSF Program

KPI-5: JSF Risk and Opportunity Management
Q-5A: What is the risk and opportunity management approach that you find very useful within Joint Strike Fighter (JSF) Program? Please specify:
Q-5B: Do you agree that a comprehensive risk and opportunity management exists in Joint Strike Fighter (JSF) Program? a. strongly agree b. agree c. neutral d. disagree e. strongly disagree

5.2.5.1. Analysis of Q-5A and Q-5B



Q-5A Codes of Content Analysis

- Taking the necessary actions
- Risk mitigation
- Alternative paths
- Opportunity assessment

5.2.5.2. Evaluation of KPI-5

Many respondents answered the question as positively. The explanations can be sorted as:

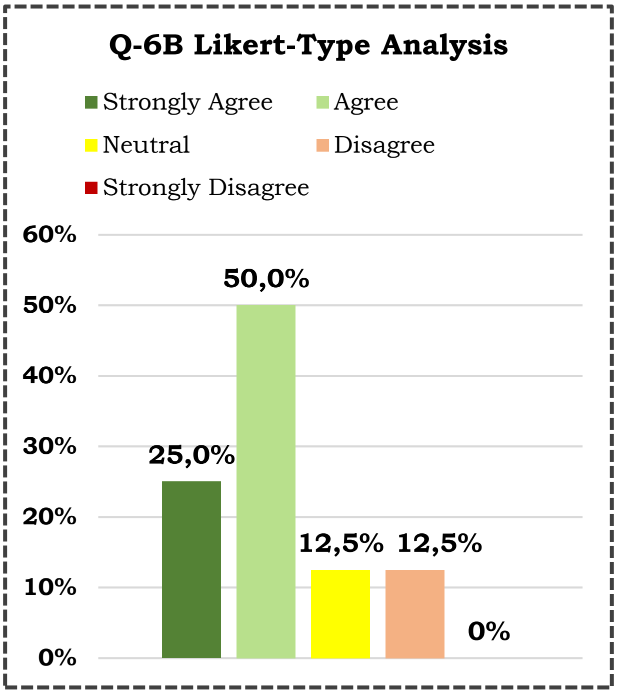
- Monitoring all program milestones and activities periodically and evaluating all the outcomes
- Taking necessary actions to make all the outcomes in order to match them with the schedule
- Holding semi-annually meetings with all JSF Program partner's seniors and bi-weekly meetings for each partner's national deputies
- Making the independent agencies audit to clarify the risks in JSF Program
- Controlling the risks and opportunities in coordination with the JSF Program partners
- Using the risk management methodologies whilst making and evaluating decisions about the JSF Program
- Modifying risks to avert and mitigate (through risk-aversion and mitigation techniques)
- Risk assessment tools can change on a case by case basis within the program; but the most used and comprehensible tool is considered the Risk and Opportunity Matrix. This matrix is updated, scheduled and unscheduled and then shared with the JSF Program partners.

As a result, the JSF Program has successful in risk and opportunity management. For example; the JSF Program Office has a special team named as Red Team. The Red Team independently examines, researches and screens any specific field of the JSF Program on behalf of the senior decision makers of the JSF Program. It is an independent team from the program and directly JSF Program Executive Officer. Red Team investigates the JSF Program risk and opportunities encountered. They report their assessments and the way of solutions about the JSF Program.

5.2.6. Technological Management in JSF Program

KPI-6: JSF Technological Management
Q-6A: What is the technological management approach that you find very useful and effective within Joint Strike Fighter (JSF) Program? Please specify:
Q-6B: Do you agree that a comprehensive technological management exists in Joint Strike Fighter (JSF) Program? a. strongly agree b. agree c. neutral d. disagree e. strongly disagree

5.2.6.1. Analysis of Q-6A and Q-6B



Q-6A Codes of Content Analysis

- Technological bases
- Technology transfer
- Technological field
- Technological level

5.2.6.2. Evaluation of KPI-6

75% of the respondents answered the question as ‘agree’ or ‘strongly agree’, They have justified their answers as follows:

- The JPO monitors all technological activities by using technological bases and controls the technological development in the perspective of the F-35 System.
- The JPO selects the aircraft production and maintenance companies in accordance with the JSF’s technological baseline document. This document is public and open to all program partners. Also, the documents are yearly updated upon approval of the partners.
- Each JSF Program’s IPT focuses on their technological fields. They report the technological advance quarterly to the seniors of the JPO.

13% of the respondents answered the question negatively, and they supported their thoughts as follows:

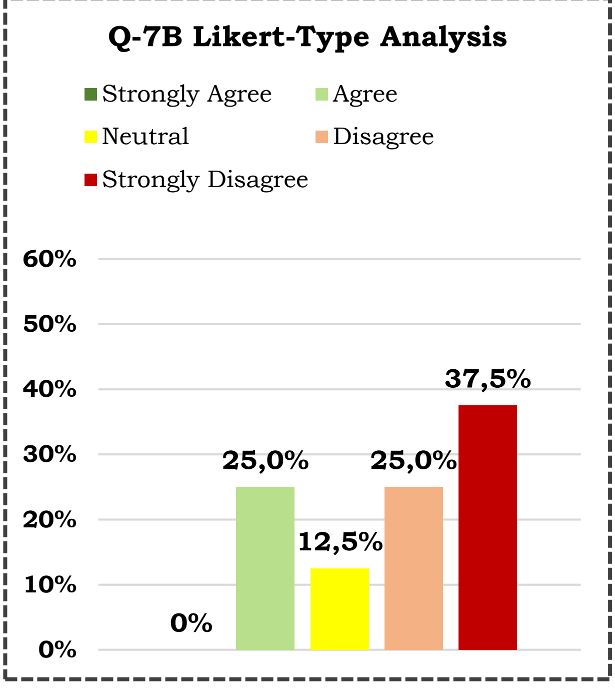
- Some of the program objectives of the F-35 technical specifications have still not been accomplished; for example, the pilot helmet technologies are currently obsolete.
- At the beginning of the JSF Program, technology transfer to the partners was one of the main program objectives; however, today, there is still no improvement on this issue.

As a result, the JSF Program is considered successful in terms of technological management. As a long-term program, the JSF Program is needed to observe and follow the technological advances closely as well as determine the required technological competency level to fulfil the program objectives. Hence, the JPO analyzes and reports to all program partners regarding the necessary technology levels in order to contribute to the program. Each partner sends its own personnel to the JPO in order to follow the technological management activities individually. Each partner is responsible for coordination between the F-35 technologies and its own national technological development level.

5.2.7. Contractual Performance in JSF Program

KPI-7: JSF Contractual Performance
Q-7A: What is the contractual management approach that you find very useful and effective within Joint Strike Fighter (JSF) Program? Please specify:
Q-7B: Do you agree that a comprehensive contractual management exists in Joint Strike Fighter (JSF) Program? a. strongly agree b. agree c. neutral d. disagree e. strongly disagree

5.2.7.1. Analysis of Q-7A and Q-7B



Q-7A Codes of Content Analysis

- Contract monitoring
- Time consuming
- Contractual obligations
- Contractual complexity

5.2.7.2. Evaluation of KPI-7

63% of the respondents answered the questions as negatively and 13% responded as neutral. The underlying causes are declared as:

- Lacking enough capability to make detail contract with the companies when increasing the number of contracts
- Probability of wrong assignment to accomplish the contractual obligations
- Difficulty in planning and monitoring of the contract
- Probability of miscommunications in the program
- Time consuming in the contract negotiations
- Increasing of the contract complexity due to number of contracts

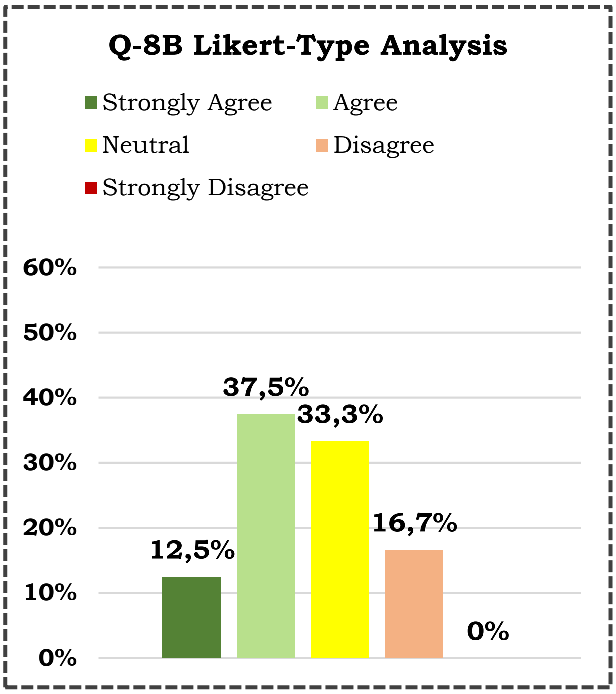
As a result, JSF Program is needed to make necessary risk mitigation to solve the contract concerns. In addition, JSF Program has too many partners and each partner have its own business contract approach, so the contractual management is a bit controversial. This was not desired but naturally occurs because of the international consortium program.

Moreover, there are more than 700 contracts in the JSF Program. The JSF Program is a large-scale program and it is not possible to determine best contract-effective solution for all contracts. Hence, the JSF Program does not have enough level of success in the contract management by comparison with two-sided single program.

5.2.8. Resource Management Performance in JSF Program

KPI-8: JSF Resource Management Performance
Q-8A: What is the resource management approach that you find very useful and effective within Joint Strike Fighter (JSF) Program? Please specify:
Q-8B: Do you agree that a comprehensive resource management exists in Joint Strike Fighter (JSF) Program? a. strongly agree b. agree c. neutral d. disagree e. strongly disagree

5.2.8.1. Analysis of Q-8A and Q-8B



Q-8A Codes of Content Analysis

- Available resources
- Resource planning
- Man-power
- Correct assignment

5.2.8.2. Evaluation of KPI-8

This topic has the greatest number of neutral answers in the study. The answers are generally positive, but only the17% of the respondents stated disagreement.

It is clarified that the JSF Program uses all partners' personnel to manage the program. In addition, the differences among the personnel are used effectively to manage the program. The JSF Program approaches acutely to the human resource management in a comprehensive way. The personnel circulation in the JSF Program is kept under the control. The collaboration and coordination between the technical and managerial project people are based on the effective relations. Despite the cultural diversity of all partners, the JSF Program established a good relation between the JSF Program staff.

The JPO generally uses the resource effectively in all partner countries but it still has some gaps,

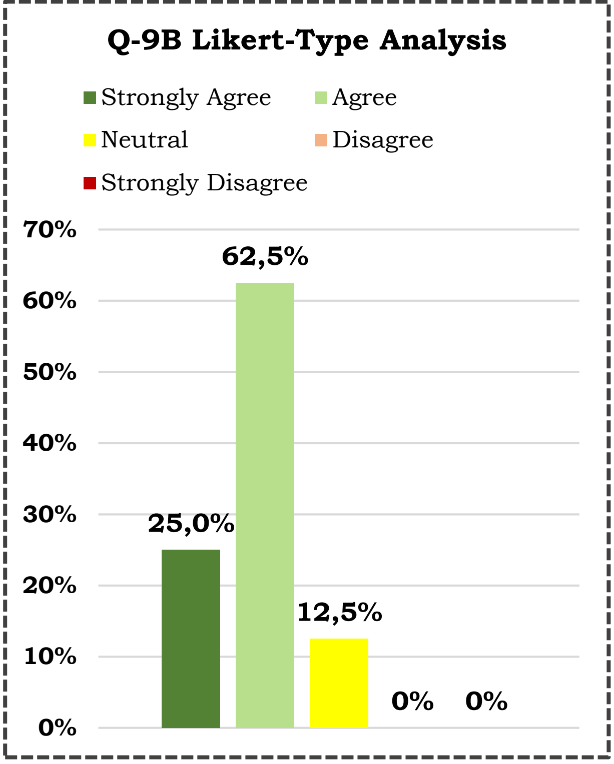
- To make efficient man-power management,
- To make correct assignment of the program personnel,
- To use available resources when required,

To manage an international program is not easy. It is required to make resource planning by considering each detail and update the resource availability frequently. As a result, it is not to say that the JSF Program has unsuccess resource management practices. And, it has applicable practices related to resource management.

5.2.9. Quality Management Performance in JSF Program

KPI-9: JSF Quality Management Performance
Q-9A: What is the quality management approach that you find very useful and effective within Joint Strike Fighter (JSF) Program? Please specify:
Q-9B: Do you agree that a comprehensive quality management exists in Joint Strike Fighter (JSF) Program? a. strongly agree b. agree c. neutral d. disagree e. strongly disagree

5.2.9.1. Analysis of Q-8A and Q-8B



Q-9A Codes of Content Analysis

- Quality Assurance
- Certification
- Qualification
- Development Test
- Production Test

5.2.9.2. Evaluation of KPI-9

More than 87% of the respondents answered the question positively.

The quality procedure of all program processes is public release. The partners can easily monitor the quality procedures. The US Air Force (USAF) is the Certification Authority of the JSF Program. Many partner countries use the same literature with the USAF. This causes to positive feedbacks to the JSF Program. With the joint library of the program, each partner country can practically access the qualification and certification test result. In addition, it is established the well-defined procedures for the program subcontractors. Every contractor uses a variety of quality process to carry out the quality management, both in subcontractor and production phases.

As a result, it is stated that the quality management in the JSF program is close to the desired level.

5.3. Summary of Chapter

In this chapter, the collected data is analyzed in both ways. The answers of the qualitative questions were analyzed by using the content analysis, being considered the most useful data interpretation technique in the qualitative data analysis method. The answers of the Likert-Type quantitative questions were analyzed by using the descriptive statistical analysis method with the Likert scale.

All nine KPIs and their coupled question set are tabulated respectively. Both methods of analysis are specified clearly. The evaluated KPIs are used in the discussion chapter in order to find best methods and practices to be applied in the National Combat Aircraft Development Program.

CHAPTER 6

DISCUSSION AND RECOMMENDATIONS

Selected Joint Strike Fighter Program's KPIs have been assessed and analyzed in previous chapters. In this chapter, with the help of assessed KPIs, the most beneficial and efficient project management practices and methods are revealed and discussed in order to be able to contribute to the management of National Combat Aircraft Development Program.

The KPIs are not listed numerically. Some of these KPIs' topics are combined with each other due to the similarity between the subjects.

6.1. Cost and Contract Management (KPI-1 and KPI-7)

JSF Program has a framework agreement for production and development named as 'Production Sustainment and Follow-on Development Memorandum of Understanding' (PSFD MOU). It is very useful for all partners because, all concerns and disputes are addressed through this framework agreement. The partnership model created under this MOU has been designed to share the overall cost based on the ratio of aircraft number in PSFD MOU. (The ratio between the number of aircraft committed by each partner country the total number of aircraft manufactured under the MOU).

With the periodically signed JSF Program contracts named as 'Low Rate Initial Production' (LRIP) contracts, the partner countries and USA services procure the F-35s and their support and training equipment. The LRIP contracts are signed for each production period individually not for all aircraft be produced, in order to the fact that these LRIP contracts enables the contract price under control. For example, according to LRIP-11 contract, main contractor Lockheed Martin will deliver 102 F-35A, 25 F-35B and 14 F-35C aircraft. Moreover, the letter of guarantee and other financial cost elements burdened by the main contractor are diminished through annual or multi-year contracts. Also, this way, it is easy to monitor the contractual activities as the time period of the contract is limited, and this limitation provides a basis for control of the program management against the main contractor. All requirements are sufficiently detailed to secure the deliverables under the contract.

The JSF Program has many types of contract considering different financial aspects. For instance, the development contract type is generally 'cost-plus incentive fee' and each contract type is handled with its own characteristics. Moreover, during the contract negotiations, the JSF Program uses the consultancy service. Any contract can be audited and examined by independent agencies.

Furthermore, 'Block-Buy' is another contract approach in JSF Program in order to reduce the program production cost. The JSF Program executes the Block-Buy contract strategy which procures three years of material and equipment in a single year enabling industry to generate savings through quantity and long-term arrangements. Indeed, the Block-Buy contract comprises several contracts under one contract, so it is assumed very cost-efficient in terms of contractual management.

The JSF Program always tries to broaden international customer base, keeps program sold and decreases the unit price. In order to drive down per unit production cost and provide the affordability, the JSF Program conducts cost reduction and investment efforts which enable the cost reduction initiatives across main contractors' and its subcontractors' production lines with the targeted goal of reducing per unit costs.

The JSF Program Office uses a specific financial system that runs within the contractual structure. The established cost database is used to investigate and monitor the cost by referencing the past cost values. Additionally, the JSF Program Office calculates the cost items with the help of the outsourced consultancy firms. This provides a control in the program cost.

Considering above assessments about cost and contract management in the JSF Program, the below are duly recommended in order to make better cost and contract management in the National Combat Aircraft Development Program.

Firstly, it is needed to use a specific customized financial system for TFX Program. A wide range of database is needed to establish to record the all program cost details. When establishing the program cost details, TFX Program should ask for help of an auditing consultancy company which has an expertise in large-scale programs.

Secondly, making the contract scope lower and contract period shorter provides the advantage the TFX Program management over the contractors. The negotiation power is always hold by the TFX Program management team during the program life-time.

Thirdly, a framework agreement that includes all the fundamental principles pertaining to the TFX Program should be constituted in order to prevent the negotiations of same contract clauses repeatedly. It provides savings in time and effort across the TFX Program.

Lastly, the TFX Program cost management should be based on the accountable mechanism. It is needed to increase the transparency of the cost management in the TFX Program in order to prevent any potential ambiguities in future.

6.2. Time Management (KPI-2)

It is no doubt that the JSF is a significant large-scale program. Therefore, the delays can be accepted as is normal for long time such programs. The delay in schedule generally seems as a state of nature of the large-scale development programs. To prevent or minimize the delays, the JSF Program uses the phased schedule management approach. In the development period of the program, each phase along with the capabilities are scheduled in line with the maturation level of the aircraft. It is called block approach as stated in third chapter. In addition, the development period was not finished when starting the F-35 aircraft manufacturing however, the JSF Program has continued the block approach decision.

In the production period, the JSF Program wants the partners to give their aircraft acquisition orders four years before the aircraft deliveries. The JSF Program gives the long time for planning and production to the contractor and its subcontractors. So, the contractor and subcontractors can plan production within two years into the program.

In addition, the schedule of the JSF Program is based on the flexibility. The schedule tables are updated quarterly basis and all parties are expected to agree on updated changes updated changes. Therefore, it is a real-time schedule. The master schedule details each task and the relationship with the other tasks. Each personnel can easily access the master schedule to see the program in a holistic way.

Considering above assessments about time management in the JSF Program, the below lesson-learnt methods are sorted for the project personnel performed in TFX Program to make better time management in the TFX Program.

Firstly, due to the complexity of TFX Program, a robust, well-defined, agile and integrated master schedule is essential that defines all the various types of assigned program tasks and how these program tasks interact with each other. The integrated master schedule covers the program tasks, task durations, sequence of tasks and dependencies / interdependencies of the tasks by analyzing the critical path of whole TFX Program. Further, the integrated master schedule is pursued in a flexible way in order to allow the compensation of any delays. The number of program tasks and activities are controlled within the limit of program scope by mapping with the program workload. The TFX Program master schedule is needed to be a living document and updated periodically by aligning with all program partners. Each TFX Program personnel is aware of all program activities.

Secondly, the program activity durations should be estimated precisely and ordered certain items to prevent the latency in long lead items. The calculation of the dates is carried out in order to be sure that master schedule meet the TFX Program milestones. The program activities / task should be phased with the entry and exit criteria.

Thirdly, while monitoring the master schedule closely, the independent program activities should be performed in parallel. The program activity durations should be amended, shortened and shifted to left where appropriate. To provide the real-time optimization for the integrated master schedule of the TFX Program, a group of project personnel should be dedicated throughout the TFX Program life time.

Lastly, in case of any milestone delay or program latencies, the TFX Program should have a quick response time in order to prevent the delay and make an equilibrium again between the planned time and actual time. The specific task force or tiger team should be created from the project personnel to interrupt latencies.

6.3. Program Management Team (KPI-3)

JSF Program principles are defined strategically. The program strategy is highly robust; therefore, it cannot be changed easily. All roles and responsibilities of the stakeholders, the parties and the partners are clearly specified in the JSF Program. Thus, there is no conflict of interest between the parties. Instead, each party has a mutual benefit. The decision-making process is pre-determined and well defined.

The JSF Program management approach can be described as ‘agile management’ due to its resourceful and responsive attitudes in the program management. In the previous chapters, the JSF Program Office (JPO) was explained as mean of the JSF Program management team. The JSF Program Office acts as an independent body, providing security of resources and managing the priorities in an efficient way. The JSF Program Office integrates all parties of the program. The communication between the project personnel and executives is well established.

The JSF Program Office uses the well-established expert working groups and decision-making boards with partner nation’s involvement to make a decision about the program. The JSF Program Office addresses program management meeting or executive steering board meeting to all the partner countries in order to declare their requests and concerns with regard to the JSF Program. These program meetings are conducted with all stakeholders of JSF Program therefore, any program-related information is quickly distributed real-time to relevant people. The JSF Program Office ensures and protects all partners’ rights to speech under the title of partnership.

In some cases, to provide the optimization in project management, JSF Program Office assigns different sub-groups to implement the same specific program tasks/activities. Each project sub-group works on the same program tasks/activities independently from each other. After the completion of sub-groups works, the JSF Program Office evaluates the results and choose the most cost-effective solution for the program. Moreover, the JSF Program Office is considered transparent and accountable to the public as much as possible. All cost documents can be found without any issue.

In any case of crisis related to the JSF Program management, the JSF Program Office establishes a red team from different expert project people to investigate the core reason of the problem and keeps the team active until it has been resolved.

As known, the JSF and TFX program are different from each other in terms of program models. Each program is the idiosyncratic and individual, so it should be evaluated in its conditions. The JSF Program is a consortium model but the TFX is not a consortium program at least for now. Although Joint Strike Fighter Program seems as a consortium program, the United States of America is the leading country and its services are the huge stakeholders in the JSF Program.

In the light of assessments and evaluations expressed along the thesis, it is recommended the following management methods and practices to use directly in the TFX Program in order to establish a better program management team.

Firstly, it is needed to clarify the roles and responsibilities all the TFX Program stakeholders. Each TFX Program stakeholder should establish its sphere of influence with increasing the mutual benefits and decreasing the conflict of interest.

Secondly, the TFX Program strategy should be settled in logical clarity and kept it on track. The TFX Program management team should execute the strategy with the defined technical, schedule and cost commitments within the program constraints by coordinating the program activities across all stakeholders.

Thirdly, the TFX Program management team should communicate quickly and transparently with the users, the contractors and the national defense management seniors in order to give reliable information related to the TFX Program and to ensure them about its status and events.

Fourthly, the management team should have comprehensive knowledge of the TFX Program, and no surprises detriment to the program are revealed. To provide a common language in the program management, it is needed to establish an information sharing platform. For example, that platform can be a digital library involving all TFX Program documents and information materials. These documents, according to their secret levels, can be shareable to all the stakeholders of the TFX Program. Furthermore, the TFX Program management team should be vigilant for publicity problems and other contrary initiatives, be transparent to the public and provide reliable information so as to prevent the spread of false news about the TFX Program.

Lastly, the TFX Program management team should be available for the new national or international stakeholders and customers by expanding the TFX Program base and synchronizing the differences. Additionally, the management team should identify a consistent message to the outside world about why people/firms/services/governments want be part of the TFX program.

6.4. Technology and Development Management (KPI-4 and KPI-6)

The JSF Program establishes its technology management approach based on a holistic development strategy. For example, there exists a science and technology forum in the JSF Program. This forum seeks the development and availability of the middle and future term technologies to be implemented in the JSF Program. Moreover, the science and technology guideline documents are published by the JSF Program for the awareness of all program stakeholders. According to the science and technology guidelines, the obsolete technologies are determined before their production date expires and they are handled in order to provide technological upgrades and technological sustainability in the F-35 aircraft. Besides, both hardware and software systems of the F-35 aircraft are implemented as an open architecture to accommodate any growth needed due to the evolving along with the partner's updated technological requirements thread.

The JSF Program conducts the incremental capability development and integration approach for the aircraft, the weapons, the support equipment and the whole integration processes. The JSF Program uses an evolving aircraft development based on the open system architecture by phasing the capabilities of the aircraft according to block phase approach. The block development approach minimizes risk in developing the operational capability. Each phase is targeted to employ certain capabilities prioritized with the users' requirements. The F-35 aircraft operational capability increments started with Block 0 where flight essential capabilities for all three variants and growth up to the Block 4. The block approach can be tailored to future capability blocks by the JSF Program decision. The additional capabilities will be developed and deployed through block upgrades such as Block 4.1, 4.2 etc.

On the other hand, the JSF Program has recently re-assessed the planned block approach and decided to apply a new type of block approach called the 'Continuous Capability Development'. The Continuous Capability Development approach is designed and optimized for continues modernization, enhancement, and improvements to the entire F 35 aircraft and deliver Block 4 in smaller capability on an expedited timeline. This new type of block approach is being carried out in a continuous manner which increases the program efficiency effectively and smoothly.

Considering above explanations about the technology and development management of the JSF Program, it is obviously clear that the block approach is the most useful method in the development management. For this reason, in order to constitute a better development and technology management in the TFX Program, the following recommendations are listed.

Firstly, phasing the development of aircraft into manageable pieces through its lifecycle instead of achieving the maximum intended capability at once should be the fundamental principle of the TFX Program.

Secondly, the TFX Program should pursue an evolutionary incremental build defined as blocks. The aircraft certain capabilities should be assigned to these blocks having the clearly and in detail defined capabilities. In order to assess maturity of each block, the block's expected capability, the expected sub-systems and components should be clarified. Even, the sub-blocks may sometimes be defined in order to manage the aircraft development. Each block is built on the previous one and have more capabilities than the previous one.

Lastly, due to the being of aircraft development program as long term, the TFX Program should establish a science and technology committee or working group in order to trace the current technology and handle the obsolete technology during the development stage of the aircraft. This committee/group should guide to the TFX Program executives/decision-makers according to the future technological trends.

6.5. Resource Management (KPI-8)

In JSF Program, one of the most important issues is the resource management. The resource management is responsible for the program non-technical infrastructure that includes the human resources, staffing, staff training and program materials. The resource management is also responsible for discretionary funds planning for the program, which includes planning for capital, information technology and production activities of the JSF Program.

The JSF Program approaches acutely to the human resource management in a comprehensive way. The personnel circulation in the JSF Program is kept under control. The collaboration and coordination between the technical and managerial project people are based on the effective relations. Despite the cultural diversity of all partners, the JSF Program established a good relation between the JSF Program staff.

The selection of global suppliers of F-35 is based on the best value approach. relationship among the partner's personnel. Moreover, it is obligatory to assign the personnel within appropriate level of skills and education in the JSF program. Each personnel should have a specified education level and they are assigned as his or her capability. For instance, the JSF Program uses the retired military personnel as a field expert on the base works. In addition, the JSF Program assigns the personnel retired from industry into the contract negotiations.

The resource management includes the material management and production activities. The JSF Program's "best value approach" is a good example for the resource management. The best value approach means that the JSF Program makes the cost and benefit trade-off among the military and industry capabilities, facilities and opportunities the program partners have. It creates a baseline as common as possible in every aspect of the program for the maximum saving. Hence, it is applied in order to increase the efficiency of the program. Both military depots and industrial capabilities are used appropriately in order to achieve a drive the multidimensional affordability.

The information management is another item of resource management. In JSF Program is managed The Joint Data Library (JDL). The JDL is a digital online sharing platform and it is the primary information source of the JSF Program. By JDL, it is so easy to control the program information and program documents. All documents about the JSF Program are uploaded to the Joint Data Library can be downloaded within the 'need to know principle'.

Considering above assessments about the JSF Program resource management practices, to make better resource management in the TFX Program, the following recommendations are listed.

Firstly, in order to have an effective resource management in TFX Program, the resource types and quantities should be assigned to related tasks within the program schedule. The purpose of assigning resource is to provide availability of resources required to carry out the TFX Program's workload.

Secondly, all the tasks and activities within TFX Program schedule should have resources with specific role types. When all resources types of the program should be determined with the total resource demand, by skill set over time should be calculated in consideration with all details. The output of this exercise should feed into the TFX Program resource-planning assumptions in order to make efficient program management. Recognizing the criticality of staff ramp-up and the specific focus should be provided to meet both the human resources targets in areas of critical skills in the TFX Program. The TFX Program executives should review program staffing on a regular basis. The generation of an accurate staffing demand line is important and should be reconciled with the integrated master schedule of the program. It is needed to plan the resource strategy in the initial months to minimize the start-up difficulties caused by delays in staffing. The TFX is a long-term program therefore; a significant increase in staff will occur over the course of the TFX program. As a result, in order to minimize disruption to the program management workload, the collaboration and coordination among the project personnel should be increased in place with a strictly detailed plan.

Thirdly, the TFX Program should assign the project people according to their education and skills and not show favor to any personnel. All the project personnel in TFX Program is also responsible to take care of skill and competency development. In this regard, the additional training requirements should be requested other than standardized with each specific role or specifically designed for the orientation. These requests should be reviewed and negotiated by the TFX Program management team and then, on a yearly basis the requests should be presented to the upper management. These trainings should be performed and monitored, and the trained project personnel should be kept in the TFX Program regardless of their position.

Lastly, in order to make better information management in TFX Program, it is needed to set a shareable information platform in the program. Building an information pool or an online library including all documents of program should be established. The TFX Program uses a variety of programmatic data and command media which interests all the TFX Program stakeholders. Therefore, that platform should be accessible to all the contractors, suppliers and users. It should provide for communicating in the collaborative workspaces along with the TFX Program life cycle.

6.6. Quality Management (KPI-9)

Three exists an independent quality management tools and process in the JPO. Whole production process is being monitored by the JPO accordingly to defined quality management plan. The JSF Program uses the holistic approach and implements the NATO quality system which provides commonality and flexibility around the globe. In addition, it is established the well-defined procedures for the program subcontractors. Every contractor uses a variety of quality process to carry out the quality management, both in subcontractor and production phases. The JSF Program controls the quality of approximately 3000 production points and manages the quality assurance in the whole global suppliers.

Considering above assessments about the JSF Program quality management practices, to make a better quality management in the TFX Program, the following recommendations are listed.

Firstly, in order to manage the quality of the TFX Program, the quality planning, quality control and quality assurance should be fulfilled. It is needed to define the quality assurance procedures along with the all program contractors and make guiding to the subcontractors to capture the same and required quality level.

Secondly, the TFX Program should be responsible for standardizing the quality processes for all parties of defense industry, planning the quality processes and control the production and development activities with respect to the quality management system by keeping the risk management and configuration management in order to provide the product safety.

Lastly, the TFX Program should ensure the evaluating, monitoring, measuring and analyzing the program performance and the stakeholder's satisfaction. As a result, the quality management is not only under the responsibility of the contractors or manufacturer and the traceability and commonality of the quality management should be provided over the course of TFX Program.

6.7. Risk and Opportunity Management (KPI-5)

The JSF Program continuously controls the program development risks and assesses the potential actions implementing the action plans and monitoring the actions until completion. The JSF Program management team encourages early threat and opportunity identification, coupled with aggressive mitigation and achievement efforts. The risk and opportunity management process apply to all threats and opportunities and defines the approach, resources, interfaces, processes, requirements, and program schedule.

The risk and opportunity management is integral to overall JSF Program management. Its value is improving the likelihood of attaining program cost, schedule and performance objectives. The JSF Program risk and opportunity management provides an orderly approach to making decisions about program threats and opportunities. It includes planning to prevent problem occurrence, the mitigation of program impacts if risks are realized and problems occur, pursuit of opportunities, and tracking the status of the risk and opportunity handling plan progress. The risk and opportunity management is designed to be a continuous process and it is active at all levels of the JSF Program involving all the partners of the F-35 Program. For example, the block phase approach is used in both development stage and production stage of the JSF Program in order to mitigate product risk.

The JSF Program applies the risk and opportunity management on the suppliers and subcontractors when renewing the contracts. The contract renewal works are done by considering the best value principles in the project with the certain period. Therefore, the risk decreases and opportunity percentage increases. In addition, the JSF Program searches for alternative companies and vendors for outsource. In order to mitigate any risk related to the contractors and subcontractors' production, the capacity of the workload distributed to two companies according to the ratio between 30% and 70%. In addition, there always exist the production opportunities for the companies because the assignments of the work packages are based on the 'best value approach' assessment.

Although, very strong risk and opportunity management process is defined by the JSF Program, the unforeseen risk sometimes occurs. From time to time, the JSF Program management team establishes the tiger teams to eliminate any potential risks especially financial and technological.

In the light of assessments and evaluations expressed above, below risk and opportunity management methods and practices are recommended in order to use directly in the TFX Program.

Firstly, the risk management strategy for the TFX Program should be identified in the critical areas in order to take necessary actions before they can become issues causing the severe cost, schedule and performance impacts. On the other hand, the opportunity management strategy for the TFX Program should be identified in the potential areas and take necessary actions to realize them in order to bring benefit to the TFX Program in terms of cost, schedule and performance. In addition, to constitute more effective and applicable risk and opportunity management, the risk and opportunity management should be driven by the two different expert working groups.

Moreover, the TFX Program should enable to create a risk mitigation tiger team that should be vigilance to solve any problem occurs.

Secondly, seeking the possible program risk, estimating the impact of risks and mitigating them before they arise are the essentials for constitute a better risk management in TFX Program. The pre-emptive measures should be justified according to the cost benefit and should be planned and carried out at the most effective time. And, phasing the development and production activities enables to the risk mitigation.

Lastly, the TFX Program management team should always have a back-up plan for production activities by using the alternative suppliers and vendors. In case of any problem, the back-up vendors and suppliers insert to the program in order to prevent the schedule delay.

6.7. Summary of Chapter

Selected JSF Program’s KPIs are discussed detailly in this chapter. It is not to say that all JSF Program’s practices and methods are applicable for using in TFX Program but many of them can be utilized by taking into consideration of TFX Program’s constraints.

CHAPTER 7

CONCLUSION

In this thesis, the Joint Strike Fighter Program has been used as a case study to better reflect the lessons learnt and critical findings to the National Combat Aircraft Development Program managed by SSB. Through this case study, selected Key Performance Indicators have been identified and interrelations between each of these factors has been investigated. As the biggest advantage of using a case study is that it enables a deeper penetration into the core of the issue (Lans & Van Der Voordt, 2002), it is thought that using this methodology generated a better outlook in terms of evaluating the outcomes of the JSF Program.

Furthermore, it is believed that transferring the JSF Program experience to the TFX Program will result in time and cost savings in resource management, namely labor, material and facilities, which undoubtedly create bigger multiplier effects on the overall defense sector as well as the country's economy as well as ensuring and enhancing national and international security through the utilization of better management practices, including better maintenance, better staff management, better leadership promoting transparency, better coordination between the partnering countries and more aligned processes.

The TFX Program is considered the largest defense development program in Turkey's history, and the management of such a program is indeed a great challenge for Turkish defense industry companies given technological and economical requirements. Therefore, it is not easy to be able to manage such a program in an efficient manner. Given that such a difficulty is coupled with the cultural, legislative, financial and technological differences between the countries, and in order to ensure a smooth management practice, a robust planning, streamlining the processes, utilization of software tools to better manage to change, such as configuration, requirements, or cost increases with limited budgets are absolute musts. The JSF Program therefore constitutes a great case in terms of taking into account all these so as to eliminate the bad practices that may be encountered in the TFX Program. Although the TFX Program currently is not a multinational program, it is believed that most large-scale programs face similar problems. As it has been further investigated in this thesis, a solid project management mechanism involving all parties is definitely a backbone of the success of any program. The most important thing is to ensure that the project management practices should be owned by all relevant people and monitored frequently and updated accordingly with the inclusion of any potential future issues.

With this thesis, the researcher aims at answering the research question:

> "How can be determined the best project management practices be determined to apply in the National Combat Aircraft Development Program by using the experience from the Joint Strike Fighter Program?"

The researcher has identified the following research objectives and aimed at achieving these objectives through an in-depth literature review, interviews and questionnaire study involving twenty-four SSB personnel so as to be able to answer the research question:

- Definition, evolution and application of the project management in defense industries
- Giving information about the National Combat Aircraft Development Program and Joint Strike Fighter Program and their status
- Showing the comparability of the both program in terms of project management approach

- Definition of the project success criteria and the measurement methods
- Measuring the level of success in project management by using Key Performance Indicators
- Determination of the applicable KPIs to capture the current status of the Joint Strike Fighter Program
- Exploration and analysis of the Joint Strike Fighter Program success and failure in terms of project management
- Making recommendations for the benefit of the National Combat Aircraft Development Program through sampling the current project management practices and methods used in Joint Strike Fighter Program

The thesis structured in seven chapters. The first chapter is the introduction, which depicts the history, problematic, methodology and discussion with the scope of thesis. The second chapter is the literature review regarding project and program management.

In the third chapter, a literature review is presented regarding the detailed characteristics of Joint Strike Fighter Program with its historical, managerial, contractual, technological and financial factors. All those details have been obtained from open source documents as well as several specific reports, papers etc. published by the United States Department of Defense and the Joint Strike Fighter Program Office. The National Combat Aircraft Development Program is partially different from the Joint Strike Fighter Program. There exists very few open source or published documents for the public use. However, for this study, SSB's unclassified official records are used whilst stating the information regarding the National Aircraft Development Program.

In the fourth chapter, the research methodology of the thesis is detailed. In order to understand the main paradigm of program management and to determine the crucial parameters of each phases of Joint Strike Fighter

Program management, a set of key performance indicators has been defined through carrying out various interviews with SSB executives who took part/are taking part in the Joint Strike Fighter Program. Furthermore, a questionnaire study has been prepared comprising 18 questions through the conversion of the Joint Strike Fighter Program's KPIs to the questions. The questionnaire was carried out on 24 SSB personnel who were/are currently in the JSF Program. Some of the respondents were/are senior or executive project personnel in the program management, and they have made tremendous contribution to this research by not only answering the questions, but also the providing refreshing viewpoints. The findings of the questionnaire have been stated at the end of this chapter.

In the fifth chapter, the answers of the qualitative questions were analyzed by using the content analysis, the useful data interpretation technique in the qualitative data analysis method. The answers of the Likert-Type quantitative questions were analyzed by using the descriptive statistical analysis method with the Likert scale. So, the collected data is analyzed within both ways. All nine KPIs and their coupled question set are tabulated respectively. The both methods of analyze are specified. Evaluated KPIs will used in discussion chapter in order to find best methods and practices to be applied in the National Combat Aircraft Development Program.

In the sixth chapter, there is the recommendations section. The discussion and recommendations chapter focuses on the compiled the list of best practices used in the JSF Program and, explains the critical methods and practices originating from the assessment of the evaluations touched upon in the fifth chapter in order to make ensure better project management in the National Combat Aircraft Development Program.

To conclude, given the recommendations and issues addressed in this study, the researcher believes that ensuring good project management in the National Combat Aircraft Development Program requires;

- Calculating each contract price with the help of a third-party consultancy company/auditing company
- Establishing a large-scale database in order to record and monitor each detail of the program cost
- Making the contract scope short in order to prevent the contractor from huge financial burden and keep the negotiation power in the hand
- Increasing the transparency of the program cost in order to prevent the ambiguities among the relevant parties
- Making a constitutional framework agreement including fundamental principles of the program and each sub-contract are covered it
- Setting a flexible master schedule and updating that schedule periodically
- Phasing the program activities with an 'entry and exit' criteria
- Ordering the certain items to prevent the delay in long lead items
- Clarifying the roles and responsibilities of all stakeholders in the program
- Setting a highly robust strategy with a logical clarity
- Increasing the mutual benefits and decreasing the probability of any conflict of interests in the program as possible
- Assigning different working groups with the same duties and tasks to find the most-suited solutions
- Providing reliable information to the public ensuring transparency
- Harmonizing and synchronizing the differences in the program
- Establishing a science and technology committee to trace the current technological advances and changes and providing updates, upgrades and modernization of obsolete technologies
- Using the block phase approach to make the continuity of the incremental development
- Determining certain capabilities of each block clearly and in a detailed manner

- Providing required training for the project personnel and keeping that personnel in the program as possible regardless of their position
- Assigning project people based on their education and skills without favoring any personnel / or avoiding nepotism.
- Building an information pool or an online library including all program documents
- Enhancing collaboration and coordination among personnel
- Defining all necessary quality assurance procedures along with the contractor
- Guiding subcontractors to ensure the standardization and to make them at the same quality level
- Standardizing quality processes for all relevant parties of the defense industry
- Investigating and finding potential risks and monitoring them through a risk management plan before they occur
- Phasing all activities in order to mitigate the risks
- Planning of alternative back-up suppliers and vendors
- Establishing tiger teams to eliminate specific risks

In the light of the above and considering the issues discussed in this thesis, the researcher concludes that there is no "magic wand" in the Joint Strike Fighter Program. All project management methods applied in the Joint Strike Fighter Program have already been stated and discussed in the project management best practice methodologies such as PMBOK or other standards, for many years. Therefore, there is nothing new in the Joint Strike Fighter Program as a management method that is recently discovered and different from the existing project management literature. The Joint Strike Fighter Program uses the already known methods and practices.

The intention of the researcher is not "to preach to the choir", however; only to discuss the success of project management methods and practices which have already been applied in the Joint Strike Fighter Program. The success of these methods and practices have been confirmed by the Joint Strike

Fighter Program as such a large-scale defense program. Therefore, it can be said that all recommendations made in the previous chapter are considered to be proven tracks to pave way to success in the project management of National Combat Aircraft Development Program. As a result, using these project management methods proportionally in order to manage the large-scale defense programs as well as the National Combat Aircraft Development Program would bring success.

To conclude, this thesis has been written in order to determine the practices and methods to be applied in the management of the National Combat Aircraft Development Program by extracting lessons-learnt from the Joint Strike Fighter Program. It is believed that transferring the Joint Strike Fighter Program experience to the National Combat Aircraft Development Program would hopefully result in significant time and cost savings. As a researcher, it is very important to be able to make contribution to the National Combat Aircraft Development Program with this study.

CHAPTER 8

FURTHER STUDIES

- Investigation on the Preliminary Design Phase and Critically Design Phase of Joint Strike Fighter Program to capture the system engineering approach.

- The probability and applicability of consortium model for the National Combat Aircraft Development Program

- Analyzing the Joint Strike Fighter Program management as a user from the Turkish Air Force perspective

- The transparency of the large-scale defense programs such Joint Strike Fighter Program as a case study

- Analyzing the conceptual comparability of the F-35 and the TFX fighter aircraft

- Analyzing the effects of the political issues on the large -scale defense programs

REFERENCES

Anadolu Agency. (2019, 6 17). *Turkey's First Fighter Jet Makes Debut in Paris*. Retrieved from Anadolu Agency: https://www.aa.com.tr/en/europe/turkeys-first-fighter-jet-makes-debut-in-paris/1506658

Air Combat Command Public Affairs Office. (2014, April 11). *F-35A Lightning II*. Retrieved from U.S. AIR FORCE: https://www.af.mil/About-Us/Fact-Sheets/Display/Article/478441/f-35a-lightning-ii-conventional-takeoff-and-landing-variant/

Akşam. (2010, 12 15). *İlk Türk Savaş Uçağı Yolda*. Retrieved from Akşam Gazetesi: https://www.aksam.com.tr/guncel/ilk-turk-savas-ucagi-yolda--3736h/haber-3736

Andrews, P. B. (2002). *An Introduction to Mathematical Logic and Type Theory* (Vol. 27). Springer Science & Business Media.

Arora, A. (1996). Contracting for Tacit Knowledge: The Provision of Technical Services in Technology Licensing Contract. *Journal of Development Economics*, pp. 233-256.

Atkinson, R. (1999). Project Management: Cost, Time and Quality, Two Best Guesses and a Phenomenon, Its Time to Accept Other Success Criteria. *International Journal of Project Management*, 337-342.

Bart, C. K. (1993, 23 3). Controlling New Product R&D Projects. *R&D Management*, s. 187-197.

Bloomberg HT. (2018, 4 26). *Aselsan ve TUSAŞ'tan Milli Savaş Uçağı İmzası.* Retrieved from Bloomberg HT: https://businessht.bloomberght.com

/sirket-haberleri/haber/1935837-aselsan-ve-tusas-tan-milli-savas-ucagi-imzasi

Bogdan, L. G. (2015, July 31). *F-35 Program Executive Office Statement*. Retrieved from U.S. Marine Corps: https://www.marines.mil/News/News-Display/Article/611704/f-35-program-executive-office-statement

Bolkcom, C. (2009, 2 17). F-35 Lightning II Joint Strike Fighter (JSF) Program: Background, Status and Issues. *Congressional Research Service Report For Congress*(RL30563), pp. 4-5.

Boone, Jr., H., & Boone, D. (2012, 4). Analyzing Likert Data. *Journal of Extension, 50*(2).

British Standard 6079. (2000). *Program Management Part 1.* British Standard Institute.

Burke, R. (1999). *Project Management: Planning and Control Techniques.* Chichester: John Wiley & Sons Ltd.

Buzan, T. (2006). *Mind Mapping.* Pearson Education.

Cahoon, S. (2019). *AN/AAQ-37 Distributed Aperture System (DAS) for the F-35.* Retrieved from Northrop Grumman: https://www.northropgrumman.com/Capabilities/ANAAQ37F35/Pages/default.aspx

Cahoon, S. (2019). *AN/APG-81 AESA Radar*. Retrieved from Northrop Grumman Corporation.: https://www.northropgrumman.com/Capabilities/ANAPG81AESARadar/Pages/default.aspx

Calvello, G., Olin, S., Hess, A., & Frith, P. (2007, April 11). PHM and Corrosion Control on the Joint Strike Fighter. *Corrosion Reviews*, pp. 51-80.

Caruso, T. (2016). *AN/ASQ-239: Electronic Warfare/Countermeasure System.* BAE Systems. Retrieved from https://www.baesystems.com/en-us/product/an-asq-239-f-35-ew-countermeasure-system

Casonato, R., & Harris, K. (1999, March 16). Can an Enterprise Really Capture "Tacit Knowledge"? We Answer TwoTop Questions on Knowledge Management from the Electronic Workplace 1999 Conference. *Gartner Group Research Note Select Q&A*.

Chief of Naval Operations. (2009, July 29). *Navy Rolls Out Joint Strike Fighter*. Retrieved from America's Navy: https://www.navy.mil /submit/display.asp?story_id=47269

Cleland, D. I., & King, W. R. (1988). *Project Management Handbook.* Van Nostrand Reinhold.

Collis, J., & Hussey, R. (2003). *Business Research.* Hampshire: Palgrave Macmillian.

Corallo, A., Passiante, G., & Prencipe, A. (2007). The Management of Intellectual Property. In *The Digital Business Ecosystem* (pp. 175 - 176). Cheltenham, U.K.: Edward Elgar Publishing Limited.

Corbetta, P. (2003). *Social Research: Theory, Methods and Techniques.* London, Thousands Oak, New Delhi: Sage Publications.

Counts, M. A., Kiger, B., Hoffschwelle, J., Houtman, A., & Henderson, G. (2018). F-35 Air Vehicle Configuration Development. *2018 Aviation Technology, Integration, and Operations Conference, 3367.* Atlanta.

Dampney, K., Busch, P., & Richards, D. (2002). The Meaning Of Tacit Knowledge. *AJIS Special Issue*, 3.

DAU. (2001). *Systems Engıneering Fundamentals.* Fort Belvoir: Defense Acquisıtion University Press.

Davis, R. (1997, 3 5). Combat Air Power Report: Joint Mission Assessments Could Enhance Investment Decisions. *United States General Accounting Office Report*, pp. 1-18.

Defence Turkey. (2017, Vol. 12). *Turkish Fighter in TuRAF Inventory Beyond 2030s.* Retrieved from Defence Turkey Magazine: https://www.defenceturkey.com/en/content/turkish-fighter-in-turaf-inventory-beyond-2030s-2838

Defense Acquisition Guidebook. (2010). *System Engineering.* Fort Belvoir: Defense Acquisition University.

DeLone, W., & McLean, E. (1992). Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research* , 60-95.

Demirağ, N. (1938). *Tayyare Atelyesi Dahilî Talimatnamesi.* İstanbul: Ülkü Basımevi.

Demirci, A. (2005). Küreselleşen Dünyamızda Coğrafyanın Siyasal Gücü ve Türkiye Ölçeğindeki Rolü. *Marmara Coğrafya Dergisi*(12), 1-16.

Douhet, G. (1942). *The Command of The Air.* New York: Coward McCann.

Dörnyei, Z. (2007). *Research Methods in Applied Linguistics: Quantitative, Qualitative, And Mixed Methodologies.* Oxford: Oxford University Press.

Drucker, P. F. (2011). *The Practice of Management* . New York: Routledge.

Dvir, D., Shenhar, A. J., & Alkaher, S. (2003). From a Single Discipline Product to a Multidisciplinary System: Adapting the Right Style to the Right Project. *Systems Engineering, 6*(3), pp. 123-134.

Etzkowitz, H. (1983, 6). Entrepreneurial Scientists and Entrepreneurial Universities in American Academic Science. *Minerva, 21*(2/3), 198-233.

Evans, A. A., & Gibbons, D. (2008). *The Compact Timeline of Aviation History.* Worth Publishers.

Family Health International. (2011, July). *Qualitative Research Methods: A Data Collector's Field Guide.* Retrieved from Family Health International: https://www.fhi360.org/sites/default/files/media/documents/Qualitative%20Research%20Methods%20-%20A%20Data%20Collector's%20Field%20Guide.pdf

FAR Subpart 16.2. (2019). *Federal Acquisition Regulation.* General Services Administration. Washington DC: United States Department of Defense.

Fisher, R., & Geiselman, R. E. (1992). *Memory Enhancing Techniques For Investigative Interviewing: The Cognitive Interview.* Charles C. Thomas Publisher.

Forecast International. (2011, March). *General Electric/Rolls-Royce F136 Archived Report.* Retrieved from Forecast International: https://www.forecastinternational.com/archive/disp_pdf.cfm?DACH_RECNO=856

Frey, T., Aguilar, J., Engebretson, K., Faulk, D., & Lenning, L. (2018). *F-35 Information Fussion.* Fort Worth, Texas: Lockheed Martin Aeronautics Company.

GAO Report. (2018, 6 13). Development Is Nearly Complete, but Deficiencies Found in Testing Need to Be Resolved. *United States Government Accountability Office Report, GAO-18-321*, pp. 4-19.

GAO Report. (2019, 4 29). Action Needed to Improve Reliability and Prepare for Modernization Efforts. *United States Government Accountability Office Report, GAO-19-341*, pp. 1-5.

GAO Report. (2019, 4 25). F-35 Aircraft Sustainment: DOD Needs to Address Substantial Supply Chain Challenges. *United States Government Accountability Office Report, GAO-19-321*, pp. 3-33.

GE Aviation. (2004, July 19). *GE Rolls-Royce F136 Program History & Engine Details*. Retrieved from GE Avıiation: https://www.geaviation.com /press-release/military-engines/ge-rolls-royce-f136-program-history-engine-details-0

Gertler, J. (2009). *Navy F/A-18E/F and EA-18G Aircraft Procurement and Strike Fighter Shortfall: Background and Issues for Congress.* Washington DC: Congressional Research Service.

Gertler, J. (2013, 7 11). Air Force F-22 Fighter Program. *Congressional Research Service Report for Congress*, pp. 3-15.

Gertler, J. (2018, 4 23). F-35 Joint Strike Fighter Program. *Congressional Research Service Report for Congress*, pp. 1-29.

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008, 3 22). Methods of Data Collection in Qualitative Research: Interviews and Focus Groups. *British Dental Journal, 204*(6), pp. 291-295.

Glathar, K. D. (2005, June 17). The Challenges Affecting Heavy Lift Aircraft Development To Support Sea Basing . *Master of Military Art And Science*. Kansas, Fort Leavenworth, USA: United States Naval Academy.

Gruetzmacher, J. (2003). Joint Strike Fighter Interoperable by Design. *National Defense Industrial Association System Engineering Conference* (pp. 2-6). San Diego, California: Lockheed Martin Cooperation.

Harrell, M. C., & Bradley, M. A. (2009). *Data Collection Methods. Semi-Structured Interviews And Focus Groups.* Santa Monica: Rand National Defense Research Institute.

Harwood, T. G., & Garry, T. (2003, 3). An Overview of Content Analysis. *The Marketing Review*, pp. 479-498.

Hehs, E. (1998, 5 15). F-22 Design Evolution, Part I. *Code One*. Retrieved from http://www.codeonemagazine.com/article.html?item_id=40

Hess, A., Calvello, G., & Dabney, T. (2004). PHM a Key Enabler for the JSF Autonomic Logistics Support Concept. *2004 IEEE Aerospace Conference Proceedings (IEEE Cat. No.04TH8720).* Big Sky, MT, USA: Institute of Electrical and Electronics Engineers.

Hurriyet. (2013, 3 29). *Turkey to Replace F-16s With Local Jets*. Retrieved from Hurriyet Daily News: https://web.archive.org/web /20150509133834/http://www.hurriyetdailynews.com/turkey-to-replace-f-16s-with-local-jets.aspx?pageID=238&nID=43867& News CatID=374

Hürkuş, V. (1942). *Vecihi Havalarda, 1915-1925.* İstanbul: Kanaat Kitabevi.

INCOSE. (2019, 10 9). *About Systems Engineering*. Retrieved from International Consul of Syetem Engineering: https:// www.incose.org/about-systems-engineering

Institute of Electrical and Electronics Engineers. (2008, February 1). Systems and Software Engineering- System Life Cycle Processes. *ISO/IEC 15288 INTERNATIONAL INTERNATIONAL*, pp. 34-36.

Investment Office Report. (2018, January). *Turkish Defense & Aerospace Industry.* Ankara: The Presidency of Republic of Turkey Investment Office. Retrieved from Invest in Turkey: http://www.invest.gov.tr/en-US/infocenter/publications/Documents/DEFENSE-AEROSPACE.INDUSTRY.pdf

Jaafari, A. (2007, 11). Project and Program Diagnostics: A Systemic Approach. *International Journal of Project Management, 25*(8), 781-790.

Katz, R. (1988). *Managing Professionals in Innovative Organizations: A Collection of Readings.* Ballinger.

Kenton, W. (2019, 6 25). *Cost-Plus Contract.* Investopedia: https://www.investopedia.com/terms/c/cost-plus-contract.asp adresinden alındı

Kerzner, H. (2017). *Project Management Metrics, KPIs and Dashboards: A Guide to Measuring and Monitoring Project Performance.* John Wiley & Sons.

Kılıç, H. (2018, 3 26). *Türkiye'nin "Gerçek Çılgın Projesi" TF-X Uçağı.* Retrieved from Kokpit Aero: http://www.kokpit.aero/hakan-kilic-cevapliyor-tfx-projesi?writer=23

Koonce, J. M. (1984). A Brief History of Aviation Psychology. *Human Factors, 26*(5), 499-508.

Kueng, P. (2000). Process Performance Measurement System: A Tool to Support Process-based Organizations. *Total Quality Management*, 67-85.

Lans, W., & Van Der Voordt, T. (2002). Ways To Study and Research Urban, Architectural and Technical Design. *Descriptive Research*, pp. 53-60.

Lee, A. S., Liebenau, J., & DeGross, J. I. (1997). *Information Systems And Qualitative Research.* London: Chapman and Hall.

Leiser, G. (1990). The Turkish Air Force 1939-1945: The Rise of a Minor Power. *Middle Eastern Studies, 26*(3), pp. 383-395.

Lemons, G., Carrington, K., Frey, D. T., & Ledyard, J. (2018). F-35 Mission Systems Design, Development, and Verification. *Aviation Technology, Integration, and Operations Conference* (pp. 4-10). Atlanta, Georgia: AIAA AVIATION Forum .

Leone, D. (2018, 6 5). *Invitations to Turkey for the Official Handover of the First Turkish F-35A.* Retrieved from The Aviation Geek Club: https://theaviationgeekclub.com/lockheed-martin-sends-out-invitations-to-turkey-for-the-official-handover-of-the-first-turkish-f-35a-on-jun-21/

Likert, R. (1932). A Technique for the Measurement of Attitudes. *Archives of Psychology, 22*(140).

Lockheed Martin Aeronautics Company. (2005, September 28). *Joint Strike Fighter F-35 Advanced Quality Requirements Supplier Manufacturing Process Capability Measurement Plan Data Submittal.* Retrieved from Lockheed Martin Aeronautics Company: https://www.lockheedmartin.com/content/dam/lockheed-martin/aero/documents/scm/Quality-Requirements/Clauses/q30_original.pdf

Lockheed Martin Cooperation. (2019). *F-35 Lightning II Electro-Opticala Targeting System (EOTS).* Retrieved from Lockheed Martin: https://www.lockheedmartin.com/en-us/products/f-35-lightning-ii-eots.html

Lockheed Martin Corporation. (2019). *Autonomic Logistics Information System* . Retrieved from Lockheed Martin Corporation: https://www.lockheedmartin.com/en-us/products/autonomic-logistics-information-system-alis.html

Lockheed Martin Corporation. (2019). *F-35 Lightning II* . Retrieved from Lockheed Martin Corporation: https://www.lockheedmartin.com/en-us/products/f-35.html

Lowry, R. (2014). *Concepts and Applications of Inferential Statistics.*

Mack, N. (2011, 7). *Qualitative Research Methods: A Data Collector's Field Guide.* North Carolina: Family Health International.

Mackinder, H. (1904, 1 25). The Geographical Pivot of History. *The Geographical Journal, 23*(4), s. 421-444.

Marshall, C., & Rossman, G. B. (2006). *Designing Qualitative Research.* Thousand Oaks, London, New Delhi: SAGE Publications.

Maurer, M. (1987). *Aviation in the US Army, 1919-1939.* Washington DC: US Air Force Office.

Maxim, P. S. (1999). *Quantitative Research Methods in The Social Sciences.* New York: Oxford University Press.

Meilinger, P. S. (1997). *The Paths of Heaven: The Evolution of Airpower Theory.* Alabama: Air University Press.

Microgenesis. (2019, 11 10). *Systems Engineering.* Retrieved from Microgenesis: https://www.mgtechsoft.com/solutions/systems-engineering/

MIL-STD-1521B (Department of Defense 6 4, 1985).

Moore, D. S., & McCabe, G. P. (2005). *Introduction to the Practice of Statistics Chapters 14-17.* Macmillan.

Nandhakumar, J., & Avison, D. (1999). The fiction of methodological development: A field study of information systems development. *Information Technology and People*, 176-189.

Nelson, C. (2019, 11 7). F-35 Lightning II Program Status and Fast Facts. *F-35 Lightning II Program Status and Fast Facts*, pp. 1-2.

Nelson, C., & Friedman, M. (2019, 4 17). F-35 Lightning II Program Status and Fast Facts. *F-35 Lightning II Fast Facts*, pp. 1-2.

Nelson, C., & Friedman, M. (2019). *Turkey Industrial Participation*. Retrieved from F-35 Lightning II - Lockheed Martin: https://www.f35.com/global/participation/turkey-industrial-participation

Nelson, C., & Friedman, M. (2019). *TURKEY Industrial Participation*. Retrieved from F-35 Lightning II - Lockheed Martin: https://www.f35.com/global/participation/turkey-industrial-participation

Nguyen, L. D., Ogunlana, S. O., & Lan, D. T. (2004). A study on project success factors in large construction projects in Vietnam. *Engineering, Construction and Architectural Management*, 404-413.

Office of the Deputy Assistant Secretary of Defense for Systems Engineering. (2017, April). Best Practices for Using Systems Engineering Standards (ISO/IEC/IEEE 15288, IEEE 15288.1, and IEEE 15288.2) on Contracts for Department of Defense Acquisition Programs. *Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics*, pp. 3-7.

Oflazoğlu, S. (2017). *Qualitative versus Quantitiative Research.* Rijeka: InTech.

Oisen, R. P. (1971). Can Project Management be Defined? *Project Management Quarterly*, 12-14.

O'Leary, Z. (2009). *The Essential Guide to Doing Your Research Project.* London, Thousands Oaks, New Delhi: Sage Publications.

Owens, A. W. (1996, February). The Emerging U.S. System of System. *Institute for National Strategic Studies*, pp. 1-3.

Parmenter, D. (2015). *Key Performance Indicators Developing, Implementing, and Using Winning KPIs.* New Jersey: John Wiley & Sons, Inc.

Peatman, J. G. (1947). *Descriptive and Sampling Statistics.*

Perrett, D. A. (2009). Experts Doubt Chinese Stealth Fighter Timeline. *Aerospace Daily & Defense Report*, 1-2.

PMBOK. (2000). *A Guide to Project Management Body of Knowldge.* Newton Square: Project Management Institute.

Presidency of Defence Industries. (2018, June 22). *Türkiye İlk F-35 Uçağını Teslim Aldı.* Retrieved from Presidency of Defence Industries: https://www.ssb.gov.tr/Website/contentList.aspx?PageID=1202&LangID=1

PSFD MOU (Joint Strike Fighter Program Production Sustainment and Follow-on Modernization Memorandum of Understanding 2 7, 2007).

Reiss, G. (1993). *Project Management Demystified.* London: E & FN Spon.

Rodrigues, L. J. (1994, 5 5). Tactical Aircraft F-15 Replacement Issues. *United States General Accounting Office Report*, pp. 2-5.

Rogoway, T. (2018, May 19). *This Is What A Boeing F-32 Would've Looked Like If Lockheed Lost The JSF Competition.* Retrieved from The Drive:

https://www.thedrive.com/the-war-zone/20971/this-is-what-a-boeing-f-32-wouldve-looked-like-if-lockheed-lost-the-jsf-competition

Roketsan. (2016). *SOM-J JSF Uyumlu Stand-Off Mühimmatı*. Retrieved from Roketsan A.Ş.: http://www.roketsan.com.tr/urunler-hizmetler/hassas-gudumlu-fuzeler/som-j-jsf-uyumlu-stand-off-muhimmati/

Rosenbloom, R. S., & Cusumano, M. A. (1987, 4 29). Technological Pioneering and Competitive Advantage: The Birth of The VCR Industry. *California Management Review*, s. 51-76.

Ross, R. (2016, July 1). NIST Special Publication 800-160. *National Institute of Standards and Technology.*

Roubtsova, E., & Michell, V. (2013). Modelling and Validation of KPIs. *Proceedings of the Third International Symposium on Business Modeling and Software Design* (s. 96-105). Noordwijkerhout, The Netherlands: Science and Technology Publications, Lda.

Ruhlman, P. M. (2000, 5 31). War Winning: Paradigms and Visions for High-End Warfare. *National Defense University Quadrennial Defense Review*, pp. 16-44.

Sandelowski, M. (2000, 1 13). Combining Qualitative and Quantitative Sampling,Data Collection, and Analysis Techniques in Mixed-Method Studies. *Research in Nursing & Health*(23), pp. 246-255.

Schrock, J. (2002, 12 9). System Development and Demonstration of the Joint Strike Fighter. *Consolidated Treaties and International Agreements, 3*, pp. 229-235.

Schwartz, M., & O'Connor, C. V. (2016, May 12). The Nunn-McCurdy Act: Background, Analysis, and Issues for Congress. *Congressional Research Service Report numbered R41293*, pp. 1-4.

Shenhar, A. J. (1993, 23 3). From Low to High-Tech Project Management. *R&D Management*, pp. 199-214.

Shenhar, A. J., & Bonen, Z. (1997). The New Taxonomy of Systems: Toward an Adaptive Systems Engineering Framework. *IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans, 27*(2), s. 137-145.

Shenhar, A. J., Levy, O., & Dvir, D. (1997). Mapping the Diemnsions of Project Success. *Project Management Journal*, 5-13.

Sigaud, L. A. (1949). *Air Power and Unification: Douhet's Principles of Warfare and Their Application to the United States.* The Military Service Publishing Co.

Sprinthall, R., & Fisk, S. (1990). *Basic Statistical Analysis.* Englewood Cliffs: Prentice Hall.

Srinivasan, B. (2013, 10 17). *Project Management Mind Maps*. Retrieved from Project Management & Leadership Champions: https://pmleadershipchamps.com/project-management-mind-maps/

SSB. (2019, 11 1). *F-35 Lightning II JSF Müşterek Taarruz Uçağı*. Retrieved from Presidency of Defense Industries: https://isbirligi.ssb.gov.tr/Sayfalar/ProjeGoruntule.aspx?jID=23

SSB. (2019, 10 11). *TFX-National Combat Aircraft.* Retrieved from Presidency of Defense Industries: https://www.ssb.gov.tr/WebSite/ contentlist .aspx?PageID=362&LangID=2

SSB Official Record. (2019). *The National Combat Aircraft Development Program.* Ankara: Presidency of Defence Industries.

Star. (2013, 9 1). *Yerli Savaş Uçağı Projesi Hazır, Maliyet 80 Milyar Dolar*. Retrieved from Star: https://www.star.com.tr/ekonomi/yerli-savas-ucagi-projesi-hazir-maliyet-80-milyar-dolar-haber-785274/

Stemler, S. (2001). An Overview of Content Analysis. *Practical Assessment, Research & Evaluation, 7*(17), s. 137-146.

Sullivan, G. M., & Artino Jr., A. R. (2013). Analyzing and Interpreting Data From Likert-Type Scales. *Journal of Graduate Medical Education, 5*(4), 541-542.

TAI. (2019, 10 10). *TF*. Retrieved from Turkish Aerospace Industries: https://www.tusas.com.tr/en/product/milli-muharip-ucak

TBMM Law No.5425, 5425 (The Grand National Assembly of Turkey, TBMM 11 2, 2005). Retrieved from T.C. Resmi Gazete: http://www.resmigazete.gov.tr/eskiler/2005/11/20051106-10.htm

TBMM Law No.5764, 5764 (The Grand National Assembly of Turkey 5 30, 2008). Retrieved from T.C. Resmi Gazete: http://www.resmigazete.gov.tr/eskiler/2008/05/20080531-1.htm

Torres, O. (2019). *F-35 Lightning II Program Overview*. Retrieved from Northrop Grumman Corporation: https://www.northropgrumman.com/Capabilities/F35Lightning/Pages/default.aspx

Treiman, D. J. (2009). *Quantitative Data Analysis: Doing Social Research to Test Ideas.* San Francisco: Jossey-Bass A Willey Imprint.

Trimble, S. (2019). Lockheed says F-35s will replace USAF F-15s. *Flight International.*

TurAF. (2019, 10 16). *History of Turkish Air Force.* Retrieved from Turkish Air Force: https://www.hvkk.tsk.tr/Custom/HvkkEN/101

U.K. Ministry of Defence. (2010, October 19). *Strategic Defence and Security Review.* Retrieved from United Kingdom Ministry of Defence: https://www.gov.uk/government/news/strategic-defence-and-security-review-published--2

United States Government Accountability Office. (2017). *Report to Congressional Committees F-35 Aircraft Sustainment.* Washington D.C.: Government Accountability Office.

United States Government Accountability Office. (2017). *Weapon System Requirements: Detailed Systems Engineering Prior to Product Development Positions Programs for Success Report numbered GAO-17-77.* Washington DC: United States Government Accountability Office.

United States Government Accountability Office. (1994). *Tactical Aircraft F-15 Replacement Issues.* Washington D.C.: United States General Accounting Office.

Wallace, W. (2014). *Project Management.* Edinburgh: Heriot-Watt University Edinburgh Business School .

Weinholtz, D., Kacer, B., & Rocklin, T. (1995). Salvaging Quantitative Research with Qualitative Data. *Qualitative Health Research, 5*(3), pp. 388-397.

Wolcott, H. F. (1994). *Transforming Qualitative Data: Description, Analysis, And Interpretation.* Thousand Oaks, London, New Delhi: SAGE Publications.

Yin, R. K. (1994). *Case study research: Design and methods.* Thousand Oaks: Sage.

APPENDICIES

A. CURRICULUM VITAE

PERSONAL INFORMATION

Name and Surname: Muhammed Ali YİĞİT

Nationality: Turkish (TC)

Date and Place of Birth: 18 March 1990, Malatya

Office Phone: +90 312 411 9344

Mobile Phone: +90 531 212 6035

Official e-mail: mayigit@ssb.gov.tr

Academic e-mail: muhammed.yigit@metu.edu.tr

Office Address: Presidency of Defense Industries
(T.C. CUMHURBAŞKANLIĞI Savunma Sanayii Başkanlığı, SSB)
Devlet Mahallesi Süleyman Emin Caddesi No:6-7 06420 Çankaya / Ankara

EDUCATION

Degree	**Institution**	**Grad Year**
MS	METU Science and Technology Policy Studies	2020
BEc	Anadolu University Department of Economics	2019
BS	METU Department of Electrical & Electronics Engineering	2013

WORK EXPERIENCE

Place	Enrollment	Location	Year
Presidency of Defense Industries	Senior Defense Industries Associate	Ankara, Turkey	2013-present
Roger Baker Co.	Test Engineer	Plymouth, United Kingdom	2013-2013
Vodafone	Young Talent (Jr) Engineer	İstanbul, Turkey	2011-2011
THY Technic	Intern Engineering Student	İstanbul, Turkey	2011-2011
Werner Heisenberg Institute	Intern Engineering Student	Munich, Germany	2011-2011
ORS	Intern Engineering Student	Ankara, Turkey	2010-2010

SSB EXPERIENCE

Programs	Year
F-16 Peace Onyx (PO-IV) Program	2016 - present
Armed Hürkuş Development (Hürkuş-C) Program	2016 - present
F-35 Joint Strike Fighter (JSF) Program	2015 - present
F-16 Structural Modification Program	2015 - present
National Regional Civil Aircraft Development Program	2015 - present
F-16 Modernization Serial Program	2015 - 2018
Command and Control Aircraft Procurement Program	2015 - 2018
Coast Guard Command Aircraft Procurement Program	2015 - 2016
Gendarmerie Trainer Aircraft Procurement Program	2015 - 2016
Basic Trainer Aircraft Development (Hürkuş-A) Program	2014 - present

New Generation Basic Trainer Aircraft Development (Hürkuş-B) Program	2014 -present
Primary Trainer Aircraft Procurement Program	2014 - 2019
A-400M Atlas Procurement Program	2014 - 2015
National Combat Aircraft Development (TFX) Program	2013 - 2014
F-16 Modernization Program	2013 - 2014

COURSES

Subject	**Institution**	**Year**
Legal Affairs in International Treaties	MND DITEC	2020
System Engineering Professional	Expert System Engineer by INCOSE	2019
Financial Literacy	TOBB ETU CEAC	2019
Advances in Quantum Computers	MND DITEC	2019
System Engineering in Project Management	SSB	2016
Safety Assessment Process SAE ARP 4761	STM	2016
Fighter Aircraft Technologies	METU CEC	2016
US DoD Risk Management Course	White Consulting LLC	2015
Civil Airborne Certification	Teknopark İstanbul	2014
Aircraft, Rotorcraft and UAV Design	METU CEC	2014
Project Management Professional	SSB	2014

B. TURKISH SUMMARY / TÜRKÇE ÖZET

GİRİŞ

Bugüne kadar hâkimiyet teorileri üzerine birçok çalışma yapılmıştır. Yapılan bu çalışmalarda ülkelerin kara ve deniz gücüyle beraber jeopolitik konumlarının etkili yönleri de farklı açılardan ele alınmıştır. II. Dünya Savaşı zamanına gelindiğinde ise hava gücü üstünlüğünün, ülkelerin silahlı gücü içerisinde en etkili faktörlerden biri olduğu askeri teorisyenlerce kabul edilmeye başlanmıştır. Önemi daha iyi anlaşılan hava gücü üstünlüğünü elde etmek ve sürdürmek için, özellikle Soğuk Savaş döneminde, ülkeler birbirlerine karşı savaş uçağı geliştirme yarışına girişmişlerdir. Bu yarış neticesinde 1990'lı yılların sonlarına doğru beşinci nesil savaş uçağı teknolojisine ulaşılmıştır.

Türkiye Cumhuriyeti Devleti geçtiğimiz 20 yıl içerisinde aldığı iki önemli karar ile bu yarıştan geri kalmamış ve V. Nesil savaş uçağı geliştirme programlarına dâhil olmuştur. Bu kararlardan ilki 1999 yılında alınmış ve Amerika Birleşik Devletleri'nin liderliğinde başlatılmış olan F-35 Müşterek Taarruz Uçağı (JSF) Programına üye ülke olarak katılım sağlanmıştır.. Öte yandan 2010 yılında, Türkiye'nin kendi V. Nesil savaş uçağını geliştirmesine karar verilmiş ve bu çerçevede Milli Muharip Uçak Geliştirme (TFX) Programı başlatılmıştır.

TEZİN AMACI

V. Nesil bir savaş uçağı geliştirmek endüstriyel, teknolojik ve ekonomik açıdan ülkeleri zorlayan bir süreçtir. TFX Programı Türkiye tarihinin en büyük teknoloji geliştirme programıdır ve bu büyük program için büyük çaplı bütçe oluşturulması gerekmektedir.

İki farklı V. Nesil savaş uçağı programının beraber sürdürülmesi esnasında, bir programdan elde edilen tecrübenin diğerine aktarılması, ülkemizin mevcut durumu göz önüne alındığında, kısıtlı kaynakların etkin kullanılması açısından önem arz etmektedir.

Buna göre, TFX Programı'nda verimlilik artırılırsa, kamu kaynaklarından o kadar tasarruf edilir. Programda verimliliğin artması ise doğru kararlar verilmesine bağlıdır. Öte yandan doğru kararların verilmesi etkin proje yönetim süreçlerin oluşturulmasına bağlıdır. Ne kadar doğru proje yönetim metotları kullanılırsa o kadar maliyet etkin süreçler gelişir ve nihayetinde TFX Programı'nda ve kamu kaynaklarında maliyet, zaman ve enerji tasarrufu sağlanmış olur. Bu çerçevede, Müşterek Taarruz Uçağı (JSF) Programından elde edilen 20 yıllık proje yönetim tecrübesinin, etkin ve verimli proje yönetim uygulamalarının Milli Muharip Uçak Geliştirme (TFX) Programına doğru şekilde aktarılması gerekmektedir.

Mevcut yüksek lisans tezi, JSF Programını örnek bir vaka gibi kullanarak TFX Programı için doğru proje yönetim metotlarını ve uygulanabilir proje yönetim pratiklerini oluşturma amacıyla kaleme alınmıştır.

PROJE YÖNETİMİ

Bazı araştırmacılara göre proje yönetiminin tarihi milattan önce Antik Mısır ve Roma dönemine kadar uzanmaktadır. Buna göre Mısır Piramitleri'nin ve Roma İmparatorluğu'nun ticaret yollarının inşa edilmesi başlı başına bir proje olup bu projelerin yürütülmesi için proje yönetimi süreçlerinin gerekliliği ileri sürülmüştür. Bu durum teorik olarak tartışılsa da profesyonel manada proje yönetimi 1950'li yıllardan sonra ele alınmaya başlanmıştır. İlk zamanlarda proje yönetimi işletme yönetimi içerisinde mahdum bir yapıya sahipken 1960'lı yılların sonlarına doğru ayrı bir disiplin olarak değerlendirilmeye başlanmıştır. Özellikle bu yıllarda uzay programlarının hız kazanması ve kompleks proje sayılarındaki artış, proje yönetimi süreçlerinin detaylı tanımlanması ve standartlaştırılması ihtiyacını doğurmuştur. 1969 yılında Proje Yönetim Enstitüsü (PMI) kurularak proje yönetim el kitapları yazılmış süreçlerin daha net anlaşılması için çeşitli standartlar oluşturulmuştur.

Genel olarak proje yönetimi üç temel esas üzerine inşa edilmiş ve bunlar maliyet yönetimi, takvim yönetimi ve performans yönetimi olarak özetlenmiştir. Daha sonraki yıllarda proje yönetimi PMI tarafından daha alt başlıklara bölünerek tanımlansa da para, zaman ve kalite/performans üçgeninin sacayakları değişmemiştir. Daha sonraki yıllarda projelerin ileri teknoloji barındırması, içerdiği belirsizlikler ve karmaşık yapıları göz önüne alınarak, projeler kendi içlerinde sınıflandırılmaya başlanmıştır. Her kategori için kendine özgü proje yönetim süreçleri oluşturulmaya çalışılmıştır. Buna göre A-tipi projeler düşük teknoloji içeren ve görece daha az belirsizlik içeren projeler iken D-tipi projeler, ileri teknoloji barındıran, belirsizlik ve karmaşıklık katsayıları çok yüksek ancak tamamlandığında kilometre taşı olabilecek projeler olarak kategorize edilmiştir.

Bu tezde bahsedilen JSF ve TFX Programları her ikisi de D-tipi proje olarak değerlendirilmiş ve proje yönetim süreçleri bu hassasiyet göz önüne alınarak incelenmiştir. Ayrıca proje yönetim süreçleri paralelinde tez içerisinde sistem mühendisliği tanımlaması da yapılmış ve yüksek teknoloji barındıran programlarda sistem mühendisliği ve ürün tasarım aşamalarının proje takvimine etkileri incelenmiştir. Netice itibariyle yüksek teknolojili D-tipi projelerde sistem mühendisliği ve proje yönetiminin bütünleşmiş bir şekilde yol alması gerektiği belirtilmiştir.

F-35 MÜŞTEREK TAARRUZ UÇAĞI (JSF) PROGRAMI

Sovyetler Birliği'nin dağılması ve I. Körfez Savaşı'nın sona ermesinin ardından ABD Savunma Bakanlığı tarafından ileriye dönük hava tehditleri ve bu tehditlere karşı alınacak önlemler yeniden incelenmiştir. Bakanlık tarafından yapılan çalışmalarda, Birleşik Devletler Silahlı Kuvvetlerinin (US

Services) her birinin savaş uçağı ihtiyacı ayrı ayrı tespit edilmiş ve her kuvvetin muharip uçak gereksinimlerine ayrı ayrı cevap verebilecek, müşterek ve maliyet etkin bir V. Nesil savaş uçağının yapılabilirliği değerlendirilmiştir. Bu çalışmalar Müşterek Gelişmiş Taarruz Teknoloji (Joint Advanced Strike Technology, JAST) programı altına yürütülmüş ve Ağustos 1995 tarihinde taarruz uçağı için konsept araştırma sürecine girilmiştir. Bu kapsamda, Mart 1996 tarihinde Teklife Çağrı Dosyası (RFP) yayımlanmış ve Amerika'nın iki büyük savunma firması teklife cevap vermiştir. İki firmanın yarışmaya başlamasıyla müşterek taarruz uçağının konsept tasarım aşamasına giriş yapılmıştır.

Ekim 2001 tarihinde, Lockheed Martin ve Boeing'in tasarlamış olduğu savaş uçağı modelleri ABD Savunma Bakanlığı tarafından değerlendirilmiş ve Lockheed Martin firmasının X-35 modeli, kazanan tasarım olarak ilan edilmiştir. Devamında programın adı F-35 Müşterek Taarruz Uçağı Programı (F-35 Lightning-II Joint Strike Fighter Program) olarak değiştirilmiştir.

F-35 düşük görünürlüğe sahip, ileri radar, algılayıcı ve aviyonik sistemleri ile donatılmış, pilot iş yükünü azaltacak ve durumsal farkındalığını artıracak füzyon teknolojisi içeren ve vektör itki sistemine haiz V. Nesil taarruz uçağı olarak tasarlanmıştır. F-35 sadece art yanma yapmadan süpersonik (super-cruise) hızlara çıkamamaktadır.

JSF Programı, ABD Hükümeti adına Müşterek Program Ofisi (Joint/JSF Program Office, JPO) tarafından yönetilmektedir. JPO içerisinde üç ABD kuvvetinden ve sekiz ortak ülkeden oluşan temsilcinin yer aldığı organizasyon yapısı da bulunmaktadır.

Türkiye'nin Müşterek Taarruz Uçağı (JSF) Programına Katılımı

Türkiye Cumhuriyeti Devleti; Türk Hava Kuvvetleri'nin yeni nesil savaş uçağı gereksinimi göz önüne alarak, Haziran 1999 tarihinde kavramsal tasarım sürecinde JSF Programı'na katılım sağlamıştır. Müteakiben uçağın mühendislik geliştirme faaliyetlerini kapsayan Sistem Geliştirme ve Gösterim Mutabakat Muhtırasını Temmuz 2002 tarihinde imzalanmıştır. Böylelikle Türkiye, ABD Kuvvetleri (Hava Kuvvetleri Komutanlığı, Deniz Piyadeleri Komutanlığı ve Donanma Komutanlığı) ile beraber programda yer alan Birleşik Krallık, İtalya, Hollanda, Avustralya, Norveç, Danimarka ve Kanada ile beraber dokuz üye ülkeden biri olmuştur.

Aralık 2006 tarihinde Savunma Sanayii Başkanlığı (SSB)nda yapılan Savunma Sanayii İcra Komitesi (SSİK) toplantısında F-35 uçaklarının seri üretim, kullanım ve lojistik destek süreçlerini içeren Üretim, Destek ve Sürekli İyileştirme fazına (Production, Sustainment, Follow-on Development, PSFD) uluslararası bir mutabakat muhtırası ile katılım sağlamanın uygun olacağını değerlendirmiştir. Bu doğrultuda, Mutabakat Muhtırası (Memorandum of Understanding, MoU) Ocak 2007 tarihinde imzalanmış ve 22 Mayıs 2008 tarih ve 5764 No'lu Kanun ile Türkiye Büyük Millet Meclisi tarafından onaylanarak yürürlüğe girmiştir.

Türkiye JSF Programı'ndan yalnızca uçak almamaktadır. Ülke olarak programın ortağı olduğu ve uçakların geliştirme sürecine destek verdiği için ABD tarafından Yabancı Askeri Satış (Foreign Military Sales, FMS) Anlaşması çerçevesinde yapılan her ticari F-35 satışında belli oranlarda "royalty bedeli" almaktadır.

MİLLİ MUHARİP UÇAK GELİŞTİRME (TFX) PROGRAMI

Diğer taraftan, Türk Hava Kuvvetleri'nin bağımsız harekât yeteneğinin artırılması amacıyla, son yıllarda savunma sanayiinde kaydedilen ilerlemeler ve Türk savunma sanayiinin teknolojik kazanımları göz önüne alınarak Aralık 2010 tarihinde Savunma Sanayii Başkanlığı (SSB)'nda yapılan Savunma Sanayii İcra Komitesi (SSİK) toplantısında Türkiye'nin kendi V. Nesil savaş uçağını geliştirmesi kararı verilmiştir. Bu karar doğrultusunda Savunma Sanayii Başkanlığı (SSB)'nda gerekli çalışmalara başlanmış ve Milli Muharip Uçak Geliştirme (TFX) Programı'nın temelleri atılmıştır. SSB ile

TUSAŞ firmasını arasında TFX Programı için sözleşme imzalanmış ve TUSAŞ firması ana yüklenici olarak belirlenmiştir. Halihazırda milli muharip uçağın konsept tasarımı tamamlanmış olup ön tasarım süreci tüm hızıyla devam etmektedir.

JSF ve TFX PROGRAMLARININ PROJE YÖNETİM ESASLARI (TAKVİM, MALİYET ve PERFORMANS) AÇISINDAN MUKAYESE EDİLEBİLİRLİĞİ

Program kurgusu açısından incelendiğinde JSF ve TFX Programlarının birbirinden farklı hüviyete sahip olduğu görülmektedir. JSF Programı çok ortaklı, çok kullanıcılı ve ABD liderliğinde ilerleyen bir konsorsiyum programı iken TFX Programında şu an için sadece tek kullanıcı bulunmaktadır. JSF Programı'nın mutabakat metni çok taraflı iken TFX Programı sözleşmesi iki taraf arasında imzalanmıştır. Dolayısıyla her iki programın işleyiş ve yapısı birbirinden farklıdır.

Ayrıca, JSF Programında uçaklar 3 farklı varyant olarak üretilecek olup her program ortağı ülke veya kuvvet kendi ihtiyaçları özelinde program süreçlerini takip etmektedir. TFX Programında ise tek bir model uçağın geliştirilip üretilmesi planlanmaktadır.

Yukarıda bahsedilen farklılıklara rağmen, JSF ve TFX Programı proje yönetiminin üç ana esası olan takvim, maliyet ve performans yönetimi açısından ortak bir zeminde incelenebilir ve mukayese edilebilir görülmektedir. JSF Programından elde edilen tecrübelerin TFX Programına aktarılmasının teorik olarak mümkün olabilmesi için her iki programın öncelikle proje yönetim esasları açısından mukayese edilebilir olması gerekmektedir.

Buna göre, JSF ve TFX Programları maliyet açısından tetkik edildiğinde;

- JSF Program bütçesinin sadece ABD açısından geliştirme maliyetinin yaklaşık 56 Milyar ABD Doları olduğu ABD 'nin alacağı 2456 uçak için toplam tedarik bedelinin geliştirme ve altyapı maliyetleri dâhil uçak destek ekipmanları ve lojistik giderleri hariç 406 Milyar ABD Doları olacağı ön görülmektedir. Uçakların ömür devri boyunca idame işletme giderleri dâhil toplam maliyetinin ise 1,12 Trilyon ABD Doları olması beklenmektedir.

- TFX Programı için toplam tedarik maliyetinin geliştirme maliyetleri dâhil 50 ile 80 milyar ABD Doları arasında olması tahmin edilmektedir. Ancak bu rakamlar resmi olarak teyit edilmiş veriler değil bağımsız uzmanların kendi değerlendirmelerine dayanan esas ön görülerdir.

- TFX Programı'nın tahmini maliyeti her ne kadar JSF Programı ile kıyaslandığında düşük gibi görünse de ülkemiz savunma projeleri açısından bakıldığında Programın bütçede büyük pay işgal etmesi beklenmektedir. Dolayısıyla TFX Programı'nda her adımın bütçe projeksiyonları göz önüne alınarak atılması uygun olacaktır. Bu tezin amaçlarından biri JSF gibi çok büyük bütçeli bir programda kullanılan, verimliliği ispat edilmiş proje yönetim metotlarını TFX Program'ına uygun şekilde aktarmak ve TFX Program verimliliğini artırarak tasarruf sağlamaktır.

JSF ve TFX Programları takvim açısından tetkik edildiğinde;

- JSF Programı'nın 1990'lı yılların ikinci yarısından itibaren başladığı kavramsal tasarım, ön tasarım ve kritik tasarım süreçlerini çok kısa sürede tamamladığı ve 1996'dan 2007'ye, 11 yıl gibi kısa bir süre içerisinde Programda düşük yoğunluklu ilk seri üretim aşamasına geçildiği görülmektedir. Bununla beraber, F-35 uçağının geliştirme faaliyetlerinin seri üretim aşamalarında da devam etmekte olduğu ve geliştirme sözleşmesinin (SDD evresinin) 2018 yılına kadar sürdüğü de bilinmektedir. Ayrıca, hâlihazırda PSFD mutabakatı içerisinde de iyileştirme faaliyetlerinin devam etmesine ilişkin maddeler tanımlanmıştır. Sonuç olarak her ne kadar 2007 yılında seri üretim fazına geçilmiş olsa da uçak üzerinde geliştirme ve iyileştirme faaliyetleri hala devam etmektedir.

- TFX Programına 2010 yılı sonlarında başlanmış olup müteakip 3 yıl içerisinde kavramsal tasarım evresi tamamlanmıştır. Hâlihazırda TFX uçağının ön tasarım sözleşmesi SSB ile TUSAŞ arasında yürütülmekte ve ön tasarım aşamasının 2022 yılında tamamlanması planlanmaktadır.

- JSF Programı geliştirme ve üretim süreçleri açsından TFX Programı'na göre daha hızlı gibi görünse de Amerikan uçak üreticisi Lockheed Martin firmasının (Bu firma daha önce F-16 ve F-22 gibi uçakları geliştirmiş ve üretmiştir) uçak geliştirme tecrübesi göz önüne alınarak değerlendirme yapılmalıdır. Öte yandan TFX Programı'nın ana yüklenicisi TUSAŞ firması ise sabit kanatlı hava platformu olarak Hürkuş eğitim uçağını geliştirmiş ve üretmiştir. Hürkuş eğitim uçağı projesi 2006 yılında başladıktan 7 yıl sonra ilk uçuşunu gerçekleştirmiştir. Dünyadaki diğer muadilleri ile mukayese edildiğinde Hürkuş projesi kısa sürede geliştirme fazını tamamlamış ve üretimine başlanmıştır. Özelde TUSAŞ'ın, genelde ise ülkemizin uçak geliştirme tecrübesi göz önüne alındığında mevcut TFX Program takvimi uzun olarak değerlendirilmemelidir.

JSF ve TFX Programları performans açısından tetkik edildiğinde;

- Her iki uçağın V. Nesil olması uçaklar açısından bir mukayese sağlanabileceğini göstermektedir. Bununla beraber, TFX uçaklarının F-35 savaş uçaklarından farklı olarak art yanma yapmadan süpersonik hızlara ulaşabilecek (super-cruise) şekilde tasarlanması planlanmaktadır.

- Programların yönetim performansı göz önüne alındığında, JSF Programının münferit bir yönetim ofisi üzerinden yönetilmesi ve programa ilişkin bazı kararların üye ülkeler ile istişare edilerek alınması şeklinde ilerlemektedir.

- TFX Programı'nda ise program yönetimi SSB tarafından kullanıcı Türk Hava Kuvvetleri Komutanlığı ile koordine edilerek yapılmaktadır.

- Her ne kadar JSF ve TFX kurgusal açıdan birbirinden farklı olsa da program performansları birbirleriyle mukayese edilebilir görünmektedir.

Netice itibariyle, proje yönetim süreçleri açısından JSF ve TFX Programlarının mukayese edilebilir olduğu ve JSF Programı'ndan elde edilen tecrübenin TFX Programı'nda uygulamaya konulabileceği teorik olarak mümkün görünmektedir.

METODOLOJİ

JSF Programında kullanılan proje yönetim metotlarının TFX Programına sağlıklı şekilde aktarılması için, JSF Programı'na ilişkin Anahtar Performans Gösterge (KPI)'lerin oluşturulması ve bu KPI'lar üzerinden JSF Programının analiz edilmesi gerekmektedir.

JSF Programı'nda hangi KPI'ların kullanılacağını belirlemek için SSB üst yöneticileri ile mülakatlar yapılmıştır. Bu vesileyle üst yönetici gözünden tüm program bütüncül bir bakışla değerlendirilmiştir. JSF Programı Anahtar Performans Göstergeleri (KPIs) sırasıyla;

- Maliyet Performansı
- Zaman Performansı
- Program Yönetim Ekibi Performansı
- Gelişim Yönetimi
- Risk ve Fırsat Yönetimi
- Teknoloji Yönetimi
- Sözleşme Performansı
- Kaynak Yönetim Performansı
- Kalite Yönetimi Performansı

olarak belirlenmiştir.

Ardından tez içerisinde nitel ve nicel araştırma teknikleri ayrı ayrı açıklanmış her bir araştırma tekniğinin avantaj ve dezavantajları ayrı ayrı sıralanmıştır. Sonuç olarak JSF Programı'nın analiz edilebilmesi için SSB proje yönetim ekibinde yer alan 24 personel ile JSF Programı'nın KPI bazlı değerlendirmesinin yapılmasının, yapılacak değerlendirmenin nitel ve nicel araştırma tekniklerinin her ikisinin de kullanılarak oluşturulmasının ve nihayetinde her iki araştırmanın nitel ve nicel olarak iki farklı şekilde analiz edilmesinin daha sağlıklı olacağına karar verilmiştir.

Buna göre, nitel araştırmanın açık uçlu sorulardan oluşan bir soru seti ile nicel araştırmanın ise Likert-tipi kapalı uçlu sorular ile yapılmasının uygun olacağı değerlendirilmiştir.

Her KPI için bir çift soru hazırlanmıştır. Nitel araştırma için açık uçlu soru ve nicel araştırma için Likert tipi soru yazılmıştır. Toplam 9 KPI için 18 adet sorudan oluşan bir soru formu oluşturulmuş ve 24 kişilik SSB personelinden soruları cevaplaması istenmiştir.

Soru formlarına gelen cevaplar soruların nitel ve nicel olmasına göre farklı analiz metotları ile analiz edilmiştir. Açık uçlu nitel araştırma soruları içerik analizi ile Likert-tipi nicel araştırma soruları ise istatistik analizi ile incelenmiştir.

Nitel analiz türlerinden biri olan içerik analizinde nitel sorulara verilen cevaplar içerisindeki ortak kavramlar teker teker tespit edilmiş ve ortak bir kelime grubu oluşturulmuştur. Bu çerçevede her cevap metni ortak kelime gruplarına göre sınıflandırılmış ve SSB personelinin soruya ilişkin cevabı ortaklaştırılarak ilgili KPI ile ilgili düşünceler ortaya çıkarılmıştır.
Bununla beraber nicel analiz yöntemi için deskriptif istatistik yöntemi kullanılmış ve SSB personeli tarafından Likert-tipi sorulara verilen "kesinlikle

katılıyorum” ve “kesinlikle katılmıyorum” cevapları kendi içerisinde oranlandırılmıştır.

Sonuç olarak tez içerisinde nitel ve nicel araştırma teknikleri beraber kullanılmış ve her iki soru tipi kendi kategorisine göre nitel ve nicel olarak analiz edilmiştir. İki analiz türü de beraber kullanılarak kapsamlı ve tamamlayıcı bir metot geliştirilmiştir. Bu sayede içerik analizinden elde edilen bulgular deskriptif analizle ağırlıklandırılarak okuyucuya sunulmuştur. Bunun sonucunda daha geniş perspektifli bir değerlendirme tesis edilmiştir.

TARTIŞMA ve ÖNERİLER

Analizler sonucunda elde edilen bulgular ve değerlendirmeler tezin tartışma bölümünde JSF Programı’ndan bağımsızlaştırılmış ve TFX Programı için bir öneri seti oluşturulmuştur. Bahse konu öneriler tartışma bölümünde detaylı şekilde irdelenmiş olup aşağıda kısa maddeler halinde sıralanmıştır. Buna göre;

- Kontrat müzakereleri esnasında gerekirse üçüncü taraf olarak bir denetim firmasının kullanılması
- Program maliyet kalemlerinin takip edilmesi için geniş çaplı ve detaylı bir veri tabanı kullanılması
- Kontrat kapsamlarını daha küçük tutup tek kontrat altında her şeyin yaptırılmaması, ileriye dönük yapılacak işlerin olması ve bu sayede kontrat müzakere gücünün yükleniciye karşı daima TFX Program yönetiminin elinde koz olarak muhafaza edilmesi
- Kontrat sürelerinin çok uzun tutulmaması ve yüklenicinin uzun süreçli teminatlar altına girmek zorunda kalmaması, bu sayede finansal maliyetlerin düşürülmesi
- Program maliyet dokümanlarının mümkün olduğunca şeffaf hazırlanması ve herhangi bir muğlaklığa mahal verilmemesi

- Yapılacak her kontratta aynı maddelerin tekrar tekrar tartışılmaması adına her kontratın üstünde bir çerçeve anlaşma imzalanması ve bu sayede uyuşmazlıkların çözümü, kabul, ödemeler ve ceza durumları gibi TFX Programı genel prensiplerinin bu sözleşmede belirtilmesi

- Esnek entegre program takvimi oluşturulması ve belli periyotlarda tüm kalemler için güncelleme yapılması

- Tüm TFX Program aktivitelerinin giriş ve çıkış kriterlerine göre fazlandırılması

- TFX Programı'na ilişkin uzun dönemli tedarik kalemlerinin gerekirse ayrı bir kontrat yapılarak erkenden sipariş verilmesi

- TFX Programı'nda yer alan tüm tarafların görev ve sorumluluklarının eksiksiz ve detaylı şekilde tanımlanması ve hiçbir şekilde hiçbir tarafa muğlak sorumluluk veya görev verilmemesi

- TFX Programı'nın değişmez ve değişmesi teklif edilemez, yıllara sâri, açık ve yalın bir strateji üzerine oturtulması ayrıca politika değişiklikleri veya görev değişikliklerinin program üzerinde mümkün olduğunca az olumsuz etki oluşturmasının sağlanması

- Program içerisinde yer alan birimler arasında karşılıklı çıkar ilişkilerinin güçlendirilmesi ve çıkar çatışmasına sebep olabilecek aksiyonlardan mümkün olduğunca kaçınılması, bu sayede firma veya devlet tarafı fark etmeksizin tüm programın sinerjisinin üst seviyede tutulması

- Birbirinden farklı alt çalışma gruplarının bağımsız şekilde benzer işler üzerinde çalıştırılarak çıkan sonuçlar arasından en optimal çözümün gerçekleştirilmesi bu sayede program içerisinde daima optimizasyon mekanizmasının işletilmesi

- TFX Programı'nın mümkün olduğunca kamuya açık hale getirilmesi ve program detaylarına ilişkin "bilinmesi gereken" prensibi çerçevesinde bilgilerin şeffaf bir şekilde kamuyla ve ilgililerle paylaşılması

- TFX Programı içerisinde tecrübe ve yetenek farklılıklarının uyumlandırılarak senkronize edilmesi

- Bilim ve teknoloji trendini yakından takip edecek bağımsız bir çalışma grubu oluşturulması bu çalışma grubunun belli periyotlarda rapor yayımlaması ve TFX gibi uzun soluklu programlarda sık karşılaşılan teknolojinin demode olması riskinin mümkün olduğunca azaltılması, yeni teknoloji fırsatlarının programa entegre edilmesi

- TFX uçağı geliştirme sürecinde blok yaklaşımı ile hareket edilmesi, her yeteneğin bir anda uçak üzerine entegre edilmemesi, gelişim sürecinde "ya hep ya hiç" bakış açısından mümkün olduğunca uzak durulması, örneğin ilk geliştirilecek prototip uçağın basit görevler yaparak sadece güvenli uçuş gerçekleştirebilmesinin dahi TFX Program yönetimi tarafından başarı olarak kabul edilmesi

- Blok yaklaşımında her bloğun yetenek setinin önceden tanımlanmış olması ve geliştirme esnasında yetenek setlerinde artırım ve azaltım yapılmaması

- TFX Programı'nda görev alacak tüm personelin ihtisaslarının gereği olan eğitim süreçlerini tamamlamış olması, program kapsamında eğitim almış ve tecrübe edinmiş personelin pozisyonlarından bağımsız olarak mümkün olduğunca TFX Program dâhilinde çalıştırılması

- TFX Programı üst kadrosunda yapılacak herhangi bir tayin veya görev değişimi durumunda ilgili makama gelecek yöneticinin daha önceden belirlenmiş sistem mühendisliği veya proje yönetim kurslarını ya da ilgili akademik dersleri almış olması

- TFX Programı’na ilişkin geniş çaplı ve internet tabanlı bir veri kütüphanesinin oluşturulması bu sayede tüm tarafların ve programa dâhil olan tüm personelin “bilinmesi gereken” prensibi çerçevesinde hızlı ve anlık olarak ilgili dokümanlara ulaşabilmesi bununla beraber veri kütüphanesi sayesinde tüm tarafların her zaman güncel tutulması, resmi yazı ve doküman paylaşımında süre kaybedilmesine mahal verilmemesi

- Personel arasındaki koordinasyonun artırılması ve üst yöneticilerin personel iş birliğine özellikle önem vermesi

- Kalite yönetim süreçlerinin TFX Program yönetiminden ana yükleniciye, alt yüklenicilerden tedarikçilere kadar tüm zincir boyunca kesintisiz şekilde işletilmesi ve kalite güvenlik görevinin sadece ana yüklenici sorumluluğuna bırakılarak işletilmemesi

- Ana alt yüklenicilere ve tedarikçilere kalite ve standardizasyon süreçlerinin oluşturtulmasında rehberlik edilmesi

- TFX Programı’na risk oluşturabilecek potansiyel problemlerin önceden tespit edilmesi ve risklerin bertarafına ilişkin proaktif aksiyonlar alınması

- TFX Program ekibinin program süresince her zaman teyakkuz halinde olması ve herhangi bir kötü niyetli politik, diplomatik veya teknik teşebbüse karşı hızlı cevap üretebilmesi ayrıca program kapsamında iletişim yönetim planı hazırlanması ve çalışma grubu oluşturulması bu sayede konvansiyonel medya ve sosyal medyanın yakından takip edilmesi

SONUÇ

Özetlemek gerekirse hâlihazırda yazılmış olan bu tez yeni bir proje yönetim pratiğini veya keşfedilmemiş bir proje yönetim metodunu ortaya çıkarma iddiasında değildir. Esas itibariyle profesyonel proje yönetimine dair son yüzyılda yazılmış olan literatür çok kapsamlı olup kompleks ve yüksek teknolojili projeler için uyumlandırılarak geliştirilmekte ve güncellenmektedir. Öte yandan bu tezde, başka hiçbir yerde karşılaşılmamış ve JSF Programı'nda ilk defa keşfedilen yeni bir uygulamadan da bahsedilmemektedir. Doğrusu JSF Programı'nda da sihirli bir değnek yoktur, yazılmış olan ve bilinen proje yönetim süreçlerini esas alarak program yönetimi yapılmaktadır.

Bu tez, TFX Programı gibi geniş kapsamlı ve büyük ölçekli bir savunma programına, daha önce bu yollardan geçmiş, V. Nesil savaş uçağı geliştirip üretmiş, kendi içerisinde çeşitli başarılı ve başarısız deneyimler yaşamış olan başka bir büyük ölçekli savunma programından elde edilen tecrübelerin aktarılmasını amaçlamaktadır.

Yukarıda da bahsedildiği gibi, JSF Programı'nda işletilen proje yönetim süreçleri herkes tarafından az çok bilinen, kitaplarda yazılı olan ve teorik olarak proje yönetim literatüründe bahsedilen uygulamalardır. Ancak bu tezde asıl anlatılmak istenen, kitaplarda yazılan proje yönetim süreçlerinden hangilerinin JSF Programı'na katma değer oluşturduğunu, hangilerinin program yönetimi esnasında verimli şekilde işletildiğini ortaya çıkarmaktır. Burada asıl amaç reel ve cari bir savaş uçağı geliştirme programı içerisinde kullanılmış ve sonuç alınarak başarısı ispatlanmış proje yönetim pratiklerini tespit edebilmek ve bunları TFX Programı'nda uygulayabilmektir.

Savunma Sanayii Başkanlığı ülkemiz adına birçok uluslararası büyük ölçekli savunma programına taraf olmuş, bu programlardan elde edilen deneyimi kendi iç süreçlerinde uygulamaya koymuş, en günceli yakalamaktan da geri kalmamıştır. Türkiye adına 20 yıldır JSF Programı'nı yürütmüş ve bu programdan gerekli deneyimi elde etmiş bir kurumun, JSF Programı içerisinde geliştirilen proje yönetimi pratiklerini ve programın öğrenilmiş derslerini, TFX gibi büyük ölçekli savunma programında uygulamaktan da geri kalmayacağına inanılmaktadır.

C. QUESTIONNAIRE FORM

PARTICIPATION INFORMATION LEAFLET & QUESTIONNAIRE STUDY
THESIS TITLE: DETERMINATION OF PROGRAM MANAGEMENT METHODS AND PRACTICES TO BE APPLIED IN THE NATIONAL COMBAT AIRCRAFT DEVELOPMENT (TFX) PROGRAM BY USING THE EXPERIENCE FROM THE F-35 JOINT STRIKE FIGHTER (JSF) PROGRAM
NAME OF RESEARCHER: Muhammed Ali YİĞİT
This sheet seeks to provide information, and advice, with respect to an individual's participation in support of the specified research project: 1. The project is entitled "DETERMINATION OF PROGRAM MANAGEMENT METHODS AND PRACTICES TO BE APPLIED IN THE NATIONAL COMBAT AIRCRAFT DEVELOPMENT (TFX) PROGRAM BY USING THE EXPERIENCE FROM THE JOINT STRIKE FIGHTER (JSF) PROGRAM" and will consider project management practices; 2. This research is being conducted by Muhammed Ali YİĞİT in support of their studies for an MSc in Science and Technology Policy Studies at MIDDLE EAST TECHNICAL UNIVERSITY, and this research is self-funded by the student;

3. The research is being supervised by Prof. Dr. Mehmet Teoman PAMUKÇU and co-adviser Dr. Eyüp Serdar GÖKPINAR, who are supervisors appointed by the METU;
4. Participation in this research is totally voluntary, and assurances are given to the effect that no negative consequences will arise from refusal to participate in the research study;
5. Your data will be collected anonymously, therefore due to the anonymity of the data at source, once completed it is not possible for participants to withdraw their data from the study;
6. Each individual is advised to fully consider, with others if necessary and prior to participation, any disadvantages, side effects, risks and/or discomforts that may arise from participation in this research;
7. All information will be held as unclassified;
8. Whilst summarised / analysed data may be used in future research and/ or publications, your individual data responses will be retained only until the student completes their course and then destroyed.

☐ I give my consent to my data submitted within this questionnaire being used for the purposes stated above.

QUESTIONS
What is your age? a. 25-29 b. 30-34 c. 35-39 d. 40-49 e. 50+
What is your gender? a. Male b. Female
Which one of the following best describe your official types in JSF Program? a. Government Civilian Personnel b. Military Personnel c. Industrial Personnel
How many years of work experience do you perform in Joint Strike Fighter (JSF) Program? a. 0-3 b. 3-7 c. 7-10 d. 10+
Which one of the following best describe your job title? a. Project Manager b. Project Associate c. Project Engineer d. Project Consultant e. Project Assistant

Q-1A: What is the financial management approach that you find very useful within Joint Strike Fighter (JSF) Program? Please specify:
Q-1B: Do you agree that a comprehensive financial management exist in Joint Strike Fighter (JSF) Program? a. strongly agree b. agree c. neutral d. disagree e. strongly disagree

Q-2A: What is the schedule management approach that you find very useful within Joint Strike Fighter (JSF) Program? Please specify:
Q-2B: Do you agree that a comprehensive schedule management exists in Joint Strike Fighter (JSF) Program? a. strongly agree b. agree c. neutral d. disagree e. strongly disagree

Q-3A: Which of the project management practices, that you find very useful and efficient, are used by Joint Strike Fighter Program management team in JPO?
Please specify:

Q-3B: Do you agree that a comprehensive project management approach is being systematically used by the Joint Strike Fighter Program management team in JPO?

a. strongly agree
b. agree
c. neutral
d. disagree
e. strongly disagree

Q-4A: What is the development management approach that you find very useful within Joint Strike Fighter (JSF) Program?
Please specify:

Q-4B: Do you agree that a comprehensive development management exists in Joint Strike Fighter (JSF) Program?

a. strongly agree
b. agree
c. neutral
d. disagree
e. strongly disagree

Q-5A: What is the risk and opportunity management approach that you find very useful within Joint Strike Fighter (JSF) Program?
Please specify:

Q-5B: Do you agree that a comprehensive risk and opportunity management exists in Joint Strike Fighter (JSF) Program?

a. strongly agree
b. agree
c. neutral
d. disagree
e. strongly disagree

Q-6A: What is the technological management approach that you find very useful and effective within Joint Strike Fighter (JSF) Program?
Please specify:

Q-6B: Do you agree that a comprehensive technological management exists in Joint Strike Fighter (JSF) Program?

a. strongly agree
b. agree
c. neutral
d. disagree
e. strongly disagree

Q-7A: What is the contractual management approach that you find very useful and effective within Joint Strike Fighter (JSF) Program?

Please specify:

Q-7B: Do you agree that a comprehensive contractual management exists in Joint Strike Fighter (JSF) Program?

a. strongly agree

b. agree

c. neutral

d. disagree

e. strongly disagree

Q-8A: What is the resource management approach that you find very useful and effective within Joint Strike Fighter (JSF) Program?

Please specify:

Q-8B: Do you agree that a comprehensive resource management exists in Joint Strike Fighter (JSF) Program?

a. strongly agree

b. agree

c. neutral

d. disagree

e. strongly disagree

Q-9A: What is the quality management approach that you find very useful and effective within Joint Strike Fighter (JSF) Program?

Please specify:

Q-9B: Do you agree that a comprehensive quality management exists in Joint Strike Fighter (JSF) Program?

a. strongly agree

b. agree

c. neutral

d. disagree

e. strongly disagree

Are there any other issues that should be evaluated as best practice in Joint Strike Fighter (JSF) Program?

Please specify:

D. THESIS PERMISSION FORM

ENSTİTÜ / INSTITUTE

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

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

Uygulamalı Matematik Enstitüsü / Graduate School of Applied Mathematics [ ]

Enformatik Enstitüsü / Graduate School of Informatics [ ]

Deniz Bilimleri Enstitüsü / Graduate School of Marine Sciences [ ]

YAZARIN / AUTHOR

Soyadı / Surname : YİĞİT
Adı / Name : Muhammed Ali
Bölümü / Department : Science and Technology Policy Studies

TEZİN ADI / TITLE OF THE THESIS (**İngilizce** / English): DETERMINATION OF PROGRAM MANAGEMENT METHODS AND PRACTICES TO BE APPLIED IN THE NATIONAL COMBAT AIRCRAFT DEVELOPMENT (TFX) PROGRAM BY USING THE EXPERIENCE FROM THE F-35 JOINT STRIKE FIGHTER (JSF) PROGRAM

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

1. **Tezin tamamı dünya çapında erişime açılacaktır. /** Release the entire work immediately for access worldwide. [X]

2. **Tez iki yıl süreyle erişime kapalı olacaktır.** / Secure the entire work for patent and/or proprietary purposes for a period of **two years**.* [ ]

3. **Tez altı ay süreyle erişime kapalı olacaktır.** / Secure the entire work for period of **six months**.* [ ]

** Enstitü Yönetim Kurulu kararının basılı kopyası tezle birlikte kütüphaneye teslim edilecektir. /A copy of the decision of the Institute Administrative Committee will be delivered to the library together with the printed thesis.*

Yazarın imzası / Signature : **Tarih** / Date : January 29, 2020