MEHMET AKİF ERSOY ÜNİVERSİTESİ
İKTİSADİ VE İDARİ BİLİMLER FAKÜLTESİ DERGİSİ
Mehmet Akif Ersoy University
Journal of Economics and Administrative Sciences Faculty

ISSN: 2149-1658
Cilt: 9 Sayı: 2 s.940-972
Volume: 8 Issue: 3 p.940-972
Temmuz 2022 July

THE EFFECT OF INTEGRATED LOGISTICS SUPPORT SYSTEM ON LIFE CYCLE MANAGEMENT*

ENTEGRE LOJİSTİK DESTEK SİSTEMİNİN ÖMÜR DEVRİ YÖNETİMİNE ETKİSİ

Sulhi ESKİ[1], İlker Hakan ÖZASLAN[2]

1. Dr. Öğr. Üyesi, İstanbul Gelişim Üniversitesi, Uygulamalı Bilimler Yüksekokulu, Lojistik Bölümü, seski@gelisim.edu.tr, https://orcid.org/0000-0003-0879-0089
2. Doktora Öğrenci, Maltepe Üniversitesi, Lisansüstü Eğitim Enstitüsü, Lojistik ve Tedarik Zinciri Yönetimi, ilkerhakanozaslan @gmail.com, https://orcid.org/0000-0002-4729-3328

Makale Türü	Article Type
Araştırma Makalesi	Research Article
Başvuru Tarihi	**Application Date**
12.04.2021	04.12.2021
Yayına Kabul Tarihi	**Admission Date**
12.05.2022	05.12.2022

DOI
https://doi.org/10.30798/makuiibf.914006

* Bu çalışma İstanbul Gelişim Üniversitesi Sosyal Bilimler Enstitüsü'nde Dr. Öğr. Üyesi Sulhi Eski danışmanlığında yürütülen, İlker Hakan ÖZASLAN'nın 2019 yılında kabul edilmiş olan "Entegre Lojistik Destek Sisteminin Ömür Devri Yönetimine Etkisi: Hava Araçları Yedek Parça Kullanımı Üzerine Bir Uygulama" adlı yüksek lisans tezinden yararlanılarak hazırlanmıştır.

Abstract

The Life Cycle is defined as a process that begins with the demonstration of an intended ability and ends when it becomes out of use. Extending the life cycle will reduce costs and increase efficiency. Integrated Logistics Support (ILS) increases the service life of the products and minimizes the need for support; thus, it provides financial benefit by reaching higher gains in the long term. Due to the understanding of these benefits, it is a system that is frequently applied by businesses. By successfully applying ILS, the life cycle of aircraft, systems, tools, and equipment is extended and costs are reduced. The aim of the study; a product or a system integrated to provide maximum use of the opportunity at minimal cost by extending the life cycle of Logistics Support Turkey is to identify and remedy the causes of failure of the application. The fieldwork method and interview technique were used in the study. The reasons for the failure of the Integrated Logistics Support application on the life cycle have been identified through a study on aircraft. It has been determined that the positive effect of Integrated Logistics Support especially extends the life cycle, prevents premature modification, prevents price increases in spare parts supply, facilitates the availability of spare parts, facilitates the provision of technical documentation, provides planning and execution of personnel training, and the problems of supplying special tools with the system or vehicle.

Keywords: Intagrated Logistics Support, Life Cycle,Aircraft.

Öz

Ömür Devri sahip olunması amaçlanan bir yeteneğin ortaya konulmasıyla başlayan, kullanım dışı kalması ile sona eren bir süreç şeklinde tanımlanmıştır. Ömür devri süresinin uzatılması maliyetleri azaltacak ve verimi yükseltecektir. Entegre Lojistik Destek (ELD)'nin başarı ile uygulanması; ürünlerin kullanım süresini arttırmakta, destek ihtiyacını en aza indirmekte; bu sayede, uzun dönemde daha yüksek kazanımlara ulaşılarak finansal fayda elde edilmesini sağlamaktadır. ELD'yi başarı ile uygulayarak hava aracı, sistem, araç ve gereçlerin ömür devri uzatılmakta, maliyetler düşürülmektedir. Çalışmanın amacı; bir ürünün veya bir sistemin ömür devrini uzatarak minimum maliyetle maksimum kullanma imkânı sağlamada Entegre Lojistik Destek Türkiye uygulamasının başarısızlık nedenlerini ve çözüm yollarının tespit etmektir.Çalışmada saha çalışması yöntemi ve görüşme tekniği kullanılmıştır. Entegre Lojistik Destek uygulamasının ömür devrine etkisindeki başarısızlık nedenleri hava araçları üzerinde yapılan çalışmayla tespit edilmiştir. Entegre Lojistik Desteğinin olumlu etkisinin; özellikle ömür devrini uzattığı, zamanından önce modifikasyonu engellediği, yedek parça ikmalinde yaşanan fiyat artışlarının önüne geçtiği , yedek parça bulunmasını ve teknik dokümantasyon sağlanmasını kolaylaştırdığı,bu konuda personel eğitiminin planlanıp yapılmasını sağladığı, özel aletlerin sistem veya araç ile birlikte tedarik edilmesinde yaşanan sorunları giderebildiği tespit edilmiştir.

Anahtar Kelimeler: Entegre Lojistik Destek, Ömür Devri, Hava Araçları.

GENİŞLETİLMİŞ ÖZET

Çalışmanın Amacı

Bir ürünün veya bir sistemin ömür devrini uzatarak minimum maliyetle maksimum kullanma imkânı sağlamada Entegre Lojistik Destek Türkiye uygulamasının başarısızlık nedenlerini ve çözüm yollarının tespit etmektir

Araştırma Soruları

Türkiye'de Entegre Lojistik Destek uygulamasının ömür devri üzerine olumlu etkisini başarısızlık kılan nedenler ve çözüm yolları nelerdir?

Literatür Araştırması

Entegre Lojistik Destek (ELD) yaklaşımı İkinci Dünya Savaşı'nda oluşmaya başlamıştır. ELD savaş sırasında ve savaşın hemen ardından yaşanan tecrübeler üzerine geliştirilmiştir. Savunma sanayi ağırlıklı olarak kullanılan ELD, kullanılması öngörülen bir sistemin tasarım aşamasından başlayarak, geliştirme, test, üretim, envantere giriş, kullanım süreci ve son olarak elden çıkarılması aşamalarına kadar tüm süreçlerin lojistik desteğinin bütünsel olarak ele alınmasıdır. ELD konseptinde sistemin performans, desteklenebilirlik, maliyet ve hazır olma durumunun birbirini bütünlemesi gerekmektedir. Sorun yaratan sistemlerin henüz tasarım aşamasında lojistiği de dikkate alarak bütünsel bir yaklaşımla şekillendirilmesi sadece kullanım sürecinde değil, sistemi oluşturan tüm alt sistem ve parçaların elden çıkarılmasına kadar olan ömür devri döngüsünü de göz önünde bulundurularak geliştirilmesini kapsaması ELD yaklaşımının temelini oluşturmaktadır. Sistemin kullanım esnasında ölçülebilir performanslarını karşılamasının hedeflenmesidir. Bu noktanın konsepte tam anlamıyla yerleşmesi için 25 yıl kadar süreye ihtiyaç duyulmuştur. ELD 1965'lerden sonra yaygınlaşmış olsa da konseptin bütünüyle oturması 1980'leri bulmuştur. Bu sürede desteklenebilirlik hedeflerinin daha tasarım aşamasında ölçülebilir performans hedeflerine uygun hâle getirilmesi üzerinde çalışmalar yapılmıştır. Silah sistemlerinin teknolojinin gelişmesine bağlı olarak sürekli değişmesi üstelik operasyonel ihtiyaçların artması bu süreci daha karmaşık hâle getirmiştir. Bu süreçte çevre konularını da içeren ömür devri yaklaşımının odak noktası olduğu Lojistik Destek Analizi (LDA) oluşum süreçleri de başlamıştır. Türkiye'de savunma sanayi Ömür Devri Yönetimi projelerinde Lojistik Destek Dönemi ile Tedarik Dönemini bir bütün halinde ele alan Ömür Devri Yönetimi konusunda millî ve ülke yapısına özgü çözümler ve modeller oluşturulması için yerli yükleniciler ve ilgili paydaşların katılımı ile Ömür Devri Yönetimi Platformu kurulmuştur.

Yöntem

Çalışmanın uygulamasında kullanılan veriler hava savunma sanayi araçlarından sorumlu bölüm çalışanları ile gerçekleştirilen görüşmelerden elde edilmiştir. Görüşme, gözlem ve dokuman analizi gibi nitel veri toplama araçlarının kullanılarak, olay ve algıların gerçekçi olarak doğal ortamında bütüncül olarak ortaya konmasına yönelik nitel süreç izlenerek gerçekleştirilen araştırma; nitel araştırma olarak açıklanmıştır. Nitel araştırma, kuram oluşturmayı temel alarak sosyal olguları doğal ortamlarında araştıran bir yöntemdir. Çalışmanın birinci aşamasında, detaylarına ulaşılabilen ELD planı, modeli ve yöntemi literatür bakımından incelenmiştir. İkinci aşamada, lojistik sektöründe çalışan ve ELD/ömür devri yönetimi konularında bilgili veya kısmi olarak tecrübeli, (hangi sektörde olduğu belirtilmelidir)kamuda çalışan 10 personel ile görüşme gerçekleştirilmiştir. Üçüncü aşamada, görüşmelerden elde edilen bilgiler ile ELD uygulamaları karşılaştırılarak, Türkiye'deki mevcut ELD ve ömür devri yönetimi uygulamalarının durum tespiti yapılmıştır. Dördüncü aşamada, ise görüşme sonucunda sağlanan bilgiler ile literatür uygulama sonuçların değerlendirmesi yapılarak, gelecekte yapılabilecek akademik çalışmalar için öneriler sunulmuştur.

Sonuç ve Değerlendirme

Çalışmanın sonuçları şu şekildedir: i. Klasik ELD yaklaşım ile idame edilen sistemlerde; ii. arıza oranının yükseldiği; iii. sistem hazır olma oranının ve sistem güvenilirliği ile sistem performansının düştüğü, bütün bunlara bağlı olarak, sistem ömür devri süresinin kısaldığı ve sistem ömür devri maliyetinin arttığı; iv. lojistik idame sorunlarından dolayı sistemlerin erken dönemde modernizasyonu tabi tutulduğu veya hedeflenen ömür devri süresinden önce envanterden çıkartılmak zorunda kalındığı; v. uygunsuz ve/veya yetersiz bakım ve onarım faaliyetlerinden dolayı can ve mal kaybının meydana gelebileceği; vi. sistemler görevlerini istenilen seviyede yerine getiremediğinden, kamu ve özel sektörün zarara uğradığı, idame sıkıntısından dolayı istenilen performansta kullanılamayan ve idamesi maliyet etkin olmayan sistemlerin yerine yenisinin alındığı vb. olumsuzlukların yaşandığı bilgilerine ulaşılmıştır. Tedarik edilecek sistemlerde, tespiti yapılan sorunların yaşanmaması için ; i. lojistik destek gereksinimlerinin, harekât gereksinimleriyle birlikte projenin ilk aşamalarında belirlenerek projenin ilerleyen aşamalarında detaylandırılmasının ;ii. sistemin LD ihtiyaçlarına göre tasarlanarak üretilmesinin; iii. sistemin ömür devri süresince lojistik desteğini sağlayacak ELD planın hazırlanmasının; iv. kamu ve özel işletmelerde ELD birimlerinin tesis edilerek lojistik destek analiz sonuçlarının uluslararası geçerliliği olan bir standarta göre raporlanmasının; v. akademik ve iş dünyasında verilen eğitimlere lojistik destek analizleri ile ELD konularının dahil edilmesinin; vi. lojistik destek analiz modeli ile ELD modelinin geliştirilerek, ELD ile sistem tasarımının optimizasyonu konularında çalışmalar yapılmasının uygun olacağı değerlendirilmiştir

1. INTRODUCTION

Upon experiencing significant operational-maintenance problems in systems (classical production and procurement strategy) taken into the inventory without planning the maintenance requirements (maintenance / repair, spare parts, tool kit, test device, training, etc.) that will be needed during the life cycle of a product or system; The logistic maintenance requirements of the systems were started to be determined before the system design, and it was aimed to produce systems that can be maintained by influencing the design. The Integrated Logistics Support (ILS) Plan, which will include all maintenance issues, was prepared, taking into account the logistics experience and gains gained during the system design, development and production process.

Systems that are produced and / or procured without preparing an effective ILS Plan are faced with various problems in operation-maintenance, resulting in increased life cycle cost, reduced life cycle time, reduced system readiness, lowered system performance, subjected to early modification, and even it was observed that the system was removed from the inventory during the half-life.

In economic terms, taking a machine or facility out of service due to high cost or low profitability and searching for new ones with other possibilities reveals the concept of life cycle.

Productions to be made without knowing what the life cycle costs are, the cost distributions and the phases of the life cycle lead to making wrong decisions for the buyers in the business and defense industry sector.

2. LIFE CYCLE MANAGEMENT

Economic life is the period of time that expires when a machine or facility is deactivated or replaced due to excess cost or low profitability.

In order for businesses to compete effectively in the increasingly competitive world market, cost, product quality and the ability to deliver on time are important. Engineering design should be compatible with the relevant physical and functional requirements, rather than being a need conversion statement of a product. Therefore, it is stated that efficiency, manufacturability, reliability, maintenance, supportability, quality, recyclability and cost can be measured in the life cycle of the product (Blanchard and Fabrycky, 1991).

Every system is born with an idea, develops by passing certain development stages and completes its life. (Blanchard and Fabrycky, 1991). When the process from the emergence of systems as an idea to removing the system from the inventory is examined, it is seen that the aforementioned process is very similar to the process that can be defined as the birth and death of people. For this reason, this process is expressed as the life cycle of the system. System / product life cycle; It consists of design and development, production / purchase or construction, use, functional support and disposal. The process from the start of designing a system or product to its removal from the inventory (decommissioning) can be defined as a life cycle. The basic idea in the concept of product life cycle is that the product offered by an enterprise has a life cycle that extends from birth to growth, maturity and finally death, as in the same living things. It was stated that the examination of the product life cycle should be a part of the strategic product and program planning of the enterprises (Humphreys,2005).

The life cycle of a system can be viewed from three angles. The estimated time to pass until the system becomes inoperable is the technological life. The period during which the system will perform its function with the desired performance is a useful life. The time it takes to perform its function with the least cost under current conditions is considered as its economic life (Dell'Isola and Kirk ,1995).

However, it should be emphasized at this point that the concept of product life cycle and the concept of life cycle of a product should be distinguished from each other in a certain way. With the concept of product life cycle, starting from the emergence of the need for a product; It refers to the processes of concept studies for the product, development of the system, mass production, entry into the inventory, putting it on the market, operating, maintaining and removing it from the inventory. The concept of product life cycle is a concept that graphically displays the sales history of the product. The product life cycle represents an approach to product strategies in marketing management. According to this approach, businesses want their new products to remain in the market for a long time and to bring profit, so eah product has a life course whose duration and shape is not known beforehand.

2.1. Life Cycle and The Conceptual Dimension of Life Cycle Management

The concept of life cycle costs was first mentioned by the Logistics Management Institute in Washington DC in 1965. The sum of all costs in the life cycle period is called life cycle costs (Dhillon, 2009).

Increases in system costs, budget constraints, competition in the sector, operating and maintenance costs, developments in technology and the complexity of new systems have forced the public and private sectors to develop new strategies in the execution of procurement, operation and maintenance activities. For this purpose, life cycle and life cycle management strategies have been developed to ensure that a product can provide the desired performance (reliability, availability, maintainability, testability and system security) cost-effectively throughout the entire life cycle, from entering the inventory to removing it from the inventory. It is possible to find more than one definition in the literature regarding life cycle and life cycle management. It is defined as a complex and long process that begins with the introduction of an intended ability and ends with its disuse (Genelkurmay Başkanlığı, 2002).

The processes in which system-related activities are planned and executed are called life cycle management. The successive phases may vary depending on the supply, source and complexity of the system (Karabağlı,2020). It is stated that life cycle phases are formed in seven stages: concept development, preliminary design, detailed design, development, production and construction, use and support, and elimination. While the life cycle phases are simplified when the project is ready, the project definition, development and production phases are carried out by the contractors (Savunma Sanayi Başkanlığı,2021).

The life cycle management is carried out by determining the needs of the user, developing the design, analyzing the alternatives, and performing the activities before the design of the system. The second phase of concept production is to make improvements to meet customer demands and needs. The last phase is the use of the system in a cost-effective way during its life cycle, providing logistical support and taking out of the inventory when the life cycle ends (Defense Acquisition University,2005).

Due to the high costs during the period from the R&D studies of the defense systems to the entry into service, the users want to use the material they have purchased for a very long time. Usually, the life cycle is kept above 30 years. On the other hand, technologies especially in defense systems are developing rapidly. The rapid change and competition in technology obliges users to make modifications and improvements. This technological speed can be so high that while modification is made, high technology is produced and even can be found in the later R&D stage. This situation can exceed the procurement costs within three to four years as it increases the operating costs very much (K.K.K.Gn.P.P., 2002).

A small portion of life cycle costs are procurement costs. These costs, which are mostly visible costs, are also referred to as accounting costs. Often invisible costs are operating and maintenance costs, with a larger share (Deran,2008).

<u>Visible (non-recurring) Costs</u>		
Research – Development Production	}	Purchasing Costs
<u>Invisible (Ownership - Recurring-Accounting) Costs</u> Maintenance costs (maintenance and repair, spare parts, maintenance training) Distribution costs (transportation, storage, loading and unloading) Software cost, technical information cost, test and support equipment cost	}	Accounting cost + sum of costs incurred for the asset (including disposal cost) = economic cost (life cycle cost)

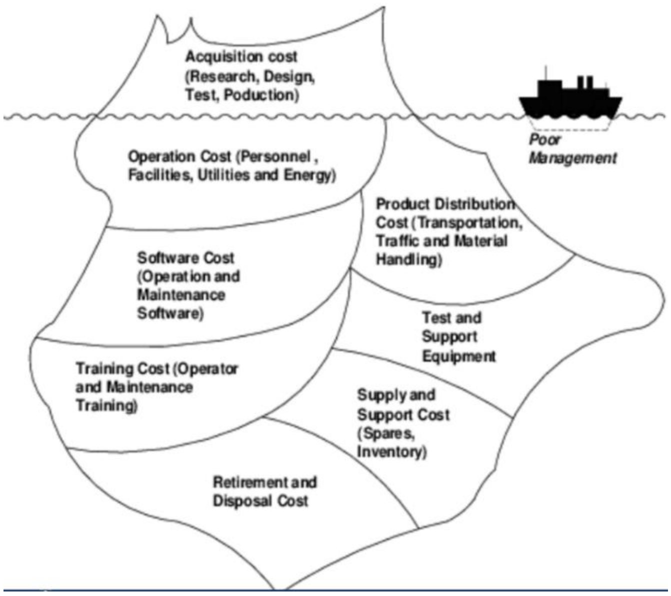
Significant logistics costs in businesses are visible and controllable. Therefore, businesses give more importance to these cost items. As for uncertain logistics costs, it is difficult to distinguish and measure from other costs, so the necessary effort is not made to determine such logistics costs. Therefore, most of the time, business managers do not know exactly which cost item increases logistics costs or how they relate to other cost items. It has been evaluated that this situation may cause decision makers to make wrong decisions (Arslan et al.,2011).

The purpose of the PDM analysis, which should be taken into consideration in the procurement of system type materials; To compare alternative products, to determine the most appropriate purchase strategy, to make long-term planning and budgeting, to control the ongoing project, to make warranty and performance follow-up, to make cost / benefit analysis, to distribute resources efficiently, to decide on the replacement of systems and equipment, to determine the main costs (Acar and Yurdakul, 2013).

In order to ensure the system design and supply effectively, the total cost of the system from the initial design or procurement stage to the period of removal from the inventory should be calculated. As a result of the information obtained, the life cycle costs of defense systems should be controlled and managed with minimum error in order to reduce budget expenditures (Işın,2009).

Life cycle costs start with logistic engineering. Life cycle cost in the form of iceberg (Figure 1) contains a large structure under the visible part. When all the costs of a system are examined in the period from the time to exit from the inventory as a requirement, it is seen that the operating / support costs are 85%.

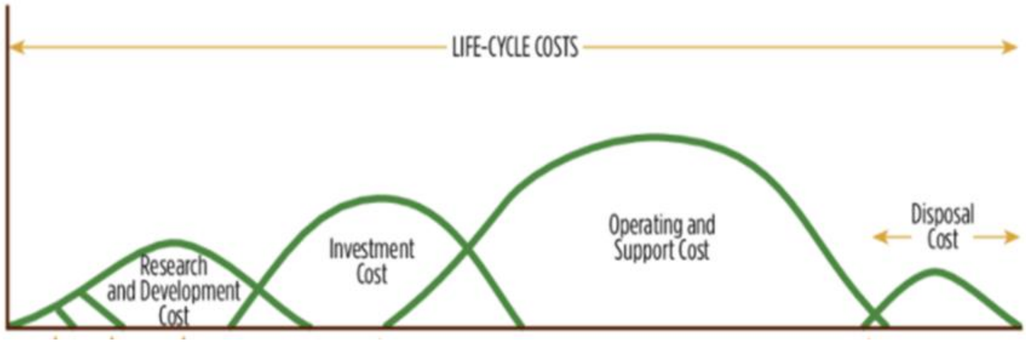
Figure 1. Costs Iceberg Related to Logistic Support



Source: Díaz et al., (2011)

The basic elements of the life cycle cost with the activities to be performed in the first five stages to the expenditure to be realized when adding a cumulative curve of the costs to occur over the life cycle phases are research, development, testing and evaluation costs, production and investment costs, operating and maintenance costs and disposal costs(Figure 2).

Figure 2. National Life-Cycle Costs For A Dod Weapon System



Source: Jones et al., (2014).

If we distribute the LCC elements in the life of the system; research, development, testing and evaluation costs average 7-10%, production and investment costs average 23-30%, operating and maintenance costs average 65-70%, disposal costs average 2%. These values can change in different defense systems. Approximate life cycle cost distributions according to the systems are shown in Table 1. It is seen that the high part of the life cycle cost of a system is composed of operating and maintenance costs. In case of determination of operating and maintenance costs, the use of the systems will be effective, unnecessary stocks and unnecessary purchases will be avoided, and the system or material will not be required to be taken out of the inventory before completing its life cycle due to uncontrolled use. Thus, material and system developers / designers emphasize the importance of increasing the reliability of the system, reducing the logistical support needs and labor force in order to reduce the operating and maintenance costs of the system.

Table 1. Life Cycle Cost Distributions of Systems

System Type	R&D	Production	Operation and Maintenance Disposal
Ship	1 %	31 %	68 %
Land Vehicles	9 %	37 %	54 %
Rotary Wing	15 %	52 %	33 %
Space	18 %	66 %	16 %
Fixed Wing	20 %	39 %	41 %
Electronics	22 %	43 %	35 %
Rocket	27 %	33 %	40 %

Source: Işın, (2009).

Life cycle analysis at the early stages of the procurement program provides important opportunities to reduce costs. Ensuring that system reliability and maintainability is at the optimum level increases the procurement cost, while reducing the total life cycle cost.

After the implementation of the project, the desired results may not be obtained with the measures to be taken to reduce the costs. For this reason, similar parameters such as life cycle periods, average time between maintenance, corrective average maintenance times, periodic average maintenance times, unit labor fees, number of personnel required for repair and maintenance, real availability rate It is seen that it is important to ask suppliers or producers.

3. INTEGRATED LOGISTICS

It is stated that the logistic support requirements needed in order to find, operate, maintain and maintain the materials at the desired performance level throughout the life cycle in a cost-effective manner, should be determined in the project planning and implementation processes (NATO, 2012).

Integrated Logistics Support is defined in different ways from different perspectives.

In terms of financial gain, Integrated Logistics Support is defined as providing a financial benefit by reaching the maximum profit periodically in the long term to increase the lifetime of the manufactured products and minimize the need for logistics support (Düzgün, 2016).

Integrated Logistics Support is defined from the perspective of the entrepreneur, one of the business stakeholders, as the disciplined management of the necessary processes to create an acceptable level of system design and support capability that can be supported to achieve a determined goal with acceptable reasonable costs (Keskin, 2011).

In terms of the life cycle of products, Integrated Logistics Support is all technical and administrative activities that effectively define, design, develop, produce, supply, commission, operate, support, terminate use, and ensure the realization of the plan (Göksu et al., 2009).

According to NATO, Integrated Logistics Support is to ensure that activities are carried out in a disciplined manner during the implementation and planning stages to maintain the continuity of the systems to be supplied at the desired performance level and the minimum cost level (NATO, 2011).

Initially, integrated logistics support was used to plan and manage logistic support activities in order to extend the life of vehicles and equipment in the armies with less support. In our time, it is effectively and intensely applied by the armies and civilian institutions. It is not an activity that can only be used and applied during the procurement and supply phase. It is explained as the main objective should be to support materials and systems throughout their life cycle.

The main purpose of ILS is to increase the service life of the products while minimizing the need for support; In this way, it is to provide financial benefit by reaching higher gains in the long term.

ILS determines the support requirements for the readiness of the product by giving feedback to the design studies of the product, and also provides the technical support requested by the customer at the lowest cost. For this reason, ILS disciplines are an integral part of engineering studies in military system designs and work together with logistics engineers and design engineers to ensure that support issues are taken into account during design studies (Göksu et al., 2009).

However;

-It has an impact on system design without compromising system performance, ensuring minimum operating and maintenance costs,

- Ensuring that all of the integrated logistics support elements are planned, developed, tested, evaluated, supplied and made available at the place of use before the materials and system, if not possible, simultaneously,

-Planning and implementing the training of personnel and support personnel who will be the users of the system,

- Taking into account the adaptation period of the workforce, the realization of plans that will ensure the supply and integration of ILS elements,

- Logistics standardization between the forces of allied countries and other units and ensuring mutual usability of logistic support elements,

- It is stated as the organization of logistics research and development programs in order to develop materials that will provide maximum benefit (NATO, 2012).

3.1. Technical Disciplines of ILS

Technical disciplines of ILS were defined as (Göksu et al., 2009);

- ILS Program Management,
- Reliability, Maintainability and Testability Engineering,
- Support (Logistic Support Analysis),
- Technical Documentation,
- Ground Support Equipment,
- Spare part,
- Packaging, Transport, Storage and Transportation,
- User and Maintenance Personnel Trainings,
- Facilities,
- Technical support,
- Warranty Tracking.

ILS Program Management process is a process that starts with the delivery of the request for proposal file (RFP) to the contractor firm and continues until the end of the technical support period defined in the contract in order to meet the contractual requirements. In the program management process, it has been stated that the assignment of contract responsibilities to the relevant ILS disciplines, the timely fulfillment of the necessary procedures in accordance with the desired standards at every stage of the project, and the effective use of program management tools such as calendar and budget (Göksu et al., 2009).

3.2. Scope of Integrated Logistics Support

It stated that the integrated logistics support should include the necessary technical support activities in order to provide the desired performance during the entire life cycle of the system, together with the planning and controls at the initial stage.

The efficiency of the system is determined by the maintenance, operation and supporting factors as well as being very well produced. This requires the analysis and management of too much data. In order to obtain these data correctly, it is necessary to find good subcontractors and users, and to carry out activities such as design, planning, production, purchasing, quality, including all parties, simultaneously. Considering that the systems will generally be used for 30-40 years, sometimes up to 100 years, besides the performance of the system, enough weight should be given to supportability and logistic support and expectations should be correctly determined and transferred to the project. To explain what the performance expectations are with an example; it is to indicate the task an aircraft will perform at what altitude, how long, weight and speed. In this context, ILS is a globally accepted analysis methodology and management process applied in most of the major military procurement projects. This methodology aims to achieve the optimum balance between cost, performance and supportability.

4. THE EFFECTS OF INTEGRATED LOGISTICS ON THE SYSTEM LIFECYCLE

There are few studies on the effects of Integrated Logistics on the System Life Cycle. This study aims to contribute to the literature on this subject.

Although the procurement of a system or platform is a very difficult process that is carried out with the suppliers and changes can be made on the product at all times, these difficulties become more severe over time and the owner organization confronts the owner organization in the form of operational problems.

Incomplete or non-completion of the ILS plan for the product during the procurement phase, (incomplete information, incomplete documentation, organizational changes made in time during the operation phase, the removal of the required spare parts in the world markets, the lack of training personnel, the retirement of the trained specialist maintenance personnel, and The inexperience of the personnel, the aging of the systems and the inability to support them, the unexpected malfunctions of the systems, the wrong supplies due to the incorrect identification of spare parts, usage errors, prolongation of maintenance processes) endanger the necessity and obligation of the systems and devices to be ready for duty at all times.

Lack of ILS plan shortens system life (early modification or deregistration / de-inventory) and increases life cycle cost significantly. As technology advances, the products supplied become more complex. Expertise subjects such as electronics, software and mechatronics come to the fore. Difficulties are encountered in providing the operation and maintenance support of these products within the product range.

An effective and effective ILS plan must be made together with "life cycle management" in order to maintain the desired performance in a cost effective and uninterrupted manner throughout the life cycle of a product, material or system from its entry into the inventory to its removal from the inventory.

Considering the longevity of the product, life cycle management of combat systems and ILS plans become a very strategic issue. The fact that the use and maintenance of the products require expertise, the constant change of personnel working in these areas and the fact that more than one generation is operating on the product puts the issue in a more difficult area to operate. The use of product life cycle management systems and the ILS system in the areas of operation and logistics support after product procurement, and the management of product information in all life cycle processes, starting from the procurement stages to operational use and then disposal, is of great importance. The main effects of the ILS system on the product life cycle and life cycle cost;

- It extends the system life cycle and reduces the life cycle cost.
- It ensures that the desired system performance (reliability, availability, maintainability, testability and system security) can be maintained cost-effectively and without interruption.
- By ensuring the continuity of the logistic link between the manufacturer of the systems and the system, the data in the period of use will be delivered to the manufacturer, and the system renewal and maintenance will be easier.
- It will ensure the increase of projects aimed at developing and increasing the capability of providing logistic support for the sustainability of the domestic industry.
- It will enable the private sector to invest in logistic support, and to make long-term contracts with incentive content that will enable them to increase and develop their capabilities.
- The manufacturer will continue to produce the materials and spare parts that will be needed by the system even after the responsibility process (warranty or spare parts supply period), thus ensuring that there are no problems in the supply of spare parts.

- In order to prevent the difficulties in material procurement, it will prevent excessive and unnecessary stocks and reduce the costs of stock, storage and shelf term.
- It will prevent the use of non-standard materials in mandatory situations for maintenance and operation activities.
- Due to the lack of support from the manufacturer / supplier / subcontractor, the systems that have difficulties in maintaining, operating, and procuring spare parts will be prevented from cost-ineffective expenses such as compulsory modernization, renovation or configuration change in the half of the projected life cycle. Since maintenance / repair, spare parts, information package, documentation and similar issues cannot be done at a sufficient level due to technical and legal reasons in order to ensure the maintenance and operation activities of the systems that are planned to remain in the inventory for many years,) or removing the systems from the inventory before the life cycle expires.
- Due to having strategically important systems and sub-units outsourced to different suppliers, interventions other than the main manufacturer will be prevented and performance loss and insecurity of the system will be minimized.
- By creating a product-oriented working environment, correct coordination will be ensured among the stakeholders involved in supporting war systems, and communication will be simplified.
- Products will be better known by maintenance and support personnel, and the maintenance requirements and material and resource requirements to be performed on these products will be standardized.
- The opportunity to answer the questions of "What, why, why" about the systems will be provided in a correct and fast way.
- With revision control and document support, the changes made on the product, maintenance and configurations will be made available to use in business processes that can be traced and comparable with previous revisions.
- The knowledge and experience accumulated personally on the personnel will be institutionalized and recorded in a product-oriented manner, and will be transferred to future generations.

In system procurement projects, the contribution of knowledge and experience to project management will be provided as lessons learned.

- Feedbacks will be delivered to all stakeholders through the system and product and process development activities will be directed.

5. THE IMPACT OF THE INTEGRATED LOGISTICS SUPPORT PLAN ON THE SYSTEM LIFE CYCLE (AIRCRAFT APPLICATION)

5.1. The Methodology of the Study

5.1.1. The Aim and Importance of the Study

Defense is an indispensable element of existence for countries. Keeping up with the changes in technology and logistics systems has become inevitable. When evaluated in terms of the region and time, the need for operation is the first priority and an indispensable element in defense expenditures. It is preferred that the tools and equipment obtained as a result of these expenditures can provide uninterrupted, active and long-term service. In order to carry out this process, the logistics issue must be applied well.

It is planned to maintain, maintain, and remove a system, vehicle, and material from the inventory when the service period expires before they are supplied and produced. After the material is produced and purchased, it is not possible to apply the elements referred to as ILS. Cost may be unpredictably high when some elements are attempted to be implemented. An ILS plan to be prepared in the early stages of system procurement will significantly reduce the life cycle costs while increasing the system life cycle and system performance. ILS plans will prevent the system from being removed from inventory early before the life cycle has expired. This will provide significant added value and savings to the country's economy.

It is observed that classical maintenance models are insufficient in providing logistics support due to the increase in the weight of electronics and software of the systems, the need for continuous updating of critical software, the discontinuation problems of the sub-units and parts that make up the system, the frequency of modernization, the long targeted life cycle, and the increase in life cycle costs.

In order to maintain the operation maintenance activities of the systems in a cost-effective and uninterrupted manner, the life cycle must be seen as a whole and the necessity of determining the logistic support needs, which are an integral part of the material supply process, arises from the first phase of the system supply. In parallel with the supply of materials, integrated logistics support plans are made in order to determine the logistics support needs. Many ILS decisions made in the early stages of the planning and concept design phase positively affect the system life cycle and system life cycle costs. Systems should be developed and produced in such a way that they can be used and maintained effectively and efficiently. An effective and effective ILS plan, which will be created before the system is in the inventory, will contribute to the cost-effective provision of all logistic support (maintenance, support equipment, infrastructure, training, spare parts, documentation, etc.) that it will need throughout its life cycle after the system is in the inventory.

In the study; The effect of the ILS plan on providing the supportability (reliability, readiness, maintainability, testability, facilities, maintenance plans, training) in a cost-effective and uninterrupted manner in order to achieve the desired performance of the system during the life cycle will be examined.

5.1.2. Limitations

Since the research includes interviews with the relevant personnel of a few companies engaged in manufacturing in the air defense industry, there are limitations in generalizing the results and applying them to the whole universe.

5.1.3. Research Model and Method

Collecting, analyzing, interpreting and evaluating data in a systematic and planned manner in order to seek reliable solutions to the identified problems is explained as research.

The research carried out by following the qualitative process aimed at revealing the events and perceptions in a realistic way in their natural environment by using qualitative data collection tools such as interview, observation and document analysis; described as qualitative research. Qualitative research is a method that researches social phenomena in their natural environment, based on theorizing.

Qualitative research usually collects information, perceptions and environmental information about the process. The most commonly used qualitative information gathering methods; interview, observation and examination of written documents. The interview method is divided into structured or open-ended according to the characteristics of the tool used, and participant or non-participant according to the position of the researcher. The interview method is the most effective method to reveal people's perspectives, experiences, perceptions, thoughts and feelings.

The "field research" model was chosen as one of the qualitative research methods in order to collect and analyze the data in accordance with the structure of the questions prepared about the effect of integrated logistics support on the life cycle.

The methodology of the research is based on interviews with people working in the public sector, especially those experienced in ILS and life cycle management, and an examination of ILS plans for the maintenance of different systems. A four-stage study was conducted in the research.

In the first stage, the ILS plan, whose details can be accessed, was examined in terms of model and method.

In the second phase, interviews were conducted with 10 personnel working in the logistics sector, who are knowledgeable or partially experienced in ILS / life cycle management, and who work in the public sector.

In the third stage, performing interviews and information provided by those in the comparison of the ILS plan, the status of ILS and life cycle management practices in Turkey have been identified.

In the fourth step, by evaluating the information obtained as a result of the interview and the results obtained from the literature review, suggestions were made for future academic studies with the employees in the logistics sector.

5.1.5. Data Collection Tools and Analysis

In the literature review, academic studies on ILS and life cycle management, Turkish and English articles, books, documents published by NATO member countries, military and civil publications, briefings and seminars, publications of SSM and TAI institutions in our country were examined.

Interview technique was used as a secondary method in data collection. When the interview questions asked to be answered for the purpose are examined in terms of structure and content, the interview technique was evaluated as the most appropriate data collection method. During the interviews, the structured interview method was used, in which the questions were prepared before, the course of the interview was determined and planned beforehand.

An interview form containing six questions used in the research was prepared. During the preparation of the questions, the resources related to the ELS plans and life cycle were examined and the questions that raised the issue were determined. Appointments were requested from the participants at available times, and mutual meetings were held, except for working hours. All participants were given a form containing six open-ended questions in ANNEX-A, indicating the research and purpose of the interview. The questions were thought to be open-ended in order to obtain their views on the subject and the information required for the research. There was no time limit for the participants and their answers were noted. The notes kept were regularly recorded and kept securely.

The evaluation was made as a text analysis. The elements of integrated logistics support are coded as system infrastructure, secondary complete and spare parts management, maintenance and repair, breakdown, standardization, fault detection testability, transportation, transportation, human and environmental health, procurement, stock building, maintenance, training, packaging handling, storage and transportation and tried to be analyzed.

5.1.6. ILS Plans and Interview Questions Used in the Study

ILS plans prepared for aircraft and systems will be examined and evaluated in the research. In addition, price increases in spare parts for aircrafts without ILS were evaluated.

Six questions given below were asked to 10 participants who were interviewed.

Q-1: What kind of problems are experienced in the operation and maintenance of the systems (vehicle / system and other materials) in the inventory of the institution you work for during the life cycle? (If there is technical infrastructure of the system, procurement, maintenance and repair, documentation, Packaging / Marking / Transportation / Storage, please specify separately.)

Q-2: What kind of negativities (inability to perform the task, waste, cost, loss of time, etc.) caused by the problems experienced in the operation and maintenance of the systems?

Q-3: What could be the reason / source of the problems experienced in the operation and maintenance of the systems? (What has not been done or has been done incompletely and these problems have arisen?)

Q-4: The logistical support needs needed for the operation and maintenance of the systems throughout their life cycle in a trouble-free and cost-effective manner:

a-At what stage of the procurement (ready purchase and / or production) process should be determined?

b-What should be the scope and content of these needs?

c-What should be considered in determining these needs?

Q-5: What effects does an appropriate ILS plan have on the life cycle and life cycle cost of the system?

S-6: Public and private sector prepared by the acquisition of system maintenance for businesses and the adequacy of the ILS plan in Turkey, what do you think the applicability and efficacy issues?

5.1.7. Analysis of The Data

The questions that did not use a scale during the study were analyzed separately. As a result of this analysis, the results have been reached. For this reason, the need for reliability analysis performed for scale reliability has disappeared. The information obtained from the literature was used to determine the possible deficiencies in the study, as well as ensuring the accuracy and reliability of the data collected from the interviews.

5.2. Findings

In this section, information on the results achieved by data from interview techniques and the examination of ILS plans made in Turkey have been given.

5.2.1. Data Obtained in Interview

Q. 1. What kind of problems are encountered in the operation and maintenance of the systems (vehicle / system and other materials) in the inventory of your institution during the life cycle?

A.1-10 Common Answer

There are problems in spare parts supply, storage, documentation, training, training support equipment, transportation, infrastructure and facilities, maintenance support equipment.

Q1.1. What are the Deficiencies and Defects Related to the Technical Infrastructure of the Systems?

A. 1-10 Common Answer

The material quality of some sub-parts / units of the system is low and poor, not in the durability and quality to meet the duty profile,

Not using metric and inch system in parts, especially European productions come according to the inch system and the need to have extra tools, long durability in geo-atmospheric challenging conditions and very rapid fractures,

Since new / up-to-date technological materials / parts / products / software / hardware are not used in the system design, the materials become obsolete in a very short time, making procurement difficult and causing problems in maintenance / repair, increasing the life cycle cost and increasing the dependency on the manufacturer companies, resulting in systems half-life cycle. Systems cannot be modernized before expiry due to maintenance problems or systems have to be removed from the inventory before the half-life cycle expires due to high maintenance costs.

Q.1.2. What are the deficiencies and defects related to the experienced supply?

A1-10 Common Answer

The system and the units of the sub-parts that make up the system are terminated by the manufacturer,

In the case of small and discontinuous spare parts supply, companies in the market are not bidding or offering high prices due to reproduction

Using standard and non-original materials instead of materials that cannot be supplied (ready to purchase or re-production) reduces system performance, increases failure rates, and most importantly, creates security weaknesses.

The procurement of materials of foreign origin is sometimes caught in international political obstacles or the time is prolonged due to different excuses put forward by the companies,

Due to the fact that the MTBF values of the lower parts of the system are not given and the past experience information for use is not available, the spare parts stock level calculations for newly produced systems are not made correctly, so the required TQC and spare parts cannot be supplied, and when the replacement and original spare parts producing company cannot be found, there are problems in maintenance and repair activities.

Q.1.3. What are the deficiencies and defects regarding maintenance / repair?

A. 1-10 Common Answer.

Poor planning based on personnel workforce prolongs the time. Prolonged supply of material and spare parts is a problem. The maintenance facilities required for proper maintenance and the lack of one of the technical personnel reduce the effectiveness of the maintenance and repair, and the life cycle of the system and the system availability rate decreases due to this improper maintenance activity, while the life cycle cost and failure rate increase. For proper maintenance, there must be tool-tool kit, test device, documentation, spare parts, maintenance / repair place and well-trained, knowledgeable and experienced technical personnel.

Q.1.4. What are the lacking points of documentation you encounter?

A. 1-10 Common Answer

During the supply of the system, the technical documentation (technical specifications, spare parts catalog, maintenance forms, circuit diagrams, etc.) is not fully taken and updated according to the relevant maintenance stages, so maintenance and repair activities at some maintenance levels cannot be done appropriately, causing confusion and loss of workforce. is happening.

Since the warranty period is not fully defined in the contracts, there are legal problems between the contractor-administration-business owner. (Not identifying user errors, not determining who will cover transportation and insurance expenses, etc.)

Since the ability to install and update the system and computer software is not gained, the company is dependent on the relevant company in case of need, and the updates and repairs cause high costs.

Q.1.5. What are the deficiencies and defects related to packaging / marking / transportation / storage?

A. 1 -10 Common Answers

Since the storage areas of the systems are not planned during the procurement stage, many systems have to be stored in open areas and in unsuitable environments. Although some temporary storages are built, this situation significantly affects the life cycle of the system.

When the marking and labeling of the materials are not done according to the standards, the signs are erased or fallen over time and there are difficulties in recognizing the materials. Thus, it causes confusion in storage and transportation and causes material loss.

There is a problem with materials that require special packaging.

Q. 2. What kind of negativities do problems experienced in operation and maintenance of systems cause?

A. 1 -10 Common Answers

Failure to supply spare parts, lack of maintenance organization (tool, toolbox, test device, documentation, maintenance place, etc.), lack of technical personnel and failure to perform maintenance and repair activities due to the inability to increase the failure rate and prolong the inactivity periods and even to be removed from the inventory before the planned time. lead to have to.

The outdated systems make it difficult to supply parts, shorten the life cycle, and increase the cost of the system life cycle.

Q. 3. What could be the reason / source of the problems experienced in the operation and maintenance of the systems?

A. 1 -10 Common Answers

The main reason for these problems is that logistical support issues were ignored, incomplete and inadequate planning during the procurement of vehicles / systems and materials.

In the project management process, since the planning phase of the logistics support needs is made after the design and development process, that is, before the prototype product is completed and before the mass production phase, the product design cannot be shaped according to the logistic support needs.

Maintenance feasibility, supportability analysis cannot be performed, maintenance levels cannot be determined according to FMECA and ZORA analyzes, Logistic support analysis is not fully performed, inputs related to configuration management are not made, other logistics support requirements (transportation, storage, packaging, maintenance establishments, training, etc.) are not planned before the design, modularity analyzes of spare parts and consumables are not performed.

In the current directives of the public, there are no provisions for planning logistic support requirements before project design and for these requirements to shape the project design.

In the procurement phase, the need for operation is considered to be more important than logistic support, and logistics remains in the background. In logistic support, traditional methods are continued to be used, modern production methods and techniques and after-sales support applications are not fully implemented, ILS plans are not implemented and left for later.

There is a prejudice that the logistics support requirements will complicate the work of the company, cause complexity in the production of the system, and exceed the project completion time and cost limit.

In the academic field, the course for logistics support planning and implementation in procurement projects is that there is no subject scope and published academic publication.

Q. 4. What are the logistic support needs needed for the maintenance of operation and maintenance of the systems in a trouble-free and cost-effective way during the life cycle?

Q.4.1. At what stage of the procurement (ready purchase and / or production) process should be determined?

A. 1 -10 Common Answers

It will be appropriate to start before the design process.

Q.4.2. What should be the scope and content of these needs?

A. 1 -10 Common Answers

12-factor product support strategy.

Q.4.3. What should be considered in determining these needs?

A. 1 -10 Common Answers

At every stage of the project design and development process, a system must be designed that fully meets the operational and logistics requirements by intervening in the team. In this process, one of the most important issues is to produce a system that can meet the operational needs at the desired level, and secondly, the product design that can be sustained cost-effectively during the life cycle of this system, and the creation of the ILS plan.

Q.4.4. At what stage of the program should the integrated logistics support plan begin, what should it cover and what should be considered in this process?

A. 1 -10 Common Answers

ILS thinking and work should begin with the project idea and thinking. Maintenance, procurement, storage, transportation, training, training support materials, documentation, packaging, transportation / transportation, maintenance support equipment, technical personnel, infrastructure and facility, product support management, design interface and sustainability analysis.

Q. 5. What affects does an appropriate ILS plan have on the lifecycle and cost of the system?

A. 1 -10 Common Answers

Since there will be no problem in procuring the materials needed for the maintenance of the system, the system will not be subject to modernization due to maintenance problems, and the life cycle cost will decrease due to the regular and proper maintenance of the system, thus the life cycle time will increase inversely.

Aircraft will not have to be modernized in a short time, as there will not be a high price increase and difficulty in the supply of spare parts for aircrafts where ILS is applied. Thus, the life cycle will increase and the cost will decrease.

Q. 6. What do you think about sufficiency, applicability and effectiveness of the ILS plan prepared for the administration and maintenance of the systems purchased by government and private sector in Turkey?

A. 1 -10 Common Answers

While the operation needs are defined in detail in the needs definition and project definition documents, the technical infrastructure and logistic support requirements of vehicles, systems and materials are not defined sufficiently. Usually abstract and general expressions are used. In practice, since there is no ILS study or similar intervention before the design, the design is shaped according to the comments and opinions of the Contractor companies. After the prototype is produced, an attempt is made to create an ILS plan. Inputs and corrections made at this stage do not work backwards in terms of shaping the prototype. From now on, a system produced as a whole cannot be converted into a modular structure. Instead of designing a system according to the required logistic support requirements, logistics support is planned according to the designed system. In ILS plans made after prototype production, the design interface, product support management (analyzes), sustainability analysis sections are removed and a superficial ILS plan is made according to the technical structure of the product produced. Analyzes are not included in the ILS plans prepared in this way. Configuration management considerations are included.

5.2.2. Data Obtained from ILS Plans

It is seen that the activities to be carried out and the points to be considered in order to maintain the logistics maintenance smoothly during the life cycle of a system included in the inventory are explained in the ILS plans. In the ILS plans examined, a system and aircraft or spare part;

- How it will be packaged, marked, transported, stored has been specified.
- By whom, where, with what maintenance facilities (tools, sets, tools, special test devices and equipment, technical documents) the maintenance and repairs are specified.

Where to procure subsidiary complete parts for aircrafts, consumable spare parts, where to be procured, consumable spare parts lists that must have the minimum in the beginning, periodic maintenance consumable parts lists, which documents will be delivered as a guarantee, how many days will the aircraft be operated. and the sanctions to be applied in other cases are stated.

Responsibilities are specified for who will follow up the unworkable material, how it will be managed, and the improvements and modifications that can be made.

- By whom and how the technical personnel will be trained, providing technical documentation and tracking and delivering updates, the minimum required special toolbox lists are specified.

When the ILS plans prepared for aircrafts are examined, the contents are;

- Maintenance, repair planning,
- Supply support (spare parts, secondary complete),
- Staff,
- Test and support devices,
- Technical documentation,
- Education,
- Facilities,
- Packaging - transportation - storage - transportation,

It is seen that the removal from the inventory has been announced.

ILS plans in other countries and in Turkey in the background is seen the same topic. Without going into details made those issues in Turkey seems to be more superficial. It has been observed that the plans abroad were created from the results of the logistic support analysis made in the design. In the design stages of a product;

- RAMT analysis (reliability, availability, maintenance, testability)
- FMEA / FMECA (failure mode effects and criticality analysis)
- LORA (repair level analysis)
- Preventive / Periodic maintenance planning
- It is seen that the maintenance task analysis has been done.
- In order to ensure that the product designed according to RAMT analysis is maintained throughout its life cycle,
- With FMECA, it is seen that error codes and periodic maintenance plans are made to correct and prevent these errors.
- With the analysis of LORA and maintenance tasks, it is seen that which operations are to be performed at which maintenance levels

The MTBF values of the parts that make up the system were determined by reliability analysis. Based on these values, maintenance and repair plans, workforce plans and stock levels were created.

With the maintainability analysis, it was determined at which maintenance stage, in how long, with which tool-test devices the LRU parts will be disassembled, mounted and tested. In this context, the maintenance facilities and support equipment that will be needed are specified.

Maintenance and repair analyzes and training of the personnel who will perform these operations are also planned. ILS requirements specified according to the results of the analysis made during the design phase of the product were transferred to the ILS plan.

In the ILS plans made in Turkey the LSA and analysis were not found. The ILS plan has been detailed in a few lines under the headings explained above and has been made in a way that will not provide any benefit in logistics maintenance during the life cycle. These plans include maintenance levels and maintenance organizations, but no logistics support analyzes have been encountered in them.

When the spare part status of the aircrafts where ILS is not applied is examined; spare parts prices may increase abnormally over time. The reason for this increase is observed as the need to apply modification ahead of time and delay it. When the part becomes obsolete, it is seen that the sellers in their hands demand higher prices, and the requested price has to be paid due to the availability of the aircraft. It is seen that this high price of spare parts payment will continue to increase for aircraft, almost all of which are dependent on foreign spare parts.

Increases in the prices of spare parts of an aircraft purchased in 1991 without ILS are shown in Table 2;

Table 2. Spare Parts Price Increase

Name of The Material	Order Date	1991 Purchase Price (Euro)	Current Offer Price (Euro)
Vhf Controller	12.08.2015	160	1000
Insturement Filter	11.08.2015	1,56	6,27
Oring	11.08.2015	0,58	10,2
Discharger	05.08.2015	19,6	56,95
De Ice Boot	21.04.2015	4020	7232
Bearıng	12.10.2015	24,15	72,45
Engine Mounth	12.10.2015	1760,78	14086,24
Tachometer	27.07.2016	434,95	2203,50
Altimeter	13.03.2017	4588	14386
Tire	19.08.2018	97	435

Note: Prices have been obtained as a result of research.

Such situations are not encountered in aircrafts where ILS is applied. The problem will be solved with the support and modifications to be provided within the period specified in the spare parts item in the ILS plan (40 years in public aircraft in general). When Table-2 is examined, it is seen that the part increase rate in the aircraft without ILS is at least 79% with the part named ice boot. The maximum increase is seen in the piece named oring with an increase of 1750%. In addition, when the exchange rate increase is considered, the purchase cost will be higher.

5.3. Data Evaluation

In procurement (ready-made purchase or production) projects, 10 people from the public sector were interviewed within the scope of ILS studies and ILS plan, product life cycle period and scope.

In these interviews, the participants were asked what kind of logistic support problems they faced in the institutions and organizations they work with, the consequences of these problems and what they cost and the reasons for the problems.

Participants also; In the supply phase of the systems, it was also asked whether the design and purchase of the logistic support of the systems would contribute to the logistic support of the system. Finally, it was asked whether ILS is being practiced in the procurement activities in Turkey, and if yes, whether the ILS planning is sufficient.

In the first question, the problems of ILS and Logistics were tried to be revealed.

In the second question, it has been tried to put forward what consequences these problems lead to.

In the third question, the source of these problems was tried to be revealed.

In the fourth question, the starting time of the application of the ILS, its content and the points that should be taken into consideration during its application have been tried to be presented.

In the fifth question, the effects of a good ILS plan on life cycle duration and cost are tried to be presented.

Sixth question has the aim to reveal the adequacy and applicability of ILS plans in Turkey.

The findings obtained from the participants were combined and presented in the previous section. In this section, the data obtained from the participants will be evaluated on the chart. For this purpose, the problems / troubles faced by the participants, the reasons and results of the troubles and the ILS activities that should be done to eliminate these problems are presented in Table 3.

Table 3. Problems Encountered in Integrated Logistics Support and Solution Suggestions

Problem Area	Problem	Cause	Results	ILS Solutions to Troubleshoot the Problem
System Infrastructure	The material quality of the units of the parts that make up the system is low and poor. It is not resistant to atmospheric and geographical conditions specified in the job descriptions.	The system is not designed to be durable enough to meet the requirements for reliability and readiness required in job descriptions.	The system could not fulfill the reliability and performance defined by the task. - Property and life safety risk has occurred. - Financial losses occurred because the system could not perform its duty. -Due to the high maintenance costs, the system Life Cycle cost has increased and the Life Cycle time has decreased.	Logistics analysis should be carried out within the scope of ILS in order to ensure that the system design is capable of meeting the atmospheric and geographical conditions in accordance with the definition of the task to be used. The system should be designed and produced according to the analysis results.
Sub complete and Spare Parts Management	The secondary complete operational spares and spare parts needed for the maintenance of	During the procurement of the system, TKM and spare parts availability were not analyzed, and	Since TKM and spare parts could not be supplied, the system failure rate increased, system readiness rate and system reliability decreased.	- Availability and availability time analysis of all kinds of parts and components to be used during system design should be done. Sub-parts

	the system are not supplied, and many of them cannot be reproduced since there is no information package. Since the maintenance materials cannot be procured, the system cannot be made ready for duty.	the analysis of the availability period was not made. In addition, a sufficient level of TKM and spare parts stock was not established during the system supply.	-Material losses have occurred since the maintenance and repairs of the system could not be made. - The system was subjected to mandatory modernization before its half-life expired or it was removed from the inventory due to maintenance problems.	that can provide system reliability and performance should be produced. - During the system procurement, all kinds of TKM and spare parts that will be needed during the logistic support phase of the system should be planned and supplied with the system and sufficient stock should be created.
Maintenance& Repair	- Some systems require more maintenance, adjustment and calibration than necessary. Since the system is not modular, its maintenance and repair is very difficult and even many systems are unnecessarily dispatched to upper maintenance levels.	During the system design, sustainability, FMECA, RCM and LORA analyze were not made from logistics analyzes. System maintenance needs are determined randomly. After the system is in the inventory, maintenance activities are planned.	* Too much maintenance activity; - Increases the system life cycle cost. -It increases the workload. -Reduces the rate of duty readiness. - The tool increases the amount of toolbox. * Since the system is not modular; - Many systems cannot be repaired at the unit maintenance level and are referred to higher care levels.	In system design, the system should be manufactured modularly by performing a maintenance analysis so that it requires the least maintenance and can be repaired at the lowest maintenance levels. During the system design phase, FMECA analysis should be performed to minimize the number of materials that may fail, and maintenance and maintenance levels should be determined with RCM and LORA analyzes.
Fault	After the system was used, it started to malfunction too much.	-The system is not produced according to job descriptions and the atmospheric and geographical conditions of the task area. -System expectations, system reliability, readiness, maintainability, etc. The system was designed haphazardly because it was not valued.	-The increase in the failure rate has reduced system reliability and system performance. - System life cycle cost has increased because of excessive breakdown, spare parts and labor requirements. - The customer has experienced financial loss since he could not get his expectations from the system.	-The expectations from the system are reliability, etc. requirements must be fully determined. -The system should be designed according to MTBF and MTTR values that will meet the expectations. Faults should be predicted and prevented during the design phase of the system.
Standardization	-The parts that make up the system are not standard. A part removed from another system does not fit another system. - Screw etc. used on the system. materials are not standard even on the same system. (both metric and	- System structure is not designed to be standard. The system sub-parts are not produced by considering the standard issue with other systems and maintenance infrastructure.	Since the parts and units used in the system cannot be used on another system, the stock type and quantity have increased. -Tool tool, test device and so on. the number of care facilities has increased. - Existing logistic support facilities and capabilities cannot be used; spare parts have to be replaced. Therefore, the system life cycle cost has increased considerably.	- Standards analysis should be done during system design. The existing possibilities and capabilities of the system should be designed to be used at the maximum level, and it should not cause excessive maintenance need by consisting of too many tools, tools, etc.

	inch screws are used)			
Fault Detection Testability	- Some systems do not have in-device test capability or external test device to detect malfunction or check / test the repaired unit. Fault detections are made by trial and error method.	-This requirement has not been taken into account in the system design. -Not specified in the system requirements.	- From the moment it stops unplanned, the average value (MTTR) of returning it back to working condition increases, and therefore the rate of operation of the system decreases. - Since accurate fault detection cannot be made, labor time and the amount of spare parts used increase. All of these increase the system life cycle cost.	During the system design, sustainability and testability analysis should be done and the system should be designed in line with the requirements of the administration according to the results obtained.
Transport and Shipping	During transportation and transportation, some systems are used as bridge-tunnel and so on. it cannot pass through the buildings.	-The system is not designed for transportation / shipping requirements. - Physical structures of transport vehicles and bridges and tunnels were not taken into account during system design.	Since the systems cannot be transported to the desired location by the desired transportation vehicle, different methods are tried to be developed. Additional costs are incurred. For example, pit wagons and trailers are produced for passages through tunnels and bridges on railways and highways. - Modernizations for transportation and transportation purposes are carried out on the produced system. All these additional investments significantly increase the system life cycle cost.	-Transport and shipping capabilities should be added to the system requirements. - The system should be designed considering that its transportation and transportation will be made by existing land, sea and air vehicles, and when necessary, it can be passed through bridges and tunnels. - Transportation and transportation analysis should be done in system design.
Human and Environmental Health	- The materials that make up the system and / or the waste materials released as a result of the use of the system harm human and environmental health.	Safety and security analyze have not been made during the design phase of the system. - The negative effect of the materials used under different effects or in case of combination with other materials has not been evaluated during the system design.	- If the use of the system adversely affects human and environmental health, legal obstacles may be encountered and high amounts of compensation may be required. - In order to eliminate the harmful effects in the system, the system may have to be modernized or the system may have to be completely disposed of.	Safety and reliability analysis should be done during the system design phase. - The system must be produced in accordance with international regulations and standards, and in a nature / structure that will not harm people and the environment.
Supply	-The lead time of foreign origin materials is prolonged due to international problems and similar reasons. -Materials that are not produced cannot be supplied or their reproduction causes high costs.	-During the supply and design of the system, spare parts, etc. availability of materials not evaluated. - Alternative solution methods have not been produced in terms of procurement.	-Spare parts, etc. that cannot be supplied. Due to the materials, the logistics maintenance of the systems cannot be provided. -Reproduction causes high costs or the manufacturer cannot be found. - As a solution, non-standard materials are used, which can cause loss of life and property, increase the failure rate, reduce the system reliability and system	-During the supply of the system, the availability of all kinds of requirements (especially spare parts) needed for the logistic support of the system should be analyzed in the future. -Information package of all kinds of materials procured must be provided. -It should be avoided to use materials that are not produced in system design.

	-Some materials can be reproduced since there is no information package.		readiness rate, and also increase the system life cycle cost and reduce the system life cycle time. - Since the logistics maintenance of the system cannot be achieved, the system is subjected to early modernization or removed from the inventory.	- Work should be done to produce critical materials that require an end user certificate domestically.
Stock Creation	- Since the parts that make up the system do not have Mean Time Between Two Failures (MTBF) values, the correct spare parts stock cannot be created for the logistic support of the system.	During system design, reliability analysis is the calculation of MTBF values or not designing the system according to the desired reliability value	Since there is no MTBF value, the estimated stock level is determined. In this case, either too many spare parts are supplied or insufficient material is received. This affects the maintenance of the system negatively.	- The system should be designed according to the desired reliability values and within this scope, all kinds of spare parts MTBF values used in the system should be determined. - Prospective spare parts stock level determination should be made according to MTBF values.
Maintenance	The basic maintenance facilities (tool-toolbox, test device, workshop, documentation, etc.) required for maintenance and repair activities of the systems are incomplete, absent or out of date.	-The tools-toolbox, test device, workshop, documentation etc. for the maintenance of the system have not been taken completely. -The missing maintenance materials are incomplete. -The documents regarding maintenance have been updated.	- Their maintenance cannot be done properly. - Fault detections and repairs cannot be made. -The repair time is increasing. -The system readiness rate is decreasing. -Due to improper maintenance and repair, the System Life Cycle Time is shortened and the Life Cycle cost of the system increases.	-All kinds of maintenance organization systems that will be needed in the logistics support of the system should be supplied together. -All kinds of logistic support requirements should be designed and produced in parallel with the system during the design phase of the system. -The reduced maintenance material should be completed on time and the documentation should be updated.
Education	The user / operator and technical staff have not received training / courses at the level to perform their duties. It is insufficient in terms of using the personnel system and performing maintenance / repairs.	-The courses taken in the procurement phase of the system were insufficient. -The lack of complete training. - Employment of trained personnel in different units in accordance with appointment / administrative policies.	- Uneducated and inexperienced personnel harm both the system and themselves while using the material, while performing maintenance and repair. - Failure rate increases and system performance decreases in the system used by untrained and inexperienced personnel and whose maintenance / repair is performed.	-The personnel responsible for the use and maintenance of the system at the system procurement stage should be trained at an adequate level. - Receiving progress training should also be included in the contracts to be made with the manufacturer.
Packaging Handling Storage and Transport (PHS-T)	- The trunks in which the system is stored cannot withstand the atmospheric and geographical conditions specified in the system	- PHS-T analysis is not done completely during system design. -The atmospheric and geographical conditions of the system's duty	-As the packages / crates intended to protect the system are dispersed quickly, the system is damaged by environmental conditions. -The failure rates are increasing and the system is disposed of very quickly.	- PHS-T analysis should be done in the system design phase. -The system should be designed according to the existing possibilities and capabilities.

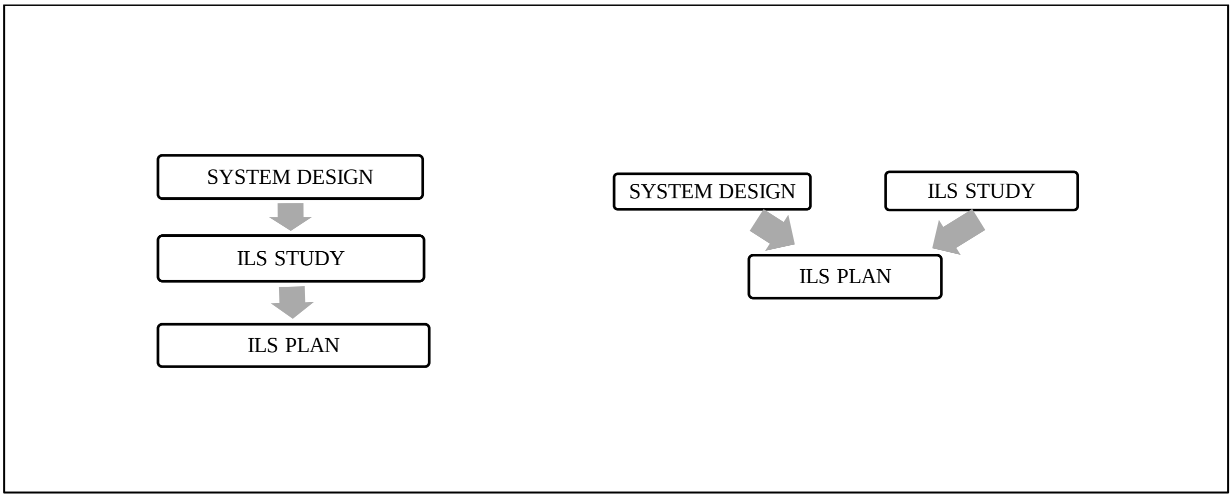
	requirement, as they lose their protection feature. - Storage on top of each other can be placed on top of a maximum of 2 chests and the storage area cannot be used at the appropriate level. -System and system sub-parts cannot be lifted or moved by handling tools. -Labels and signs on the package and device wear out very quickly.	area are not taken into account. - Existing handling and storage facilities and capabilities are not taken into account in the design.	- Handling tools and storage space cannot be used at an appropriate level, and new handling tools and warehouses are provided. -The signs and labels on the packages and the system wear out quickly and material tracking becomes difficult.	In the ILS plan, PHS-T considerations should be clearly stated.

According to the participants, ILS requirements should be taken into consideration when determining operational requirements in the first phase of the project and detailed in the later phases of the project (PTD, PPP-1, PPP-2, RFP). In the design phase of the system, ILS analyzes (reliability, maintainability, readiness, testability, FMECA, RCM, LORA, LCC) should be performed. As a result of these analyzes, a sustainable system should be designed and together with the system, it should be designed and produced together with the system of logistics requirements that will be needed for the logistics support of the system.

Figure 3 was created with the answers given by the participants to the questions. The classical ILS plan method should be abandoned and the system design and ILS studies should be continued in parallel. ILS studies should shape the system design, and system design should shape the ILS plan.

Figure 3. Change in ILS Approach

Classical Approach Required Approach



It was stated that ILS analyzes did not affect the design, but rather the analysis result was derived from the values obtained from the designed / manufactured prototype.

The acquirer authority's development of ILS requirements, digitization of these requirements, performing ILS analysis of manufacturers will enable the design of a sustainable system based on these analyzes.

According to the participants, it was stated that there has been partial progress in the academic field, supply chain and logistics issues, but studies on ILS analysis and ILS approaches are very limited.

It has been stated that the number of personnel trained in ILS analysis and ILS in the market is very low.

6. CONCLUSION

As a result of the study conducted to determine the effect of ILS studies and ILS plan on the system life cycle time and cost, in systems maintained with the classical ILS approach;

- The failure rate has increased,
- The system readiness rate has decreased,
- System reliability and system performance decreased,
- Due to all these, the system life cycle is shortened and the system life cycle cost has increased,
- Systems are modernized at an early stage due to logistical maintenance problems or have to be removed from the inventory before the targeted life cycle period,
- Loss of life and property due to improper and / or insufficient maintenance and repair activities,
- The public and private sector suffered losses because the systems could not fulfill their duties at the desired level,
- Systems that cannot be used at the desired performance due to maintenance problems and whose maintenance is not cost-effective, are replaced with a new one, etc. It was found that the negativities were experienced.

In the systems to be procured, in order not to experience the problems mentioned above, to maintain the logistic support smoothly and cost-effectively during the system life cycle, and for the system to function at the desired level of reliability and readiness;

- Determining the logistic support requirements together with the operational requirements at the initial stages of the project and detailing them in the later stages of the project,

- Making LS analyzes at the design stage of the project to ensure that the system can fulfill the desired mission profiles from the desired atmospheric and geographical conditions at the desired reliability and readiness rate,
- Simultaneously with the system design, designing the logistics requirements of the system for LS,
- According to the results of LS analysis and ILS studies, the preparation of the ILS plan for providing Logistics support during the life cycle of the system,
- Ensuring ILS studies and analysis to shape the design of the system, the ILS plan in the design of the system,
- Digitization of ILS requirements and controllability of the requirements, establishment of ILS structuring in public and private enterprises,
- Selecting and developing an internationally valid standard suitable for the business for logistic support analysis and reporting the analysis results,
- ILS plans are prepared to contribute to the logistical support during the life cycle of the system,
- System design, reliability, availability, maintainability and so on. to be made according to the needs,

Simultaneous design of logistic support requirements with the system design,

- Training personnel for academic and business areas by opening courses on logistic support analysis and ILS,
- Development of logistic support analysis model,
- Development of ILS plan format / model, and optimization of system design with ILS is considered appropriate.

REFERENCES

Acar, A. Z., Yurdakul, H. (2013). Tedarik lojistiğinde sistem satin alma ve entegre ürün timi: Sağlık sektörü için öneriler, *Akademik Bakış Dergisi*, 34,1-15. Access address akademikbakis.org.

Arslan, S., Deran, A., Tokay, S. H. (2011). Lojistik maliyet yönetiminde izlenebilecek stratejiler ve muhasebe eğitiminden beklentiler, *Dumlupınar Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 29, 225-244.

Blanchard B.s., Fabrycky, W. J. (1991). *Life cycle cost and economic analysis.* Englewood Cliffs: NJ:Prentice Hall.

Defense Acquisiton University. (2005). *Performance based logistics: A program managers product support guide,* Fort Belvoir: Defense Acquisiton University Press.

Dell'Isola, A. J., Stephen J. K. (1995). *Life cycle costing for design professionals*, Subsequent edition, New York: McGrew-Hill Book Company.

Deran, A. (2008). Stratejik bir karar verme araci olarak yaşam seyri maliyet analizlerinin tedarik sürecindeki yeri ve önemi, *Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 17*(2),465-484.

Díaz, V. G., Pérès, F. and Márquez, A. C. (2011). On the risks and costs methodologies applied for the improvement of the warranty management, *Journal of Service Science and Management,4,*191-202. doi.org/10.4236/jssm.2011.42023

Dhillon, B. S. (2009). *Life Cycle Costing for Engineers,* First Edition.USA:CRC Press. doi.org/10.1201/9781439816899

Düzgün, K. (2016). Savunma ve Güvenlik Organizasyonlarında Yürütülen Lojistik İle Özel Sektör Lojistiğinin Entegrasyonu, *Uluslararası İktisadi ve İdari Bilimler Dergisi,*2(1),120-143.

Genelkurmay Başkanlığı. (2002). *Lojistik Mühendislik İle Başlayan Lojistik Değişim ve Gelişim.* Ankara: Genelkurmay Basımevi.

Göksu, N., Ovacıllı, R., Özen,S. (2009). Hava Platformları Tedariğinde Entegre Lojistik Destek Uygulamaları, *Savunma Sanayi Gündemi Dergisi*, Aralık sayısı, 14-21.

Humphreys, K. K., (2005). *Project And Cost Engineers' Handbook*, Fourth Edition, New York: Marcel Dekker Inc.

Işın, Z. (2009). Ömür Devri Maliyet Analizi Yaklaşımı ve Savunma Projelerine Uygulamaları, *Savunma Sanayi Gündemi Dergisi*, Aralık sayısı, 39-43.

Jones, G., Ritschel, J. D., Ryan, E.T. and White, E. (2014). Investigation into the Ratio of Operating and Support Costs to Life-Cycle Costs for DoD Weapon Systems, *Defense ARJ, 21*(1), 442-464.

Karabağlı, H. (2020). *Savunma Sanayinde Ömür Devri Yönetimi,* Türk Savunma Sanayii Ömür Devri Yönetimi Platformu,Ankara: Savunma Sanayi Başkanlığı.Erişim adresi https://www.milsoft.com.tr/wp-content/uploads/2020/08/SAVUNMA-SANAYINDE-OMUR-DEVRI-YONETIMI.pdf

K.K.K.Gn.P.P. (2002). *Ömür Boyu Maliyeti*.Ankara: Kara Kuvvetleri Komutanlığı Basımevi.

Keskin, M. H. (2011). *Lojistik El Kitabı*, Gazi Yayıncılık, Ankara:Nobel Akademik Yayıncılık.

NATO. (2011). *NATO Guıdance On Integrated Logıstıcs Support For Multınatıonal Armament Programmes,* Brussels:Allied Logistics Publication.

NATO. (2012). *Logistics Hand Book*, Brussels: LC Secretariat International Staff Logistics Capabilities Section Defence Policy and Planning Division NATO HQ.

Savunma Sanayi Başkanlığı. (2021). *Sistem Ömür Devri Yönetimi Rehberi (Ana Çerçeve),* 22. Ankara: Savunma Sanayi Başkanlığı Erişim adresi https://tssodypwiki.ssb.gov.tr/images/4/40/TSSODYP_02_web_y.l.pdf

APPENDIX

Questionnaire on Effect of Integrated Logistics Support on Life Cycle in Turkey

DEAR PARTICIPANT

This questionnaire has been prepared to collect data for the master thesis of ……….…University, Department of Business Administration titled "THE EFFECT OF INTEGRATED LOGISTICS SUPPORT ON THE LIFE CYCLE".

The purpose of the survey is to obtain statistical results by collecting the opinions and suggestions of public sector employees on ELD and Life Cycle Time and Cost.

Since the research has a scientific nature, the information of the person will be kept confidential. Please write down the answer that best suits you after reading the questions thoroughly.

Your evaluation adds great importance to my research.

Please! We request you to fill in all questions completely and sincerely, and thank you in advance for your contributi on

Prepared Thesis advisor

Title	Search Manager	Working	
Age	0-20	20-40	40-60
Gender	Woman	Male	
Organizational Structure	Public	Private	
Duty Term	0-10	10-20	20-30

Q 1	What kind of problems are experienced in the operation and maintenance of the systems (vehicle / system and other materials) in the inventory of the institution you work for during the life cycle? (If there is technical infrastructure of the system, procurement, maintenance and repair, documentation, Packaging / Marking / Transportation / Storage, please specify separately.)
Q 2	What kind of negativities (inability to perform the task, waste, cost, loss of time etc.) caused by the problems experienced in the operation and maintenance of the systems?
Q 3	What could be the reason / source of the troubles experienced in the operation and maintenance of the systems? (What has not been done or has been done incompletely and these problems have emerged?)
Q 4	Regarding the logistic support needs required for the operation and maintenance of the systems throughout their life cycle in a trouble-free and cost-effective manner: a. At what stage of the procurement (ready purchase and / or production) process should be determined? b. What should be the scope and content of these needs? c. What should be considered in determining these needs?
Q 5	What effects does an appropriate ILS Plan have on the life cycle and cost of the system?
Q 6	What Do You Think About Sufficiency, Applicability and Effectiveness of the ILS Plan Prepared for the Administration and Maintenance of the Systems Purchased by Government and Private Sector in Turkey?