IBN HALDUN UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF AIR TRANSPORT MANAGEMENT

MASTER THESIS

THE PERCEPTIVE ANALYSIS OF THE EFFECT OF PROACTIVE MAINTENANCE SCHEDULING ON MAINTENANCE COSTS AND AIRLINE PROFITABILITY: A CASE STUDY OF TURKISH AIRLINES TECHNIC

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THESIS SUPERVISOR

PROF. TAMER AKSOY

ISTANBUL, 2022

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by

BERKCAN OKAN

A thesis submitted to the School of Graduate Studies in partial fulfillment of the requirements for the degree of Master of Science in Air Transport Management

THESIS SUPERVISOR

PROF. TAMER AKSOY

ISTANBUL, 2022

APPROVAL PAGE

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 in Management.

Thesis Jury Members

Title - Name Surname	Opinion	Signature

This is to confirm that this thesis complies with all the standards set by the School of Graduate Studies of Ibn Haldun University.

Date of Submission Seal/Signature

ACADEMIC HONESTY ATTESTATION

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

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Signature:

ÖZ

PROAKTİF BAKIM PLANLAMASININ BAKIM MALİYETLERİ VE HAVAYOLU KARLILIĞINA ETKİSİNİN ALGISAL ANALİZİ: TÜRK HAVA YOLLARI TEKNİK ÖRNEĞİ

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Tez Danışmanı: Prof. Dr. Tamer Aksoy
Ocak 2022, 61 Sayfa

Havacılık sektörünün içerisinden geçtiği yüksek ivmeli gelişim trendi, havayolları arasında yoğun bir rekabet ortamı oluşmasına sebep olmuştur. Sektörde gözlenen yoğun rekabet ve kar oranlarındaki büyük düşüşler asli gelirlere ilaveten gider ve maliyetlerin de düşürülmesinin önemini artırmıştır. Bu bağlamda tüm havayolları, kendi maliyetlerini düşürmek için çok çeşitli yöntemler denemekte ve uygulamaktadır. Bakım maliyetleri toplam maliyetlerin içerisinde önemli yere sahip maliyet kalemlerinden bir tanesidir. Diğer tüm maliyetler gibi bakım maliyetlerini düşürmek için de çeşitli yöntemler denenmektedir. Bu yöntemlerden bazılarının maliyetleri olumlu yönde etkilediği görülmüş ve uygulanmaya başlamıştır. Proaktif bakım planlaması bakım maliyetlerini düşürmeyi ve havayolu karlılığını artırmayı amaçlayan yöntemlerden bir tanesidir ve birçok havayolu tarafından aktif olarak kullanılmaktadır. Proaktif bakım planlaması yöntemi ile bakım maliyetlerinin ve karlılığı etkileyen yer zamanının minimuma indirilmesi, bakım için gerekli adam-saat harcamasının azaltılması, devam eden arızaların ve komponent değişimleri için gereken sürelerin ve materyal kullanımlarının da minimuma indirilmesi hedeflenmekte ve gerçekleştirilmektedir. Türk Hava Yolları, proaktif bakım planlaması yönetimini efektif bir şekilde kullanan sayılı şirketler arasında yer almaktadır. Ancak bazı proaktif bakım uygulamaları tartışmalı bir konu olarak görülmektedir. Bundan dolayı, bu çalışmada proaktif bakım planlamasının bakım maliyetlerine ve havayolu karlılığına etkisinin sektör lideri konumundaki Türk Hava Yolları Teknik A.Ş. çalışanları üzerindeki algısal analizinin yapılması amaçlanmıştır.

Bu çalışma 133 Türk Hava Yolları Teknik personelinden oluşan bir örneklemle nicel anket kullanılarak gerçekleştirilmiştir. Çeşitli görevlerde yer alan personeller bakım aktivitelerinde bulunan departmanlardan seçilmiştir. Çalışanlar üzerinde yapılan anket, çalışanların proaktif bakım planlaması hususundaki algısını ölçen soruların yanı sıra, çalışanların demografik özelliklerinin ve tecrübe durumlarının, konu hakkındaki görüşlerini etkileyip etkilemediğini ölçen değişkenleri de kapsamaktadır. Bu çalışmada kullanılan veriler çevrimiçi anket yöntemi kullanılarak toplanmış ve SPSS sürüm 22 ile analiz edilmiştir. SPSS analizi için birbirinden bağımsız verilerin kıyaslanmasında en uygun yöntem olan ki-kare (Chi-Square) ve Fisher's testleri kullanılmıştır. Çalışma proaktif bakım planlamasının bakım maliyetlerini düşürücü etkide, havayolu karlılığını ise artırıcı etkide bulunduğunu ortaya koymuştur.

Anahtar Kelimeler: Bakım maliyetleri, havayolu karlılığı, havayolu maliyetleri, havacılık ve finans, proaktif uçak bakım planlaması, uçak yer zamanları

ABSTRACT

PERCEPTIVE ANALYSIS OF THE EFFECT OF PROACTIVE MAINTENANCE SCHEDULING ON MAINTENANCE COSTS AND AIRLINE PROFITABILITY: A CASE STUDY OF TURKISH AIRLINES TECHNIC CASE

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The accelerated development trend that the industry is going through has created an intensively competitive environment between global airlines. Intense competition in the sector and the pronounced decline in profit rates have increased the importance of reducing expenses and costs, in addition to the management of incomes. Towards this aim, airlines implement various methods to reduce their own costs.

Maintenance comprises one of the significant expenses incurred by airlines, while airlines adopt various approaches in their cost-reduction efforts, including general maintenance enhancement programs. It has been seen that some of these methods positively affect cost-reduction efforts that have begun to be implemented. Proactive maintenance planning, on the other hand, is considered one of the methods aimed at reducing maintenance costs and thus increasing airline profitability and is actively used by many airlines.

Turkish Airlines is playing a leading role in the effective use of proactive maintenance planning management. However, some proactive maintenance practices are controversial. In order to clear the air about these controversies, this research was carried out to make a perceptive analysis of the Turkish Airlines Technic employees.

I carried out this study by using a quantitative survey with a sample of 133 Turkish Airlines Technic staff, which consists of technicians, engineers, planning staff, clerks, and managers. Staff was chosen among departments relating to maintenance. Besides questions that measure the perception of Turkish Airlines Technic staff on the effects of proactive maintenance scheduling on maintenance costs and airline scheduling, some questions relating to demography and experience are also posed. The data which is obtained as a result of this study were collected using an online survey method and analyzed with SPSS version 22. Chi-square and Fisher's tests, which are the most appropriate methods for comparing independent variables, were carried out to analyze the results.

Keywords: Aircraft ground times, airline costs, airline profitability, aviation and finance, maintenance costs, proactive aircraft maintenance planning.

DEDICATION

I dedicate this thesis first to my family, my company, Turkish Airlines Technic, my supervisor, all Ibn Haldun University staff, and my classmates who have always supported me during the process of my MA education.

ACKNOWLEDGEMENTS

First, I would like to thank my supervisor, Prof. Tamer Aksoy, for his sincere support and guidance during my thesis writing process. I would also like to thank my managers at Turkish Airlines Technic, who continuously supported me and provided me with the information I needed.

Berkcan OKAN

ISTANBUL, 2022

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LIST OF ABBREVIATIONS

AMP	Aircraft Maintenance Planning
PMS	Proactive Maintenance Scheduling
MRO	Maintenance and Repair Organization
IATA	International Air Transportation Association
MTS	Maintenance Task Scheduling
AOG	Aircraft on Ground
NDT	Non-Destructive Inspection Techniques
IATA	International Air Transportation Association
EASA	European Aviation Safety Agency
ICAO	International Civil Aviation Organization
BIST	Borsa Istanbul
THY	Türk Hava Yolları (Turkish Airlines)
HF	High Frequency
VHF	Very High Frequency

CHAPTER I

INTRODUCTION

In recent years, the global aviation sector has been facing evolving economic stresses, including, most notably, intensified competition. Sound financial management, focused on lowering costs and growing revenues, has acquired renewed importance in order to continue and sustain the business. Airlines have had to find ways to cut their overall expenses while increasing their profits. Furthermore, the emergence of coronavirus has further complicated this issue for companies.

Airworthiness and maintenance expenditures account for a significant share of total airline expenses in the civil aviation business. At this point, there are some applications that airlines utilize to decrease maintenance costs. As I will show, proactive maintenance scheduling is a very effective and beneficial method for this purpose. In this thesis, the impact of proactive aircraft maintenance scheduling on maintenance costs and airline profitability will be investigated, and Turkish Airlines (THY) was selected for analysis on account of its operating its own specific maintenance and repair group (Turkish Airlines Technic). Additional qualifications were also considered in the choice of Turkish Airlines: (dependence on government, corporate governance, the largest airline in the country, full-service carrier, member of IATA and the global airline confederation-Star Alliance, and a publicly traded/listed corporation (Borsa Istanbul-BIST).

This study measures the perception of Turkish Airlines Technic staff with respect to the effects of proactive maintenance scheduling on maintenance costs and airline profitability. Additionally, another aim of the study is to find out if the perception of the staff changes according to specific demographic features and experiences are also examined.

My research model reveals changes in the perception of Turkish Airlines Technic staff with respect to questions regarding the effects of proactive maintenance scheduling on maintenance costs and airline profitability in terms of the demographic features of the staff. Two hypotheses, H1 and H2, given below have been prepared to clarify the opinion of Turkish Airline Technic staff on the subject.

> H1: Proactive aircraft maintenance planning has the effect of reducing maintenance costs
> H2: Proactive aircraft maintenance planning has the effect of increasing airline profitability.
>
> The remaining 16 hypotheses, which are H3, H4, H5, H6, H7, H8, H9, H10, H11, H12, H13, H14, H15, H16, H17, and H18, show the changes according to demographic features. Twelve hypotheses which are argued for in a related chapter (Chapter X), pertain to demographic features and are proved by analyzing demographic questions together with H1 and H2.

Methodologically, the survey method has been utilized to collect data. The survey consists of 133 Turkish Airlines Technic professionals, many of whom actively or directly work in aircraft maintenance and scheduling roles, such as aircraft maintenance technicians, maintenance planning clerks/experts, supervisors, chiefs, and managers. SPSS version 22 version has been used to analyze the data, including necessary tests, which will be introduced in detail in the following parts.

This thesis has been structured into four chapters. Economic stressors and profitability in aviation will be examined. The first introductory chapter lays out the problem and its larger context. In the second chapter, I unpack the basic concepts used as well as discuss theoretical issues. Further, I profile the recent emergence of proactive maintenance scheduling and discuss it briefly with respect to Turkish Airlines and Turkish Airlines Technic. Finally, using airline financials, I examine in detail the reasons for the importance of considering maintenance costs. The importance of scheduling proper aircraft maintenance will be examined and justified in terms of costs and operation. In the second chapter, I elaborate on previous studies about airline finance and aircraft maintenance. My study will also make a contribution by showing airlines the importance of new methods, which decrease overall airline costs and increases their profitability. In the third chapter, research and application, the method for obtaining and processing the data will be explained in detail. In the fourth chapter, empirical results and analysis, I introduce and interpret the results obtained from my questionnaire and analyze its findings. Finally, I conclude my investigation by stating that my findings corroborate the use of proactive maintenance scheduling in Turkish Airlines, with the scope for potential replication and learning with respect to other Turkish aviation companies.

CHAPTER II

BASIC CONCEPTS AND THEORETICAL BACKGROUND

2.1. Financial Difficulties in the Aviation Industry

> Parallel to the great increase in competition in the digital age, the importance of new models, approaches, and strategies, which stand out in all areas of the business ecosystem in overcoming financial difficulties, ensuring sustainability, and increasing financial performance/profitability has increased tremendously (Hacioglu and Aksoy, 2021).

Financial conditions in the airline industry have always been harsh. Although overall revenues are very high, being able to make a profit is difficult for airlines. On account of rolling expenditures, profit rates are relatively low. Fuel, maintenance, labor, traffic costs, general administration, depreciation, and amortization can be considered the key expenses incurred by airlines on a routine basis. From 1950 to 2015, the average airline industry net profit margin after debt and tax was only 0.2% (IATA, 2016). In 2018, the total revenue of the global aviation business was US$754 billion, while the total profit was only about $3,8B (IATA, 2019).

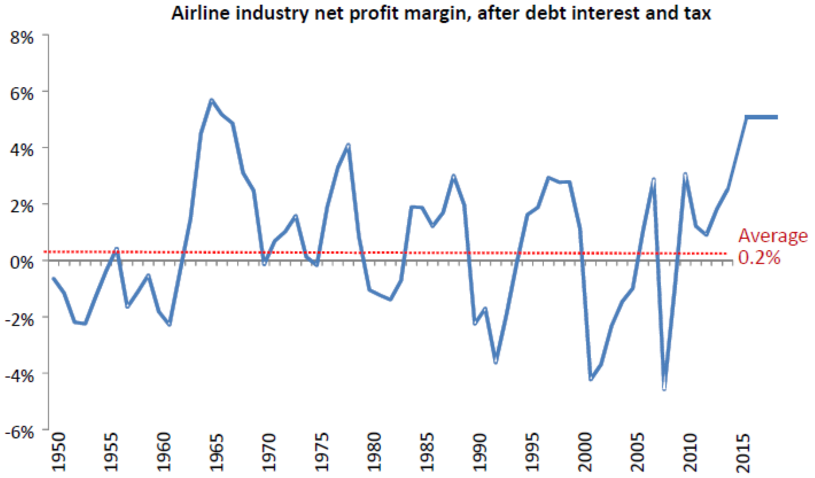

Figure 2.1. Airline Industry Net Profit Margin After Debt Interest and Tax

Source: (IATA, 2016)

In an industry where the net profit margin is very low, every cost driver indicates great importance. Earnings from airlines have always been risky, and industry returns on investment have historically been low. Wensveen (2007) states that with a few noteworthy exceptions, airline cash flows have been insufficient to cover capital requirements throughout time (p.428).

2.2. Aircraft Maintenance as a Cost Driver

In the digital age we live in, a wide variety of changes, new trends, developments, models, approaches, and strategies have had a deep and multidimensional impact on all strategic business functions and activities, including the financial ecosystem, through effective management of all costs and expenses (Aksoy and Hacioglu, 2021).

Maintenance constitutes a key expenditure of airlines. Like other cost drivers, as maintenance costs are a set of high expenses, airlines are looking for creative ways to reduce them. Doganis (2002) states that total maintenance expenses include a variety of expenditures connected to various kinds of maintenance and overhaul that should ideally be considered individually. In reality, there are several shared expenditures in various areas of maintenance. Aside from routine maintenance and inspections performed between flights or overnight, more costly periodic overhauls and significant inspections add to the account of keeping planes in good condition. The maintenance process covers two significant expense categories. The first is the multiple uses of labor and the costs associated with all levels of personnel involved in maintenance tasks, whether directly or indirectly. Out-station maintenance personnel expenses should be segregated from station expenditures and included under maintenance if practicable. Second, there is a significant expense associated with the use of spare components. Most components of each engine and airframe have a use-life that is measured in block hours or flight cycles or landings and takeoff. Doganis (2002) described how each part of maintenance costs affects total costs:

> Once its certified life has expired, each part must be removed and checked or replaced. Hence the consumption of spare parts is high and costly. The costs of workshops, maintenance hangars, and offices are also included. Finally, if an airline is subcontracting out any of the maintenance done on its own aircraft, the charges it pays for any such work should be allocated to the maintenance and overhaul category. (p.82)

Deng et al. (2021) state that despite the tremendous growth of the global aviation sector and the expansion of fleet sizes, innovations in aircraft maintenance planning (AMP) have struggled to keep up. In reality, AMP comprises assigning maintenance checks to each aircraft, assigning duties to each check, arranging the workforce for each task, optimizing the inventory, and, finally coordinating maintenance tools. According to maintenance planners' experience, AMP is not as demanding for small airlines and may be done manually (p. 2). Maintenance costs constitute an important amount of total airline costs.

Deng et al. (2021) also state that the AMP problem grows more difficult for major airlines since maintenance planners must spend many days or weeks organizing maintenance tasks due to a lack of effective solutions. Because aircraft maintenance accounts for 9 percent to 10% of an airline's overall operating costs, or around $2.5 million per aircraft per year, the savings from effective AMP may be significant (p.2). It is possible to make an inference that Aircraft Maintenance Planning is a very important concept that helps airlines reduce maintenance costs, according to the sources utilized above.

Table 2.1. Cost of Sales of Turkish Airlines in the First Nine Months of 2021

	1 January – 30 September 2021	1 July – 30 September 2021	1 January – 30 September 2020	1 July – 30 September 2020
Fuel Expenses	1,853	872	1,308	323
Depreciation and amortisation charges	1223	420	1176	395
Personnel expenses	713	261	627	152
Ground services expenses	486	202	356	117
Aircraft maintenance expenses	385	147	442	132
Airport expenses	365	161	240	80
Air traffic control expenses	329	149	221	64
Passenger service and catering expenses	199	102	181	37
Wet lease expenses	143	53	150	47
Insurance expenses	35	6	33	8
Transportation expenses	31	12	27	9
Service expenses	28	9	24	8
Rents	22	9	36	12
Taxes and duties	15	6	15	5
Aircraft rent expenses	5	2	15	3
IT and communication expenses	4	1	3	1
Other expenses	22	6	19	6
	5,864	2,414	4,873	1,399

Source: (Turkish Airlines Financial Statements, 2021)

Figure 2 shows the expenses of Turkish airlines in the first nine months of 2021. Expenses are sorted from greater to lesser as follows; fuel expenses, depreciation and amortization charges, personnel expenses, ground services expenses, aircraft maintenance expenses, airport expenses, air traffic control expenses, passenger services and catering expenses, wet lease expenses, insurance expenses, transportation expenses, service expenses, rents, taxes and duties, aircraft rent expenses, IT and communication expenses, and other expenses. Not surprisingly, fuel expenses constitute the greatest expense.

However, the maintenance expenses of Turkish Airlines in the first nine months of 2021 are exactly $385 million. While the financial report of Turkish Airlines indicates the total expenses for the first nine months of 2021 as $5,864,000,000, the total maintenance costs for the same period are $385,000,000. According to its financial statements, the maintenance costs of Turkish Airlines constitute 6.56% of total expenses.

2.3. Maintenance Scheduling

Aircraft should undergo some periodic maintenance checks as recommended by manufacturers. Some of these maintenance checks are reactive, while many of them are considered to be proactive maintenance. There are compulsory maintenance requirements that the operator should meet, and there are some options that the airline may take to further reduce costs.

Bergh et al. (2013) state that there are many different types of maintenance performed on aircraft, which are briefly: Routine and non-routine checks, hangar and line maintenance, scheduled and un-scheduled checks, etc. They categorized the scheduled checks into four main parts, which are letter checks (A, B, C, and D checks) (p.7). The intervals of these checks are defined by manufacturers and regulatory authorities. Besides advanced proactive maintenance scheduling methods, these regular checks are also considered to be proactive maintenance actions.

However, airline companies not only apply the requirements of manufacturers but also seek ways to improve their maintenance programs. Such programs are enhanced by utilizing proactive maintenance scheduling. Many other ways of enhancing and developing the maintenance scheduling process are continually attempted and implemented by airlines.

2.3.1. Maintenance Cost Items

An index of some of the crucial expenses involved with aircraft maintenance will be stated in detail below. They include material expenses, man-hour (labor) expenses, component replacement, and ground times. The age and type of aircraft influence the cost of maintenance as well. The aviation sector is a highly competitive industry. Airlines are attempting to reduce their operating costs in order to compete in the market.

The design and manufacturing expenses of aircraft are well understood, as there is some historical evidence for such predictions, but the long-term costs and drivers connected with the operational period are sometimes concealed. Identifying the root reason for increasing maintenance expenditures during the operational phase would help airlines revise their maintenance procedures and better manage the maintenance plans of their companies.

Mofokeng et al. (2020) state that the design, manufacture, operation, and decommissioning phases of an aircraft's life cycle are analyzed separately. Aircraft design must take into account the requirements of manufacture, operation, and disposal. The aircraft's performance, safety, dependability, manufacture, and assembly are all factors in its design. On newly-designed aircraft, it is impossible to predict upcoming problems; thus, manufacturers rely on cumulative knowledge and data provided during their operation.

The operational phase involves the management of aircraft utilization as well as maintenance and repair. Depending on its actual design and the purpose of use, each aircraft performs or shows flaws and weaknesses differently. A breakdown of one aircraft component might also influence other components, resulting in many faults. Because the cost of the operational phase is unknown, it differs from the design, manufacturing, and decommissioning phases. During the operational phase, the maintenance process focuses on increasing aircraft dependability and lowering maintenance costs. The decommissioning step involves the aircraft's safe disposal or recycling.

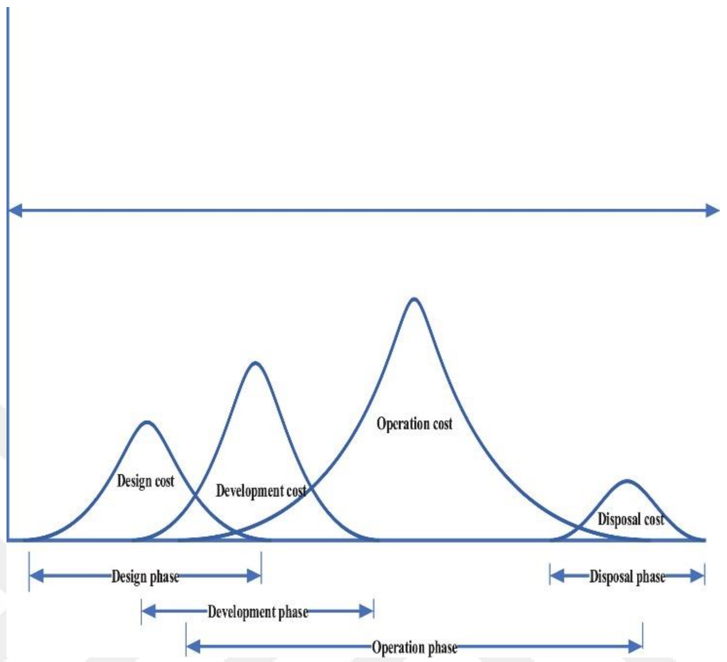

Figure *2.2*. Aircraft Life Cycle Costs

Source: Mofokeng et al., 2020

As seen in Figure 3, operational costs indicate the highest portion of the life cycle of an aircraft. Aircraft maintenance occurs during the operational phase of an aircraft's life cycle and is crucial since it accounts for a significant portion of an airline's operating costs. Various aircraft life cycle costs are affected by aircraft design, the complexity of the operation, human factors, maintainability, and dependability. As shown in Figure 4 below, maintenance planning, availability of spare parts, staff training, and logistical support all play a role in the efficacy of aircraft systems. When an aircraft system delivers excellent performance, safety, and availability, it becomes effective.

Maintenance procedures must be followed during the operational period of the aircraft in order to save costs, increase safety, and improve performance. Aircraft maintenance is necessary to keep the aircraft in a serviceable and dependable state in order to create income, avoid physical degradation in order to decrease operating costs due to failure, and comply with regulatory requirements. A-checks, C-checks, D-checks, and daily maintenance checks are all examples of aircraft maintenance services.

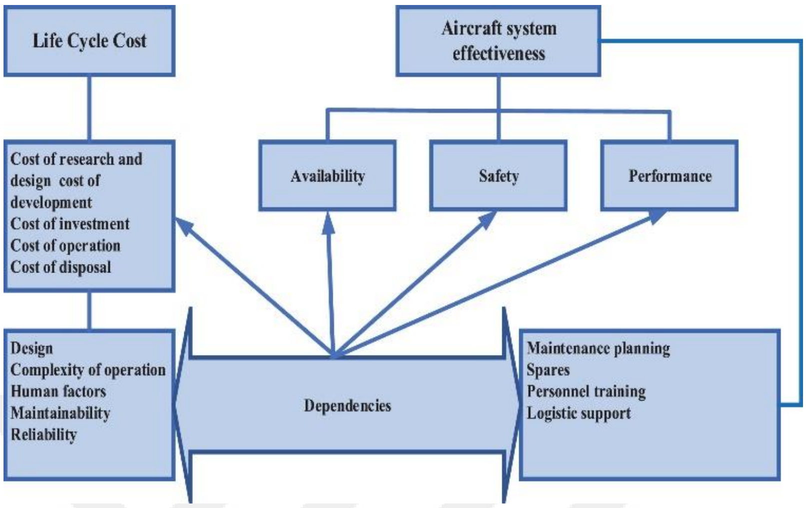

Figure 2.3. The Link Between Life Cycle Cost and Aircraft System Effectiveness

Source: Mofokeng et al., 2020

A-checks are done biweekly to monthly and consist of a visual inspection of the aircraft's interior and exterior. Checking and servicing the oil, filter change, lubrication, operational testing, and inspection are all A-check tasks. A-check maintenance usually takes place overnight when airlines schedule fewer flights. This maintenance is done in the hangar lasting around 10 hours per aircraft. Functional and operational system checks, cleaning and servicing of aircraft systems, and minor structural inspections are all part of the C-check process.

Mofokeng et al. (2020) also indicate that C-checks take place in the hangar every 12 to 20 months, depending on the kind of aircraft, flying cycles, flight hours, and calendar months. For a single aircraft, C-checks require between three days to a week. D-check activities include peeling paint off aircraft exteriors, removing panels, and inspecting the airframe structure as well as its wings, landing gear, engines, and the majority of structurally critical elements. Many of the aircraft's interior components are inspected, overhauled, and repaired during D-check. Every six to twelve years, D-checks are done in the hangar and adapted to the aircraft type, flight cycles, flying hours, and calendar months. (p.467-472) D-checks are usually carried out for a month.

Daily maintenance checks, in addition to the aforementioned maintenance, include routine maintenance such as inspection, small maintenance, and service. When the aircraft is in transit, daily maintenance inspections are done at the gate before the first flight or at each stop. The average maintenance time is one hour. Scheduled and unscheduled maintenance are two types of aircraft maintenance. Technical failures reported faults, and problems discovered during inspection trigger unscheduled maintenance. On the other hand, scheduled maintenance is based on the concepts of flying hours, flight cycles, and the calendar period. Flight hours are the number of hours flown by aircraft over a specific time period, from the time the wheels lift off the ground and during take-off to the time the wheels touch the ground during landing (FH). Flight cycles contain take-off and landing runs (FC). They cover the complete duration from engine start to engine shutdown, regardless of flying conditions.

Mokofeng et al. (2020) briefly characterize maintenance as an inevitable necessity. Maintenance planners, who are heavily involved in aircraft maintenance, guide such checks. The aircraft maintenance process aims to improve aircraft safety and dependability, restore the safety and dependability of aircraft components once they have deteriorated, gather data for the purpose of improving the design of objects with insufficient dependability levels, and to reduce the expense of maintenance and the risk of residual failure. Maintenance activities are often divided into planned and unscheduled categories by planners. Lubrication, operating checks, visual inspection, deep inspection, restoration, and disposal are all scheduled tasks. Non-scheduled tasks include faults reported by the flight crew.

Ackert (2012) states that for the purposes of analysis, aircraft are separated into major areas known as Air Transport Association (ATA) systems and sub-systems. The ATA technology allows the aircraft to be managed properly. The manufacturer publishes maintenance requirements to authorities concerned with airworthiness before a new aircraft enters service. Although airline maintenance procedures differ, the initial procedures are the same. The maintenance process covers activities such as management, planning, preparation, execution, assessment, and improvements that are necessary during aircraft maintenance. The below procedure for maintenance procedure is a general guideline used by several airlines.

1. An aircraft arrives in the hangar for A-check, C-check, or D-check maintenance.
2. Flight logs and task cards are reviewed for faults that have been reported.
3. Technicians remove the panels to obtain access to sections that need to be serviced.
4. Operational tests are carried out to verify suspected sub-system flaws.
5. Aviation maintenance and repairs are carried out in accordance with aircraft maintenance instructions.
6. All replacement components are double-checked for leakage and installation integrity.
7. Operational tests are performed to prove the airworthiness of an aircraft, such as a ground run, flight controls, or thrust reversers.
8. After that, the aircraft documentation is signed, and the aircraft is released for service. (Mokofeng et al., 2020)

2.3.2. Proactive Maintenance Scheduling

Proactive aircraft maintenance scheduling (PAMS), also called preventive maintenance, is a way of maintenance schedule that aims to lower maintenance costs and increase airline profitability by taking precautions against possible malfunctions in an aircraft. PAMS can be basically defined as taking proactive maintenance actions on aircraft in order to avoid possible malfunctions. For example, replacing a fuel filter before it completes its service life, in order that the filter will not clog an outstation. Unlike reactive maintenance, proactive maintenance provides some advantages and profits to airlines.

Arnaiz et al. (2010) Maintenance is evolving, as effective asset use is a critical problem in sustaining the existing quality of operation and development in every field of activity, from manufacturing to transportation and energy. The concept of maintenance must undergo numerous fundamental modifications that include proactive considerations, such as changing old "fail and repair" maintenance techniques to "predict and avoid" e-maintenance techniques. The fundamental benefit is that maintenance is only done when a predetermined degree of equipment deterioration occurs rather than after a certain amount of time or usage. (p. 31)

Maintenance activities can account for up to 20% of an operator's direct operating expenses, according to recent civil aerospace research, and the costs have stayed at this level for many years. A thorough examination reveals that there is much room to improve the maintenance process' efficiency. If unplanned maintenance is required, for example, it might result in costly delays and cancellations, particularly when the situation is not resolved in a timely way.

Since the airline industry mostly depends on tourist activities, it is a highly cyclical business. The cyclicality of airlines may affect them in a number of ways. Airline operators change their maintenance plans in accordance with the seasons. Thus, flight times and ground times of aircraft may also vary.

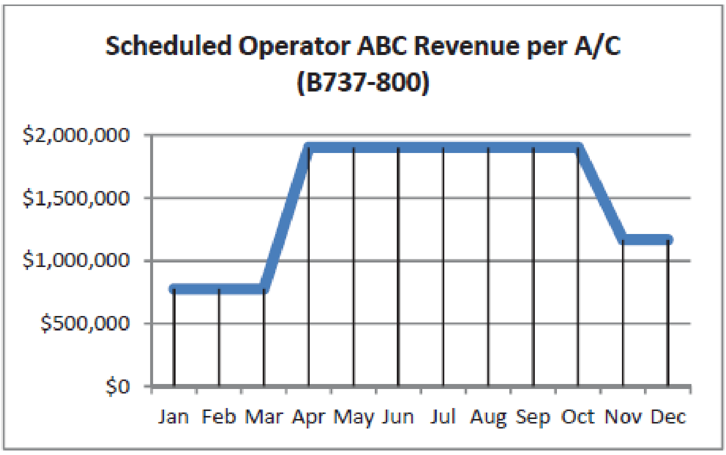

Figure 2.4. Scheduled Operator ABC Revenue per A/C

Source: Saltoglu et al., 2016

As can be clearly seen in Fig. 5 above, airlines make most of their profits at a specific time of the year. Revenue information for a B737-800 aircraft has been given in the figure. According to the graph, revenue per aircraft increases after April and stays high until November, which is called the high season. On the other hand, airlines do not prefer flying their aircraft in the low season. Airline companies utilize the low season by performing longer checks.

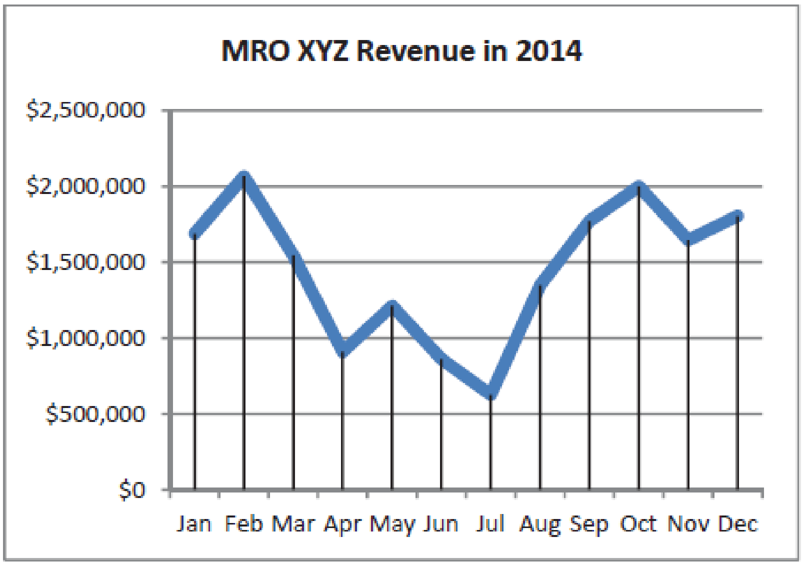

Figure 2.5. Maintenance and Repair Organization XYZ Revenue from Base Maintenance in 2014

Source: Saltoglu et al., 2016

Taking Figs. 5 and 6 above, we can see that airline companies prefer flying their aircraft in the high season (summer season) and performing the required maintenance applications in the low season (winter season). This is a perfect example of maintenance scheduling, and it might be considered the foundation of proactive maintenance planning.

2.3.3. Emergence of Proactive Maintenance Scheduling

As the years have passed after the first flight of the Wright brothers on December 17, 1903 (Smith, 2004), the aviation industry has kept growing continuously. When the regulations got into the business, aircraft maintenance scheduling became more detailed and deliberate. Airlines have scheduled maintenance tasks earlier than they should be performed to prevent possible malfunctions.

Frolova et al. (2019) state that in the 2000s, organizational and technological changes in the system of technical operation of aircraft and other industrial aircraft, as well as a qualitative shift in the principles of economic and transport construction, necessitated new scientifically-based approaches, new methods of aircraft maintenance, and operational aircrafts' repair. This significantly increased requirements for the efficiency and comprehensiveness of measures for the regular maintenance of components, assemblies, and aviation equipment, resulting in fundamentally different ways to complete measures for aircraft repair, both in operational and factory circumstances. (p.537)

Manufacturers started to develop onboard maintenance systems that provide proactive precautions to the operator in order to avoid malfunctions. Now many aircraft are able to send signals from air to ground in order to inform the ground crew about existing and potential malfunctions. If a malfunction occurs in the air, related systems of the aircraft send required data via HF (High Frequency) and VHF (Very High Frequency) communication antennas.

2.3.4. Importance of Proactive Maintenance Scheduling

Smith and Hawkins (2004) state that it was difficult to change the trend in maintenance scheduling; however realizing it was a great success for maintenance planners. It has been seen that by utilizing proactive maintenance scheduling, 25 technicians suffice for a specific type of task, which normally requires 40 technicians. Thus, man-hours are reduced through proper scheduling. This was an action that increased the efficiency of maintenance organizations. (p.223)

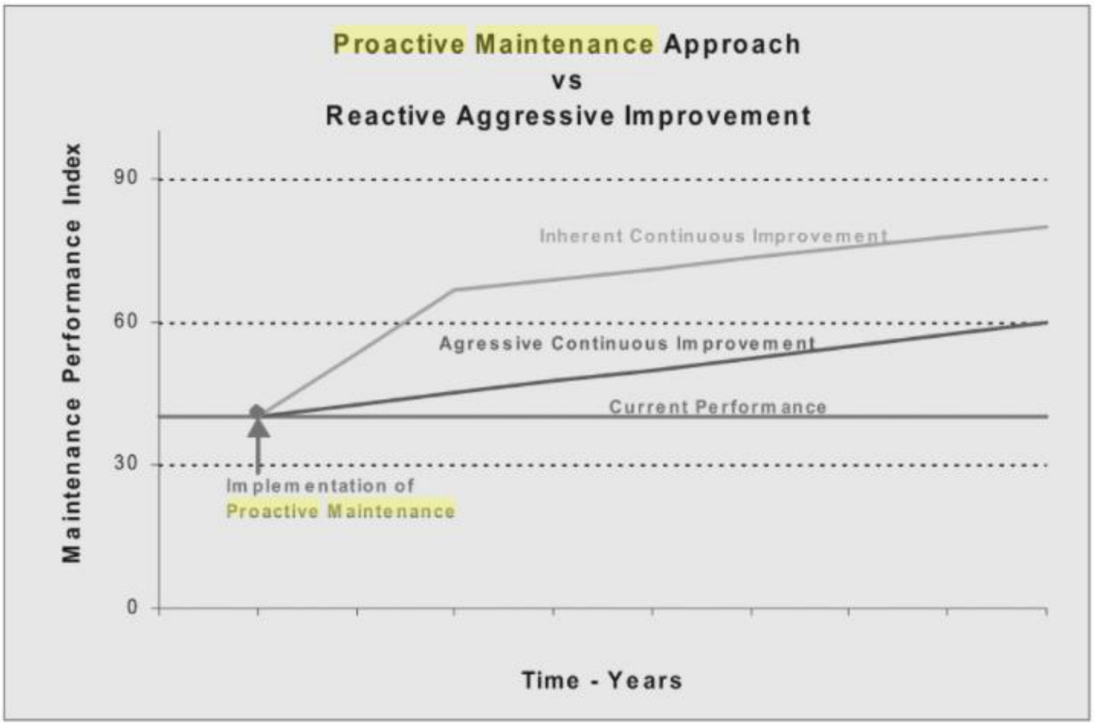

Figure 2.6. Proactive Maintenance Approach vs. Reactive Maintenance Approach

Source: Smith and Hawkins, 2004

The effect of the proactive maintenance approach on the maintenance performance index can be seen in Figure 4 above. The graph shows that the proactive maintenance approach causes the maintenance performance index to increase. Thus proactive maintenance scheduling has become an indispensable approach to maintenance applications.

2.4. Turkish Airlines

Turkish Airlines was founded in 1933 with the mission of "integrating people, cultures, continents, nations, and cities while providing everyone with new and inspiring travel experiences" (Turkish Airlines, 2021). On May 20, 1933, Turkish Airlines took to the skies as the State Airlines Administration. Fesan Evrensev, Turkey's first aviator and top executive, led the airline with only 30 employees and five planes. It made its first international flight in 1947, from Istanbul to Athens, proudly flying the Turkish flag. It increased its fleet to 33 aircraft in 1951 and began flying to new destinations, including Nicosia, Beirut, and Cairo. In 1955, under the name Turkish Airlines, it released a memorandum outlining its significant achievements. Furthermore, its name was added to the list of IATA (International Air Transport Association) members. (Turkish Airlines, 2021)

Istanbul Yeşilköy Airport opened to international aviation in 1954 after being constructed in 1953. In 1985, it was renamed Atatürk Airport, and it has since grown into a global public square and a hub for thousands of noteworthy events. Turkish Airlines acquired five Viscount 794 planes to its fleet in 1958, bringing a new era in aviation history as piston engines gave way to jet engines. Turkish Airlines' distinctive symbol, the wild goose, was created by Mesut Maniolu in 1959, a fitting image which is given that geese can fly to 9,000 feet above ground level. Turkish Airlines pilots Zihni Barn and Nurettin set a new record in 1961 when they flew an F-27 aircraft from the United States to Istanbul in 30 hours. (Turkish Airlines, 2021)

Turkish Airlines launched its website in 1998. In 2001, it created a phone center. Purchasing tickets became easier with the introduction of e-tickets and check-in in 2003. The new interface for Turkish Airlines' corporate website (www.turkishairlines.com) was introduced. Customers can now visit the company's website in English, German, Japanese, French, Italian, Spanish, Portuguese, Korean, Chinese, and Russian. Customers could also book tickets in under a minute using the company's intuitive smartphone app, which is used by millions of people every day (Turkish Airlines, 2021).

Turkish Airlines states its main focus as customer happiness, which understands as ensuring that passenger travel goes as smoothly as possible. The airline introduced its frequent flyer program, Miles&Smiles, to its passengers in the year 2000, giving them comparatively better benefits. Turkish Airlines became a member of the Star Alliance, a worldwide airline alliance, in 2008. Upgrades have been made to its catering services aimed at making passengers' trips more satisfying, while its partnership with Turkish Do&Co provides travelers with delectable meals prepared by the flying chefs. The in-flight entertainment system is full of the latest movies, music, and games, ensuring a pleasant and enjoyable voyage for its customers. Additionally, its in-flight Wi-Fi service allows travelers to stay connected to the rest of the globe. (Turkish Airlines, 2021)

Keeping up with technology is defined as an important part of Turkish Airlines' innovation goals and ensuring that it has Europe's youngest and most advanced fleet. Its fleet thrived as a result of its high-tech, fuel-efficient, and ecologically sensitive aircraft purchases, which provided a high degree of comfort. Turkish Airlines has won the title of Best Airline in Europe because of its unequaled route network, youthful and modern fleet, comfortable seats, and delectable food. (Turkish Airlines, 2021)

It travels to practically every country on the planet with unending enthusiasm and drive. Turkish Airlines thrive on the one-of-a-kind experiences it provides to its passengers. Turkish Airlines has made a reputation for itself with sponsorships and ads from around the world. Turkish Airlines has won the distinction of being the airline that travels to the majority of the world's countries. With a fleet of 373 recently-acquired aircraft, they now fly to 120 countries from their new home, Istanbul Airport. Turkish Airlines proudly fly the Turkish flag across the world, allowing its passengers access to the rest of the world. (Turkish Airlines, 2021)

Turkish Airlines began flying on May 20, 1933, with only five planes and less than 30 people, and since then, it has become the airline that flies to most countries around the globe, commemorating its 87th year. Turkish Airlines' 87-year story is distinguished by the resilience they have developed in the face of adversity.

2.5. Turkish Airlines Technic

Turkish Airlines Technic has been aiming to become leading the Maintenance and Repair Organization (MRO) market since the year it was founded (2006).
According to the TAT website, the organization is spread across two continents, with 576.000 square meters of enclosed area, eight hangars, and cutting-edge technological facilities. Turkish Airlines Technic performs A, B, C, and D maintenance for all aircraft within company capabilities, owing to international maintenance certificates (EASA, FAA), cutting-edge technology, a workforce of over 7,500 people, and qualified workers who are specialists in their professions. Along with aircraft base maintenance, the company offers a variety of high-quality and dependable services to its customers, including cabin renewal, aircraft painting, line maintenance, and business jet maintenance. Engineers who are professionals in their fields

systematically carry out maintenance operations to meet the needs and desires of consumers (Turkish Airlines Technic, 2021)

2.5.1. History of Turkish Airlines Technic

The first civil aviation institution in Turkey was established in 1933 and named State Airlines (Devlet Havayolları). The name was changed to Turkish Airlines in 1955. The company started aircraft maintenance operations on 1957 at the Yesilkoy facility of the company. In 1959, the company made an agreement with Lockheed International to undertake the maintenance operations for Turkish Air Force and foreign airline operations. By 1960, however, the company had gained the requisite ability to perform maintenance, repair, and revision work on piston and turboprop aircraft by developing the capacity of its shops.

In 1963, maintenance workshops were able to perform maintenance, repair, alteration, and revision operations on all aspects of the body, engine and accessories of the aircraft. In 1973, the facilities of the company affirmed that they were in compliance with the international standards by achieving the 820-1F numbered FAA Certificate. In 1977, the first base maintenance facility was opened to service. In 1996, the company acquired the Joint Aviation Requirements (JAR) certificate from EU Joint Aviation Authority (JAA). In 1999, the second base of the company, which has 13,000 m^2 of closed space and 67,200 m^2 total using area with additional building sections, was opened to service.

In 2006, Turkish Airlines Technic was established with full ownership by Turkish Airlines. In 2010, the HABOM project (Aviation Maintenance Repair and Modification Center) was founded, In 2014, a second HABOM, merged with TAT facilities, was set up at Sabiha Gökçen Airport, where it began its operations. The HABOM project ended in 2015, and it was replaced by Turkish Airlines Technic. In 2019 after Turkish Airlines relocated to Istanbul Airport, the Line Maintenance Hangar of Turkish Airlines Technic was brought into service. In 2021 CD hangars were put into service (Turkish Airlines Technic, 2021).

2.5.2. Capabilities of Turkish Airlines Technic

Turkish Airlines Technic supports its maintenance teams by performing letter checks and overhauling activities through its production and maintenance planning, component workshops, engineering, logistics, and quality assurance units. Turkish Airlines Technic provides its customers with quick and immaculate services by knowing the importance of quality, work/flight safety, and customer satisfaction. Turkish Airlines, Pegasus, Sun Express, Onur Air, Atlas Jet, Air Berlin, Midex, Amsterdam Airlines, Balkan Air, Neos, Sojitz, Yemen Air, Izairi Oren Air, Royal Jet, ULS Airlines, Shaheen Air, Saudi Arabia Airlines, Air Blue, and Ariana Afghan Airlines are some of the customers that receive overhaul services from Turkish Airlines Technic (Turkish Airlines Technic, 2021).

Turkish Airlines Technic also has the ability to perform major and minor modifications on aircraft. Turkish Airlines Technic responds to the requests of its customers and conducts modifications and maintenance operations in a timely and systematic fashion. Turkish Airlines Technic is able to make modifications on IFE, GCS, CDSS, ACARS, SatCom, EFB, ATC Mode S, TCAS, T2CAS, T3CAS, EGPWS, Cockpit Door, RIB 5/6, SSIP, T/R, and many other systems. (Turkish Airlines Technic, 2021).

Table 2.2. Turkish Airlines Technic Capabilities

<table>
<tr><td colspan="6">Aircraft types found in our capability:</td></tr>
<tr><td>AIRBUS</td><td>BOEING</td><td>CESSNA</td><td>GULFSTREAM</td><td>BOMBARDIER</td><td>DIAMOND</td></tr>
<tr><td>A300</td><td>727</td><td>172/F172</td><td>G-IV</td><td>CL600</td><td>DA40</td></tr>
<tr><td>A310</td><td>737 CL-NG</td><td>510</td><td>GV-SP</td><td></td><td>DA42</td></tr>
<tr><td>A320 Family</td><td>757</td><td colspan="4" rowspan="3"></td></tr>
<tr><td>A330</td><td>767</td></tr>
<tr><td>A340</td><td>777</td></tr>
<tr><td colspan="6">Aircraft types found in our capability:</td></tr>
<tr><td colspan="3">CFMI</td><td colspan="3">IAE</td></tr>
<tr><td colspan="3">CFM56-5C/7B</td><td colspan="3">V2500</td></tr>
</table>

**Within our affilate TEC*

Source: Turkish Airlines Technic, 2021

From Fig. 8 above, we may observe Turkish Airlines Technic's maintenance capabilities on various aircraft and engine types. Turkish Airlines Technic provides both line and base maintenance with "top quality service." In summary, Turkish Airlines Technic has the abilities of calibration services, line maintenance, NDT, production and design services, aircraft maintenance, engineering services, engine & APU services, landing gear, component pool, component services, fleet asset management, training services and AOG services (Turkish Airlines Technic, 2021).

2.6. Related Studies

In this part of the thesis, I analyze the existing literature on the subject. A number of studies about proactive maintenance planning and its benefits on maintenance costs, aircraft ground times, and airline profitability.

In a paper published by Arnaiz et al. (2010), it is stated that airlines are adopting proactive approaches in order to increase the effectiveness of the maintenance process and increase profitability. The article describes a new proactive feature that will be introduced to contemporary line aircraft repair turn-around-time procedures, in which the health assessment function of an aircraft's integrated vehicle health management (IVHM) aids future flying decisions. The concept of "operational risk assessment" appears here, an expanded function of operational support that is based on IVHM data to develop predictions of future maintenance-related events (e.g., component degradation-driven repair or replacement events) and their impact on the aircraft/operational fleet's planning. Short-term line maintenance tasks are proactively defined based on the operational risk assessment.

In a study by Senturk (2010), it is stated that one of the important issues for an airline company is the optimization of aircraft usage. By making more flight hours, direct operating costs per flight hour can be reduced. Senturk examines the methods for reducing the scheduled maintenance downtime of an aircraft. In his study, he developed a more flexible structure to complete all tasks while the aircraft is on the ground for any reason. In this method, a single maintenance-driven maintenance concept is proposed, and this concept is supported by the "fuzzy" AHP analysis approach, which is developed to facilitate the organization of labor resources. Also, a more flexible model has been developed that can manage the aircraft and enable maintenance to be performed whenever the aircraft is on the ground.

In a study conducted by Cömert (2010), it is found that organizations and systems need to use their resources effectively and efficiently to meet the demands expected from them. In this context, whenever a production facility or a system aims to fulfill its objectives, it is important that it plans maintenance activities that will ensure its activities can be continued without interruption. Cömert (2010) also indicated that a maintenance planning model was created by using the integer linear programming technique in a public enterprise, where aircraft maintenance was carried out at the factory level. The model was run in the LINGO program, and the results were evaluated accordingly.

In another study, Zorbacı (2011) carried out research on minimizing maintenance costs by optimizing a maintenance plan. She stated that the intense preference for aircraft as a means of transportation due to its speed and safety has led to the entry of new airline companies into the sector, which in turn has led to an increase in the number of flights and an increase in the need for aircraft maintenance. Considering the magnitude of the amount paid to technicians and aircraft parts in the aircraft maintenance process, it is clear how high the cost is. Zorbacı (2011) added that reducing costs to a minimum can only be possible with a well-organized management system. For this purpose, detailed information about the content of the aircraft maintenance management system was given in the study, and suggestions for improvement were made for the existing management system by developing computer-aided application studies in the aircraft maintenance company.

There are also studies carried out on proactive maintenance activities. Detecting the possible defects and damages and taking proactive actions against them is a widespread method sued by airlines and maintenance organizations. Korkmaz (2010) investigated a proactive maintenance method, Non-destructive Inspection Techniques, to find possible corrosion formation on aluminum structures on aircraft. Korkmaz also indicates that they performed experimental studies concerning non-destructive inspection techniques and examined the results.

Uludağ (2002) carried out a study concerning the examination of damages caused by fatigue in aircraft jet engines and maintenance approaches to the issue. In the study, Uludağ states that proactive maintenance approaches were applied in jet engine maintenance activities in order to determine the importance of fatigue damage in jet engines. In the context of increasing the service life of jet engines and components, non-destructive testing methods have been examined as a proactive maintenance action.

In an article written by Çoruh et al. (2019), it is stated that proactive maintenance applications are also used in the detection of aging and deterioration in the cable systems of aircraft. In this study on aircraft electrical wiring system aging, a maintenance-oriented assessment was made that determines the level of deterioration in wiring harnesses. Çoruh et al. also expressed that factors such as vibration, humidity, metal chips, indirect damage, contamination, and extreme temperature in the cable system are the main causes of deterioration. In their study, the levels of deterioration in the cable system and its bundles were determined. Additionally, the risks of the analyzes obtained within the scope of MIL-HDBK-525 regarding general visual inspection, detailed inspection, and a combination of these were also evaluated in order to take preventive action.

An analogous study carried out by Alper (2000) proves the importance of aircraft maintenance planning from another point of view. He examined the case of the Turkish Air Force and the maintenance plan applied to F16 aircraft in the inventory. The effectiveness of their maintenance plan was examined in terms of actual conditions in the country. The effectiveness of the current maintenance plan has been found to be unsuitable. Thus, the need for a change in the maintenance plan for country requirements was recognized.

Atik (2019), in his study, has touched upon the ancillary revenues of airlines that aim to provide extra income and increase profitability. Ancillary income is described in the aviation industry as profit made as part of the travel experience through sales to passengers directly or indirectly prior to, during, or after a flight. The goal of this research is to determine the extent to which the low-income business model has an influence on the financial success of side-income applications. To show the influence of the low-cost business model on the financial performance of the airline's subsidiary income applications, the OLS approach was employed. Data from only two Turkish airlines (Turkish Airlines and Pegasus) were available to the public. Hence these two airlines were chosen for the study.

In another study carried out by Dongling (2010), air cargo revenues were taken into consideration. As a strong source of income for airlines, the importance of air cargo and revenues obtained from carrying cargo by aircraft has been examined in detail. The integration of short-term and long-term revenue management models was also examined by Dongling (2019).

As two of the widest business models in the airline industry, the sustainability of full-service carriers and low-cost carriers were compared by Köse (2020). Turkish Airlines and Pegasus Airlines were examined and analyzed in detail concerning their business models. The decisions of these two airlines for the period of 2014-18 were examined and interpreted in terms of sustainability.

In another paper by Aksoy and Bas (2021), Bas and Aksoy (2022), it was revealed that cargo and ancillary revenues have a positive effect on increasing net profit for full-service carrier airlines.

There are a number of other studies concerning airline costs. One of them is carried out by Banker and Johnston (1993). The authors carried out an empirical study of cost drivers in the US airline industry. In the study, it is stated that according to a recent cost driver analysis study, transactions resulting from a company's diverse product range and the complexity of its manufacturing process, as well as output volume, increase overhead expenses. As a result, traditional cost accounting methods focused only on volume-related measurements, such as units of production, direct labor hours, or machine hours, arguably yield skewed and significantly misleading cost estimates for pricing and product line choices.

Baltagi, Griffin, and Rich (1995) carried out research concerning the cost drivers of airlines and methods utilized for decreasing them. Using a database that consists from airlines, this research examined the cost changes in the US airline business throughout the pre-and post-deregulation era. It aimed to separate cost variations caused by technological improvement, economies of scale and density, and input costs. Baltagi, Griffin, and Rich also calculated and analyzed the drivers of a purely generic indicator of the industry: technical change. Despite the fact that productivity growth slowed in the 1980s, deregulation appears to have sparked technological innovation by allowing for more efficient route architectures.

In another study, Tsai and Kuo (2004) carried out research on the operating costs and capacity costs of airlines. Using activity-based cost models, this research demonstrated how to determine precise costs, such as operational costs for specific airplanes and trips, as well as expenses per available seat kilometers and per available ton-kilometers. It also defined each airplane's and flight's primary activity items and drivers. It also provided a case study to show how production variation, marketing variance, and predicted idle passenger capacity could be calculated in the airline business. This information is crucial with respect to buying or leasing an airplane with idle capacity.

Tanner and Cook (2011) conducted research concerning European airline delay cost reference values. The paper is intended to serve as a reference source on airline delays in Europe, both at the strategic (planning) and tactical levels. Quantifying these expenses is critical to SESAR's (Single European Sky ATM Research) goals of providing future airspace users with solutions that are centered on the "optimal commercial outcome." It contained thorough expense tabulations as well as instructions on how to use them.

Zou and Hansen (2012) carried out research that examined the impact of operational performance on air carrier cost structure by concerning evidence from US airlines. The authors used an aggregate, statistical cost-estimating technique for the influence of operational performance on airline cost structure. To justify the claim, two separate sets of operational performance indicators are produced and used in airline cost models. Both delay and schedule buffers are key cost drivers, according to the results of modeling a range of airline cost models. Zou and Hansen (2012) also discovered that flying outside of schedule windows raises costs but flying within schedule windows does not. They estimate the airlines’ cost savings of "perfect" operational performance using anticipated cost models, resulting in a range of $7.1–13.5 billion for 2007.

In a paper by Aksoy and Okan (2021), Okan and Aksoy (2022) the authors discuss that proactive maintenance scheduling has an increasing effect on airline profitability and a decreasing effect on maintenance costs.

F.G. Demiral (2006) examined an application of aircraft maintenance system development by lean thinking. The goal of the paper written by Demiral was to show how an aircraft company utilized lean thinking concepts to boost production and reduce waste. As an example of lean thinking, an existing aircraft maintenance system was analyzed, new procedures were developed, and a new maintenance planning tool was suggested. Despite the fact that considerable amounts of garbage have been discovered, there are still several underserved ways to reduce waste from the system.

In the study “The Place of Service Sector in The Revenue Management” conducted by Gürel and Kayar (2016), the importance of revenue management is introduced. Authors state that many service industries are implementing their activities in order to forecast the future, keep existing consumers, and gain new customers at the greatest level possible by removing the primary operations (such as air tickets) and side operations (air excess luggage, meals, etc.). Rival companies in the same industry intensify competition among clients by revenue management in order to maintain their market position. As a result of the rivalry, revenue management is being used. The most significant goal of revenue management is to increase evidence-based profit. In this literature, revenue management was analyzed, which is different from yield management.

In an article written by Hacıoglu (2011), the importance of revenue management was indicated, and he mentioned important airline financial terms like yield management. Hacıoglu stated that selling the right seat to the right consumer at the appropriate price is what yield management is all about. Companies utilize yield management as one way to increase profitability and income. Airline firms that operate in a competitive market make significant efforts to boost profitability and retain consumers. To stay up with the times, airline firms require a variety of systems and laws. The author also addressed that yield management in Turkey began with Turkish Airlines and has since been explored by other businesses. Since it provides a pricing advantage, it has been embraced by price-sensitive clients. Yield management, which was designed as a solution to the problem of declining profits and revenue in a competitive environment, has become an essential system in aviation companies in Turkey, particularly since the 1980s.

CHAPTER III

EMPIRICAL RESEARCH AND AN APPLICATION

This chapter presents the details of empirical research and application conducted on Turkish Airlines Technic for the perceptual analysis of the impact of proactive maintenance planning on maintenance costs and airline profitability. In addition, the research model, hypotheses, methodology, data collecting, analysis, and necessary tests are also discussed in detail.

There are many concrete results that prove the benefits of proactive maintenance scheduling. However, it is still considered a controversial issue because it is not known if aviation staff is like-minded about the subject. In order to clarify the opinion of Turkish Airlines Technic personnel on the subject, a questionnaire will be performed. This study will not only reveal the perception of Turkish Airlines Technic personnel about the advantages and disadvantages of proactive maintenance scheduling but also show the innovativeness level of Turkish Airlines Technic personnel regarding new trends in the airline industry.

After analyzing the effect of proactive maintenance planning on maintenance costs and airline profitability on Turkish Airlines Technic staff, this study seeks to address the following questions:

- To analyze if Turkish Airlines Technic staff think proactive maintenance scheduling has a decreasing effect on maintenance costs.

- To analyze if Turkish Airlines Technic Staff thinks proactive maintenance scheduling has an increasing effect on airline profitability.

- To analyze if demographic features of Turkish Airlines Technic staff affect their opinion with respect to the first two research questions.

The quantitative research method has been chosen as the research method, and data has been collected by carrying out a questionnaire.

The results of the questions will be examined in terms of the demographic features of the participants. The hypothesis created for determining the demographic changes will be examined in terms of two types of answers, which are “Accepted” and “Refused.”

3.1. Research Model and Hypothesis

Two hypotheses, H1 and H2, are prepared to realize the opinion of Turkish Airline Technic staff on the subject. The remaining 16 hypotheses, which are H3, H4, H5, H6, H7, H8, H9, H10, H11, H12, H13, H14, H15, H16, H17, H18, aim to show changes according to demographic features. The twelve hypotheses regarding demographic features are proved by analyzing the demographic questions together with H1 and H2.

3.1.1. Research Hypothesis

The main hypotheses (H1, H2) that measure the perception covered in this study and other hypotheses related to demographic characteristics are as follows:

H1: Proactive aircraft maintenance planning has the effect of reducing maintenance costs

H2: Proactive aircraft maintenance planning has the effect of increasing airline profitability.

H1.1: There is a significant difference between the education level of the employees and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.

H2.1: There is a significant difference between the education level of the employees and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.

H1.2: There is a significant difference between the gender of the employees and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.

H2.2: There is a significant difference between the gender of the employees and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.

H1.3: There is a significant difference between the age range of the employees and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.

H2.3: There is a significant difference between the age range of the employees and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.

H1.4: There is a significant difference between the experience of the employees in the aviation industry and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.

H2.4: There is a significant difference between the experience of the employees in the aviation industry and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.

H1.5: There is a significant difference between the position of employees and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.

H2.5: There is a significant difference between the position of employees and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.

H1.6: There is a significant difference between the number of positions employees work in and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.

H2.6: There is a significant difference between the number of positions employees work in and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.

H1.7: There is a significant difference between the maintenance-related activities of the employees in the aviation sector and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.

H2.7: There is a significant difference between the maintenance-related activities of the employees in the aviation sector and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.

H1.8: There is a significant difference between the employees' involvement in fleet planning activities and their perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.

H2.8: There is a significant difference between the employees' involvement in fleet planning activities and their perception of the effect of proactive aircraft maintenance scheduling on airline profitability.

3.2. Data Collection and Analysis

In the research, a questionnaire form has been preferred as the data collecting method. In the questionnaire, ten questions regarding the effects of proactive maintenance scheduling on maintenance costs and airline profitability were asked, besides the demographic questions to participants. The results of the questionnaire have been analyzed in SPSS version 22.

The questionnaire form used to reach the research data was distributed to the participants by the researcher himself, and the participants were assured that the questionnaires were conducted for scientific purposes, that no personal information was requested, and that the forms would not be shared outside of their purpose. For this reason, it was inferred that the participants who were surveyed had basic competencies and that they answered the survey questions in an impartial manner.

Chi-Square and Fisher's Exact tests have been utilized to understand the two main hypotheses, H1 and H2, after determining the results of the H1 and H2 hypotheses. The frequency distributions between H1, H2, and demographic features have been examined by using the Chi-Square and Fisher's Exact tests. Both tests are used for determining frequency distribution between two independent categorical variables.

Fisher's Exact test is more accurate than the Chi-Square test on small samples, and the Chi-Square test is more accurate than the Fisher's Exact test on large number of samples. In order to get the most accurate results out of survey data, both Chi-Square and Fisher's Exact tests were used. Both results are shown in the tables in Chapter 4, and the results of the Chi-Square test are shown with the "X2" symbol, and the results of Fisher's Exact tests are shown with the "P" symbol in the tables.

3.2.1. Chi-Square Test

McHugh (2013) states that the Chi-square statistic is a non-parametric (distribution-free) tool for analyzing group differences when the dependent variable is evaluated at a nominal level. Like other non-parametric statistics, the Chi-square statistic is adaptive to data distribution. It does not, for example, need equality of variances among research groups or data homoscedasticity. It may be used to evaluate both dichotomous independent variables and studies with multiple groups. Unlike many other non-parametric and parametric statistics, the computations required to create the Chi-square give considerable information about how each of the groups performed in the research. This degree of detail aids the researcher in comprehending the data, and, as a result, this statistic provides more information than many others. (p.143)

McHugh (2013) states that a key metric to be followed by a strength meter is the Chi-square statistic.

> "Cramer's V is the most common strength test used to test the data once a significant Chi-square result has been attained. The Chi-square has various advantages, including data distribution robustness, ease of calculation, substantial information given by the test, use in research when parametric assumptions are not met, and versatility in processing data from both two and multiple-group studies. Sample size constraints, difficulties understanding when the independent or dependent variables have a large number of categories (20 or more), and Cramer's V's tendency to generate very low correlation measurements, even for highly significant results, are some of its drawbacks. "(p.143)

3.2.2. Fisher's Exact Test

Fisher's exact test is commonly used in the analysis of small samples; however, it is truly applicable to all sample sizes. Kim (2017) explains that Fisher's exact test is one of the exact tests, whereas the chi-squared test is based on an approximation. Fisher's exact test must be employed when more than 20% of cells have predicted frequencies of less than 5, as the approximation technique is insufficient.

The null hypothesis of independence is tested using a hypergeometric distribution of the numbers in the table cells in Fisher's exact test. For 2 x 2 contingency tables, several programs give Fisher's exact test findings, but not for larger contingency tables with more rows or columns. For 2 x 2 contingency tables, the SPSS statistical software, for example, gives an analytical result of Fisher's exact test as well as the chi-squared test. In some cases, a chi-squared test can be employed with big samples. However, the significance value it calculates is simply an estimate since the test statistic's sample distribution is only roughly equivalent to the theoretical chi-squared distribution. (p. 154) When sample sizes are small or data is highly unequally distributed across the cells of the table, the approximation fails, resulting in low cell counts anticipated by the null hypothesis.

When the anticipated values in any of the cells of a contingency table are fewer than five or less than 10 when there is only one degree of freedom, the usual rule of thumb for deciding if the chi-squared approximation is good enough is that the chi-squared test is not acceptable. However, statisticians have discovered that this criterion is too cautious.

As a result of the tests and analyzes above performed in this study, it was found that there is a negative correlation between proactive aircraft maintenance scheduling and maintenance costs. Besides, there is a positive linear correlation between proactive aircraft maintenance scheduling and airline profitability. The study indicated that the H1 and H2 hypotheses were accepted. It was also revealed that proactive aircraft maintenance scheduling has the effect of decreasing maintenance costs and has the effect of increasing airline profitability as well.

CHAPTER IV

EMPIRICAL ANALYSIS AND RESULTS

In this chapter, the empirical analysis and results of the study are examined in detail. The data collected for carrying out a perceptive analysis of the effect of proactive maintenance scheduling on maintenance costs and airline profitability on Turkish Airlines Technic staff was recorded in SPSS version 22 (Statistical Package for Social Sciences) and analyzed. Findings from tests and analyses that concern the hypotheses have been analyzed in the following parts of this chapter.

4.1. Findings and Discussion

The effects of proactive maintenance scheduling on maintenance costs and airline profitability were evaluated with attention to specific demographic characteristics, and some questions were evaluated by frequency analysis, and the percentage was defined as the frequency.

4.1.1. Findings on the Demographic Features

In this section, the analysis of the demographic characteristics of Turkish Airlines Technic personnel covered in the study is given.

Table 4.1. Findings on Demographic Features

Variables		n	%
Gender	Male	91	68.4
	Female	42	31.6
Education	Elementary School	2	1.5
	Lise	18	13.5
	Associate Degree	27	20.3
	Bachelor's Degree	58	43.6
	Post-graduate	28	21.1
Age	18-24	14	10.5
	25-35	35	26.3
	36-45	35	26.3
	46-55	35	26.3
	55 or more	14	10.5

As shown in Table 1, 68.4% of participants were male, while 31.6% were female. %1.5 of them graduated from elementary school, and %13.5 from high school. %20.3 of them held an associate degree, %43.6 a bachelor's degree, and %21.1 were post-graduates. %10.510.5 of the participants were between 18-24, %26.3 were between 25-35, %26.3 between 36-45, %26.3 of them were between 46-55, and %10.5 of them were between 55 or more.

4.1.2. Findings on the Experience of Participants

In this section, an analysis of the (work) "experience of participants in the field of maintenance" as a demographic characteristic of Turkish Airlines Technic personnel are given below:

Table 4.2. Findings on the Experience of Participants in the Area of Maintenance

Variables		n	%
Experience of Participants in the Field of Aviation	1 year or less	17	12.8
	2-4 years	26	19.5
	5-9 years	40	30.1
	10-15 years	35	26.3
	16 years or more	15	11.3
Position of Participants	Management (Chief, Manager, Director)	17	12.8
	Engineer/Specialist	35	26.3
	Technician	41	30.8
	Clerk	19	14.3
	Planning Personnel	21	15.8
Number of Positions	1	52	39.0
	2	42	31.5
	3	19	14.3
	4	12	9.0
	5	8	6.0
Status of staff on taking place in maintenance-related activities in the aviation industry	Yes	97	72.9
	No	36	27.1
Status of staff on taking place in activities related to fleet planning	Yes	39	29.3
	No	94	70.7

As elaborated in Table 2, with specific reference to the field of aviation, 12.8% of participants have one year of experience or less, 19.5% have 2-4 years, 30.1 have 5-9 years, 26.3% have 10-15 years, and 11.3% have 16 years or more experience. 12.8% of them are working in managerial positions (e.g., chief, manager, director), 26.3% are working as engineers or specialists, 30.8% are working as technicians, 14.3% are working as clerks, and 15.8% are working as planning personnel positions.

39.0% of the participants have only worked in 1 position, 31.5% worked in 2 positions, 14.3% have worked in 3 positions, 9,0% have worked 4 positions and 6,0% have worked 5 positions in their career so far.

While 72.9% of participants have taken place in activities directly related to aircraft maintenance, 27.1% of them have never been directly involved with maintenance. In addition, and unlike maintenance activities, 29.3% of the participants have performed some duty in aircraft fleet planning, while 70.7% of them have never engaged with fleet planning.

It can be seen that there is an inversely proportional relationship between maintenance activities and fleet planning, indicating that Turkish Airlines Technic is relatively more interested in the maintenance side compared to fleet planning of aircraft.

4.1.3. Findings on the Opinion of Turkish Airlines Technic Staff on the Effect of Proactive Maintenance Scheduling on Maintenance Costs and Airline Profitability

In this section, the Opinion of Turkish Airlines Technic Staff on the Effect of Proactive Maintenance Scheduling on Maintenance Costs and Airline Profitability has been analyzed below in detail.

Table 4.3. Analysis of Data That Contains the Opinion of Turkish Airlines Technic Staff on the Effect of Proactive Maintenance Scheduling on Maintenance Costs and Airline Profitability

Statements	Variables	n	%
Proactive aircraft maintenance scheduling has the effect of reducing maintenance costs by making the maintenance planning process and maintenance more efficient.	I definitely do not agree	3	2.2
	I do not agree	4	3.0
	I partially agree	27	20.3
	I agree	42	31.6
	I definitely agree	47	35.3

Table 4.3. (cont.)

Proactive aircraft maintenance scheduling makes the management of the maintenance process more efficient and reduces maintenance costs.	I definitely do not agree	7	5.3
	I do not agree	4	3.0
	I partially agree	22	16.5
	I agree	32	24.1
	I definitely agree	68	51.1
Proactive aircraft maintenance scheduling has the effect of reducing maintenance costs by facilitating the planning and resolution of ongoing malfunctions on the aircraft.	I definitely do not agree	2	1.5
	I do not agree	5	3.7
	I partially agree	29	21.8
	I agree	34	25.6
	I definitely agree	57	42.8
Proactive aircraft maintenance scheduling has the effect of reducing maintenance costs by preventing material waste during maintenance.	I definitely do not agree	5	3.7
	I do not agree	7	5.2
	I partially agree	16	12.0
	I agree	27	20.3
	I definitely agree	78	58.6
Proactive aircraft maintenance scheduling reduces maintenance costs by making man-hour planning more efficient.	I definitely do not agree	2	1.5
	I do not agree	4	3.0
	I partially agree	22	16.5
	I agree	20	15.0
	I definitely agree	85	63.9

In the following analysis, variables “I definitely do not agree” and “I do not agree” will be considered negative answers, and participants are thought to disagree with the statements. The variables “I partially agree,” “I agree,” “I definitely agree,” will be considered positive answers, and participants are thought to agree with the statements.

As shown in Table 4.3, 84.2% of the participants agreed with the statement, “Proactive aircraft maintenance scheduling has the effect of reducing maintenance costs by making the maintenance planning process and maintenance more efficient,” while 15.8% of them disagreed. 91.7% of the participants agreed with the statement, “Proactive aircraft maintenance scheduling makes the management of the maintenance process more efficient and reduces maintenance costs," while 8.3% disagreed. 90.2% of participants agreed with the statement, "Proactive aircraft maintenance scheduling has the effect of reducing maintenance costs by facilitating the planning and resolution of ongoing malfunctions on the aircraft," while 9.8% disagreed. 90.9% of participants agreed with the statement, "Proactive aircraft maintenance scheduling has the effect of reducing maintenance costs by preventing material waste during maintenance," while the other 8.1% disagreed. 95.5% of the participants agreed with the statement, "Proactive aircraft maintenance scheduling reduces maintenance costs by making man-hour planning more efficient," while the other 4.5% of them disagreed with the related statement.

4.1.4. Findings on the Impact of Proactive Aircraft Maintenance Planning on Airline Profitability

In this section, analysis of the Impact of Proactive Aircraft Maintenance Planning on Airline Profitability has been analyzed.

Table 4.4. Distribution of Data on the Impact of Proactive Aircraft Maintenance Planning on Airline Profitability

Statements	Variables	n	%
Proactive aircraft maintenance scheduling has a positive impact on increasing airline profitability	I definitely do not agree	2	1.5
	I do not agree	2	1.5
	I partially agree	8	6.0
	I agree	45	33.8
	I definitely agree	77	57.9
Proactive aircraft maintenance scheduling positively impacts airline profitability by reducing maintenance costs	I definitely do not agree	6	4.5
	I do not agree	5	3.7
	I partially agree	17	12.8
	I agree	27	20.3
	I definitely agree	78	58.6

Table 4.4. (cont.)

Proactive aircraft maintenance scheduling has a positive impact on profitability by shortening the grounding time of aircraft.	I definitely do not agree	4	3.0
	I do not agree	5	3.8
	I partially agree	12	9.0
	I agree	22	16.5
	I definitely agree	90	67.7
Proactive aircraft maintenance scheduling increases airline profitability by increasing and facilitating the efficiency of fleet planning.	I definitely do not agree	0	0
	I do not agree	3	2.3
	I partially agree	8	6.0
	I agree	24	18.0
	I definitely agree	98	73.7
I think that the questions asked before this question (1-9), in the "Distribution of Data on the Impact of Proactive Aircraft Maintenance Planning on Airline Profitability" and "Analysis of Data That Contains the Opinion of Turkish Airlines Technic Staff on the Effect of Proactive Maintenance Scheduling on Maintenance Costs and Airline Profitability" part are directly related with maintenance costs and airline profitability.	I definitely do not agree	4	3.0
	I do not agree	3	2.3
	I partially agree	4	3.0
	I agree	42	31.6
	I definitely agree	80	60.2

As shown in Table 4.4, 97.5% of participants agreed with the statement "Proactive aircraft maintenance scheduling has a positive impact on increasing airline profitability," while 2.5% disagreed. 91.7% of them agreed with the statement, "Proactive aircraft maintenance scheduling positively impacts airline profitability by reducing maintenance costs", while 8.2% disagreed. 93.2% of participants agreed with the statement, "Proactive aircraft maintenance scheduling increases airline profitability by increasing and facilitating the efficiency of fleet planning," while 6.8% disagreed. 97.7% of participants agreed with the statement, "Proactive aircraft maintenance scheduling increases airline profitability by increasing and facilitating the efficiency of fleet planning," while 2.3% disagreed. 94.8% of the participants thought that 9 previous questions introduced in Table 3. and Table 4. were directly related to maintenance costs and airline profitability.

4.1.5. Findings on the Statement of "Proactive Aircraft Maintenance Planning Has a Positive Effect on Increasing Airline Profitability" with Demographic Variables

In this section, the analysis of the statement "Proactive Aircraft Maintenance Planning Has a Positive Effect on Increasing Airline Profitability" with demographic variables has been provided.

Table 4.5. Comparison of Participants' Answers on the Statement "Proactive Aircraft Maintenance Planning Has a Positive Effect on Increasing Airline Profitability" with Demographic Variables

Variables		**Proactive maintenance scheduling has a positive effect on increasing airline profitability.**						**X^2 P**
		I do not agree		I partially agree		I agree		
		n	%	n	%	n	%	
Gender	Male	17	(0.81)	5	(0.63)	69	(0.66)	**X^2=1.86*** **P=0.39**
	Female	4	(0.19)	3	(0.38)	35	(0.34)	
Age	18-24	2	(0.1)	2	(0.25)	10	(0.1)	**X^2=11.77**** **P=0.1**
	25-35	6	(0.29)	1	(0.13)	28	(0.27)	
	36-45	4	(0.19)	1	(0.13)	30	(0.29)	
	46-55	3	(0.14)	3	(0.38)	29	(0.28)	
	55 - +	6	(0.29)	1	(0.13)	7	(0.07)	
Education	High School and Below	4	(0.19)	1	(0.13)	15	(0.14)	**X^2=5.31**** **P=0.48**
	Associate Degree	3	(0.14)	4	(0.5)	20	(0.19)	
	Bachelor's Degree	8	(0.38)	2	(0.25)	48	(0.46)	
	Master's Degree	6	(0.29)	1	(0.13)	21	(0.2)	

* Pearson Chi-Square ** Fisher's Percentage of the column has been taken

As Table 4.5 shows, no significant difference was found between the gender of the employees and their perception of the effect of proactive aircraft maintenance scheduling on airline profitability. Thus, (p>0,05). A significant difference was found between the age of the employees and their perception of the effect of proactive aircraft maintenance scheduling on airline profitability (p>0.05). A significant difference was found between the education levels of the employees and their perception of the effect of proactive aircraft maintenance planning on airline profitability (p>0.05).

4.1.6. Findings on the Statement "Proactive Aircraft Maintenance Planning Has a Positive Effect on Increasing Airline Profitability" with Experience-Related Variables

In this section, an analysis of the statement "Proactive Aircraft Maintenance Planning Has a Positive Effect on Increasing Airline Profitability" with experience-related variables has been provided.

Table 4.6. Comparison of Participants' Answers on the Statement "Proactive Aircraft Maintenance Planning Has a Positive Effect on Increasing Airline Profitability" with Experience-Related Variables

Variables		Proactive maintenance scheduling has a positive effect on increasing airline profitability.						X^2 P
		I do not agree		I partially agree		I agree		
		n	%	n	%	n	%	
Experience of participants in the field of aviation	1 or less	5	(0.24)	3	(0.38)	9	(0.09)	**X^2=35.47*** **P=0.01**
	2-4 year	11	(0.52)	3	(0.38)	12	(0.12)	
	5-9 years	2	(0.1)	2	(0.25)	36	(0.35)	
	10-15 years	3	(0.14)	0	(0)	32	(0.31)	
	16 - +	0	(0)	0	(0)	15	(0.14)	
Position of participants	Management	0	(0)	0	(0)	17	(0.16)	**X^2=33.94*** **P=0.01**
	Engineer	3	(0.14)	1	(0.13)	31	(0.30)	
	Technician	2	(0.1)	2	(0.25)	37	(0.36)	
	Clerk	7	(0.33)	2	(0.25)	10	(0.1)	
	P. Staff	9	(0.43)	3	(0.38)	9	(0.09)	
The number of positions participants have worked in	1	7	(0.33)	0	(0)	16	(0.15)	**X^2=22.44*** **P=0.01**
	2	8	(0.38)	5	(0.63)	17	(0.16)	
	3	4	(0.19)	2	(0.25)	25	(0.24)	
	4	2	(0.1)	1	(0.13)	26	(0.25)	
	5	0	(0)	0	(0)	20	(0.19)	
Employees' involvement in aircraft maintenance directly.	Yes	10	(0.48)	6	(0.75)	81	(0.78)	**X^2=8.12*** **P=0.01**
	No	11	(0.52)	2	(0.25)	23	(0.22)	

Table 4.6. (cont.)

Employees' involvement in fleet planning activities	Yes	18	(0.14)	8	(0)	68	(0.65)	**X^2=7.01* P=0.03**
	No	3	(0.86)	0	(1)	36	(0.35)	

* Pearson Chi-Square ** Fisher's Percentage of the column has been taken

As shown in Table 4.6, a significant difference was found between the experience period of the employees in the aviation sector and their perception of the effect of proactive aircraft maintenance scheduling on airline profitability ($p<0.05$). The ratio of those who agree that proactive aircraft maintenance scheduling is effective with respect to increasing airline profitability is 0.35 for those with 5-9 years of service, and 0.09 for those with 1 or less. It can also be stated that those who have experience time of more than 16 years in the sector fully agreed with the statement.

A significant difference was found between the employees' working position and their perception of the effect of proactive aircraft maintenance scheduling on airline profitability ($p<0.05$). While the rate of participation in the effectiveness of proactive aircraft maintenance scheduling on airline profitability is 0.36 for technicians, this ratio is 0.10 for those working as a clerk. It can also be seen that those who work in managerial positions completely agreed with the statement. Technicians are the least of those who did not agree with the statement.

A significant difference was found between the number of positions participants have worked in and their perception of the effect of proactive aircraft maintenance scheduling on airline profitability ($p<0.05$). The perception of staff on the effect of proactive aircraft maintenance scheduling on airline profitability is 0.15 for those who work in one position, while it is 0.25 for those who work in 4 positions.

A significant difference was found between the employees' status of taking place in the maintenance activities in the aviation sector and their perception of the effect of proactive aircraft maintenance planning on airline profitability ($p<0.05$). While the rate of agreement of such personnel on proactive aircraft maintenance scheduling having a positive effect on airline profitability is 0.78, this ratio is 0.22 for those not involved in maintenance activities.

A significant difference was found between the employees' involvement in fleet planning activities and their perception of the effect of proactive aircraft maintenance planning on airline profitability ($p<0.05$). While the participation rate of those who voted for the effectiveness of proactive aircraft maintenance planning on airline profitability is 0.65 for those who are engaged in fleet planning activities, the participation rate for those not involved in fleet planning activities is 0.35.

4.1.7. Findings on the Statement "Proactive Aircraft Maintenance Planning Positively Affects Airline Profitability by Reducing Maintenance Costs" with Demographic Variables

In this section, the analysis of the statement "Proactive aircraft maintenance planning positively affects airline profitability by reducing maintenance costs" with demographic variables has been presented.

Table 4.7. Comparison of Answers of Participants on the Statement "Proactive Aircraft Maintenance Planning Positively Affects Airline Profitability by Reducing Maintenance Costs" with Demographic Variables

Variables		**Proactive aircraft maintenance scheduling positively affects airline profitability by reducing maintenance costs.**						**X^2 P**
		I do not agree		I partially agree		I agree		
		n	%	n	%	n	%	
Gender	Male	18	(0.69)	11	(0.65)	62	(0.69)	**X^2=0.12* P=0.93**
	Female	8	(0.31)	6	(0.35)	28	(0.31)	
Age	18-24	6	(0.23)	1	(0.06)	7	(0.08)	**X^2=17.23** P=0.10**
	25-35	7	(0.27)	2	(0.12)	26	(0.29)	
	36-45	4	(0.15)	8	(0.47)	23	(0.26)	
	46-55	3	(0.12)	6	(0.35)	26	(0.29)	
	55 - +	6	(0.23)	0	(0)	8	(0.09)	

Table 4.7. (cont.)

Education	High school or lower	6	(0.23)	4	(0.24)	10	(0.11)	**X^2=5.16**** **P=0.52**
	Associate degree	5	(0.19)	3	(0.18)	19	(0.21)	
	Bachelor's Degree	11	(0.42)	5	(0.29)	42	(0.47)	
	Master's Degree	4	(0.15)	5	(0,29)	19	(0,21)	

* Pearson Chi-Square ** Fisher's Percentage of the column has been taken

As shown in Table 7, no significant difference was found between the gender of the employees and the perception that proactive aircraft maintenance scheduling has a positive effect on airline profitability by reducing maintenance costs (p>0.05).

No significant difference was found between the age of the employees and the perception that proactive aircraft maintenance scheduling has a positive effect on airline profitability by reducing maintenance costs (p>0.05).

No significant difference was found between the education level of the employees and the perception that proactive aircraft maintenance scheduling has a positive effect on airline profitability by reducing maintenance costs (p>0.05).

4.1.8. Findings on the Comparison of Answers of Participants on the Statement "Proactive Aircraft Maintenance Planning Positively Affects Airline Profitability by Reducing Maintenance Costs" with Experience-Related Variables

In this section, the analysis of the comparison of answers of participants on the statement "proactive aircraft maintenance planning positively affects airline profitability by reducing maintenance costs" with experience-related variables has been analyzed below in detail.

Table 4.8. Comparison of Answers of Participants on the Statement “Proactive Aircraft Maintenance Planning Positively Affects Airline Profitability by Reducing Maintenance Costs” with Experience-Related Variables

Variables		Proactive aircraft maintenance scheduling positively affects airline profitability by reducing maintenance costs.						X^2 P
		I do not agree		I partially agree		I agree		
		n	%	n	%	n	%	
Participant’s experience in aviation	1 year and below	9	(0.35)	2	(0.12)	6	(0.07)	**X^2=34.07** P=0.01**
	2-4 years	10	(0.38)	4	(0.24)	12	(0.13)	
	5-9 years	2	(0.08)	9	(0.53)	29	(0.32)	
	10-15 years	2	(0.08)	1	(0.06)	32	(0.36)	
	16 - +	3	(0.12)	1	(0.06)	11	(0.12)	
Position of participants	Management	3	(0.12)	0	(0)	14	(0.16)	**X^2=40.72** P=0.01**
	Engineer	2	(0.08)	1	(0.06)	32	(0.36)	
	Technician	3	(0.12)	9	(0.53)	29	(0.32)	
	Clerk	5	(0.19)	4	(0.24)	10	(0.11)	
	P. Personnel	13	(0.5)	3	(0.18)	5	(0.06)	
Number of positions participants worked	1	8	(0.31)	2	(0.12)	13	(0.14)	**X^2=24.00** P=0.01**
	2	11	(0.42)	3	(0.18)	16	(0.18)	
	3	4	(0.15)	7	(0.41)	20	(0.22)	
	4	0	(0)	5	(0.29)	24	(0.27)	
	5	3	(0.12)	0	(0)	17	(0.19)	
Employees’ involvement in aircraft involvement directly.	Yes	17	(0.65)	12	(0.71)	68	(0.76)	**X^2=1.11* P=0.01**
	No	9	(0.35)	5	(0.29)	22	(0.24)	
Employees’ involvement in fleet planning directly	Yes	5	(0.19)	2	(0.12)	32	(0.36)	**X^2=5.49* P=0.01**
	No	21	(0.81)	15	(0.88)	58	(0.64)	

* Pearson Chi-Square ** Fisher's Percentage of the column has been taken

As shown in Table 4.8, a significant difference was found between the experience of the employees in the aviation sector and the perception that proactive aircraft maintenance scheduling has a positive effect on airline profitability by reducing maintenance costs ($p<0.05$). The rate of those who agree that proactive aircraft maintenance scheduling affects airline profitability positively by reducing maintenance costs is 0.32 for those who have experienced between 5-9 years, while it is 0.07 for those aged 1 year or less.

A significant difference was found between the position of the participants and their perception of the positive effect of proactive aircraft maintenance scheduling on airline profitability by reducing maintenance costs ($p<0.05$). The ratio of those who agree that proactive aircraft maintenance scheduling affects airline profitability positively by reducing maintenance costs is 0.36 for engineers, while this ratio is 0.06 for planning personnel.

A significant difference was found between the number of positions of the participants and the perception that proactive aircraft maintenance scheduling has a positive effect on airline profitability by reducing maintenance costs ($p<0.05$). The rate of those who do not agree that proactive aircraft maintenance planning affects airline profitability positively by reducing maintenance costs is 0.42 among those working in 2 positions, while this rate is 0.12 among those working in 5 positions.

A significant difference was found between the participants' involvement in maintenance activities in the aviation sector and their perception of the positive impact of proactive aircraft maintenance scheduling on airline profitability by reducing maintenance costs ($p<0.05$).

A significant difference was found between the participants' involvement in fleet planning in the aviation sector and their perception of the positive impact of proactive aircraft maintenance scheduling on airline profitability by reducing maintenance costs ($p<0.05$).

CHAPTER V

CONCLUSION

The financial conditions of the airline industry are austere. And making a profit is proportionally difficult. In this context, management and decreasing costs stand out as important actions for airline financials. Maintenance costs indicate an important portion of total airline costs. As well as any other cost items, airlines are continually making attempts to decrease maintenance costs. As mentioned above, there are several factors that affect maintenance costs. Ground times, man-hour costs, and material costs are especially pertinent. In order to decrease these costs, proper maintenance scheduling is of great importance. As I have shown, proactive maintenance scheduling is a helpful method for decreasing maintenance costs and increasing airline profitability.

In this study, three hypotheses were tested. The first measures if Turkish Airlines Technic staff thought proactive maintenance scheduling was helpful for decreasing maintenance costs. The second hypothesis measured if Turkish Airlines Technic staff think that proactive maintenance scheduling is helpful for increasing airline profitability. Other hypotheses measure if the perception of Turkish Airlines Technic staff changes according to their demographic features and their qualifications. In order to find out their opinion, a quantitative survey was carried out on 133 personnel who were chosen from departments with active roles in maintenance. The results of the survey were analyzed on SPSS version 22. Chi-Square and Fisher's methods were utilized in order to compare two independent variables, which are the first two hypotheses and demographic features. The first two hypotheses were affirmed by the participants. While demographic features like age, gender, and education did not affect their perception, qualitative features like experience, job position, and their specific activities in aviation did affect the results of the hypotheses.

As we have seen, there is a substantial link between the maintenance schedule and maintenance expenses. According to the findings, proper maintenance scheduling has a significant impact on maintenance expenses. Additionally, it was discovered that taking a proactive approach to maintenance scheduling and planning helps to reduce maintenance expenditures. Furthermore, the study found that aircraft maintenance scheduling has a valuable impact on airline profitability.

As a perfect example of that topic, Lufthansa Technik provides airlines with excellent maintenance planning, shops for maintenance execution, and management techniques for properly operating aircraft (UKEssays 2020). The management technique offered by Lufthansa integrates several maintenance activities that can consolidate and centralize asset management tools. This study has revealed that proactive aircraft maintenance scheduling is indispensable for airlines that aim to decrease their maintenance costs and increase airline profitability. It has proven that proactive aircraft maintenance scheduling contributes to decreasing maintenance costs and increasing airline profitability in a number of important contexts, including but not limited to decreased ground time man-hours and materials with respect to maintenance. On the other hand, it has also been shown that proactive maintenance scheduling makes the management of the maintenance process more effective. In light of my analysis, as well as previous studies, it follows that many successful airlines and maintenance organizations are utilizing proactive maintenance scheduling very effectively.

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APPENDICES

APPENDIX A

QUESTIONNAIRE FORM (IN TURKISH)

Değerli Katılımcı,

Bu anketin amacı "Proaktif bakım planlamasının bakım maliyetleri ve havayolu karlılığına etkisinin THY teknik personeli üzerindeki algısının incelenmesidir". Anketteki sorulara vereceğiniz doğru ve samimi cevaplar, akademik amaçlar için kullanılacak ve verilen bilgiler kesinlikle gizli tutulacaktır. Bu çalışmaya katkılarınız gelecekteki araştırmalara ve uygulamalara ışık tutması bakımından büyük önem arz etmektedir. Ayırdığınız vakit ve konuya gösterdiğiniz ilgi için şimdiden çok teşekkür eder, iyi çalışmalar dileriz.

Berkcan OKAN — Prof. Dr. Tamer Aksoy

İbn Haldun Üniversitesi — Danışman

1. Cinsiyetiniz: **[ ] Erkek [ ] Kadın**

2. Yaş aralığınız: **[ ] 18-24 [ ] 25-35 [ ] 36-45**
[ ] 46-55 [ ] 55 ve daha fazlası

3. Eğitim Durumunuz: **[ ] İlkokul/Ortaokul [ ] Lise [ ] Ön lisans**
[ ] Lisans [ ] Lisansüstü

4. Havacılık sektöründe tecrübe süreniz: **[ ] 1 Yıldan daha az [ ] 2-4 yıl [ ] 5-9 yıl**
[ ] 10-15 yıl [ ] 16 yıldan fazla

5. Çalıştığınız pozisyon: **[ ] Yönetimsel pozisyon (şef, müdür, başkan) [ ] Mühendis/Uzman**
[ ] Teknisyen [ ] Memur [ ] Planlama Personeli [ ] Diğer

6. Havacılık alanında çalıştığınız pozisyon sayınız: **[ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 ve fazla**

7. Daha önce havacılık sektöründe doğrudan bakımla ilgili faaliyetlerde (*bakım, planlama, maliyetlerinin hesaplanması, analizi, yönetimi)* **ve pozisyonlarda bulundum.** **[ ] Evet [ ] Hayır**

8. Daha önce doğrudan havayollarının filo planlama faaliyetlerinde bulundum. **[ ] Evet [ ] Hayır**

PROAKTİF UÇAK BAKIM PLANLAMASININ BAKIM MALİYETLERİNE VE HAVAYOLU KARLILIĞINA ETKİSİ

Lütfen, aşağıdaki ifadelere ne ölçüde katıldığınızı belirtiniz.
1 = I definitely do not agree 2 = I do not agree 3 = I partially agree 4 = I agree 5 = I definitely agree

Proaktif Uçak Bakım Planlamasının Bakım Maliyetlerine Etkisi						
1.	Proaktif uçak bakım planlaması, bakım planlama sürecini ve bakımı daha verimli hale getirir	1	2	3	4	5
2.	Proaktif uçak bakım planlaması bakım sürecinin yönetimini daha verimli hale getirir	1	2	3	4	5
3.	Proaktif uçak bakım planlaması uçak üzerinde devam eden arızaların planlanıp çözülmesini kolaylaştırır.	1	2	3	4	5
4.	Proaktif uçak bakım planlaması bakım esnasında oluşan materyal israfını önler	1	2	3	4	5
5.	Proaktif uçak bakım planlaması adam-saat planlamasını daha verimli bir hale getirir.	1	2	3	4	5
Proaktif Uçak Bakım Planlamasının Havayolu Karlılığına Doğrudan Etkisi						
6.	Proaktif bakım planlaması havayolu karlılığını artırıcı etkide bulunur	1	2	3	4	5
7.	Proaktif bakım planlaması bakım maliyetlerini düşürerek havayolu karlılığını olumlu yönde etkiler.	1	2	3	4	5
8.	Proaktif uçak bakım planlaması, uçakların yerde kalış süresini kısaltıcı etkide bulunur.	1	2	3	4	5
9.	Uçuş ve operasyon tarafı ele alındığında, proaktif uçak bakım planlaması filo planlamasını daha verimli ve kolay hale getirir.	1	2	3	4	5
10.	Proaktif Bakım Planlamasının Maliyetlerine Etkisi ve Proaktif Uçak Bakım Planlamasının Havayolu Karlılığına Doğrudan Etkisi bölümünde bu sorudan önceki sorular (1-9) bakım maliyetleri ve havayolu karlılığıyla doğrudan alakalıdır.	1	2	3	4	5

APPENDIX B

RESULTS OF HYPOTHESIS (IN TURKISH)

Araştırma Hipotezleri	**Sonuç**
H1: Proaktif uçak bakım planlaması, bakım maliyetlerini azaltıcı etkide bulunur	KABUL
H2: Proaktif uçak bakım planlaması, havayolu karlılığını artırıcı etkide bulunur.	KABUL
Araştırma Hipotez Sonuçlarının Demografik Özelliklere Göre Değişimi	**Sonuç**
H1.1: Çalışanların eğitim durumu ile proaktif uçak bakım planlamasının bakım maliyetlerine etkisine dair algısı arasında anlamlı farklılık vardır.	RET
H2.1: Çalışanların eğitim durumu ile proaktif uçak bakım planlamasının havayolu karlılığına etkisine dair algısı arasında anlamlı farklılık vardır.	RET
H1.2: Çalışanların cinsiyeti ile proaktif uçak bakım planlamasının bakım maliyetlerine etkisine dair algısı arasında anlamlı farklılık vardır.	RET
H2.2: Çalışanların cinsiyeti ile proaktif uçak bakım planlamasının havayolu karlılığına etkisine dair algısı arasında anlamlı farklılık vardır.	RET
H1.3: Çalışanların yaş aralığı ile proaktif uçak bakım planlamasının bakım maliyetlerine etkisine dair algısı arasında anlamlı farklılık vardır.	RET
H2.3: Çalışanların yaş aralığı ile proaktif uçak bakım planlamasının havayolu karlılığına etkisine dair algısı arasında anlamlı farklılık vardır.	RET
H1.4: Çalışanların havacılık sektöründeki tecrübe süresi ile proaktif uçak bakım planlamasının bakım maliyetlerine etkisine dair algısı arasında anlamlı farklılık vardır.	KABUL
H2.4: Çalışanların havacılık sektöründeki tecrübe süresi ile proaktif uçak bakım planlamasının havayolu karlılığına etkisine dair algısı arasında anlamlı farklılık vardır.	KABUL
H1.5: Çalışanların çalıştığı pozisyon ile proaktif uçak bakım planlamasının bakım maliyetlerine etkisine dair algısı arasında anlamlı farklılık vardır.	KABUL
H2.5: Çalışanların çalıştığı pozisyon ile proaktif uçak bakım planlamasının havayolu karlılığına etkisine dair algısı arasında anlamlı farklılık vardır.	KABUL
H1.6: Çalışanların çalıştığı pozisyon sayısı ile proaktif uçak bakım planlamasının bakım maliyetlerine etkisine dair algısı arasında anlamlı farklılık vardır.	KABUL
H2.6: Çalışanların çalıştığı pozisyon sayısı ile proaktif uçak bakım planlamasının havayolu karlılığına etkisine dair algısı arasında anlamlı farklılık vardır.	KABUL
H1.7: Çalışanların havacılık sektöründe bulunduğu bakım ile alakalı faaliyetler ile proaktif uçak bakım planlamasının bakım maliyetlerine etkisine dair algısı arasında anlamlı farklılık vardır.	KABUL
H2.7: Çalışanların havacılık sektöründe bulunduğu bakım ile alakalı faaliyetler ile proaktif uçak bakım planlamasının havayolu karlılığına etkisine dair algısı arasında anlamlı farklılık vardır.	KABUL
H1.8: Çalışanların filo planlama faaliyetlerinde bulunmaları ile proaktif uçak bakım planlamasının bakım maliyetlerine etkisine dair algısı arasında anlamlı farklılık vardır.	KABUL
H2.8: Çalışanların filo planlama faaliyetlerinde bulunmaları ile proaktif uçak bakım planlamasının havayolu karlılığına etkisine dair algısı arasında anlamlı farklılık vardır.	KABUL

APPENDIX C

QUESTIONNAIRE FORM (IN ENGLISH)

Dear participant,

The purpose of this questionnaire is to make a perceptive analysis of the effect of proactive maintenance scheduling to maintenance costs and airline profitability on Turkish Airlines Technic staff. Honest and sincere answers that you are supposed to give to this questionnaire will only be used for academic purposes and definitely be kept secret. Your contribution to this study indicates great importance in terms of contributing to future studies. Thank you in advance for sparing your time and your interest the subject.

Berkcan OKAN	Prof. Tamer Aksoy
İbn Haldun University	Advisor

1. Gender: **[ ] Male** **[ ] Female**

2. Age: **[ ] 18-24** **[ ] 25-35** **[ ] 36-45**
[ ] 46-55 **[ ] 55 or more**

3. Education: **[ ] Elementary School** **[ ] High School** **[ ] Associate degree**
[ ] Bachelor's degree **[ ] Post-graduate**

4. Experience in the aviation: **[ ] Less than 1 year** **[ ] 2-4 years** **[ ] 5-9 years**
[ ] 10-15 years **[ ] More than 16 years**

5. Your Position: **[ ] Managemental position (chief, manager)**
[ ] Engineer/Specialist **[ ] Technician** **[ ] Clerk**
[ ] Planning Personnel **[ ] Other**

6. Number of positions you have worked in aviation: **[ ] 1** **[ ] 2** **[ ] 3** **[ ] 4**
[ ] 5 or more

7. I have been involved in activities that are directly related to maintenance (Maintenance, planning, calculation, analysis, and management of costs) **[ ] Yes** **[ ] No**

8. I have taken place in fleet planning activities of airlines before. **[ ] Yes** **[ ] No**

THE EFFECT OF PROACTIVE MAINTENANCE SCHEDULING ON MAINTENANCE COSTS AND AIRLINE PROFITABILITY

Please point out your opinion about to what extent you agree with the following statements
1 = I definitely do not agree   2 = I do not agree   3 = Hesitant   4 = I agree   5 = I definitely agree

Effect of Proactive Maintenance Scheduling on Maintenance Costs						
	Proactive aircraft maintenance scheduling makes the maintenance scheduling process and maintenance more efficient.	1	2	3	4	5
2.	Proactive aircraft maintenance scheduling makes the management of the maintenance process more efficient.	1	2	3	4	5
3.	Proactive aircraft maintenance scheduling facilitates the planning and resolution of ongoing malfunctions on the aircraft.	1	2	3	4	5
4.	Proactive aircraft maintenance scheduling prevents material waste during maintenance.	1	2	3	4	5
5.	Proactive aircraft maintenance scheduling makes man-hour scheduling more efficient.	1	2	3	4	5
Effect of Proactive Maintenance Scheduling on Airline Profitability						
6.	Proactive aircraft maintenance scheduling has the effect of increasing airline profitability	1	2	3	4	5
7.	Proactive aircraft maintenance scheduling positively affects airline profitability by reducing maintenance costs.	1	2	3	4	5
8.	Proactive aircraft maintenance scheduling has the effect of shortening the grounding time of aircraft.	1	2	3	4	5
9.	On the flight and operations side, proactive aircraft maintenance scheduling makes fleet planning more efficient and easier.	1	2	3	4	5
10.	In the section "the effect of proactive maintenance scheduling on maintenance costs and airline profitability" the questions before this question (1-9) are directly related to maintenance costs and airline profitability.	1	2	3	4	5

APPENDIX D

RESULTS OF HYPOTHESIS (IN ENGLISH)

Research Hypothesis	**Result**
H1: Proactive aircraft maintenance planning has the effect of reducing maintenance costs	ACCEPTED
H2: Proactive aircraft maintenance planning has the effect of increasing airline profitability.	ACCEPTED
Change of Research Hypothesis Results According to Demographic Characteristics	**Result**
H1.1: There is a significant difference between the education level of the employees and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.	REJECTED
H2.1: There is a significant difference between the education level of the employees and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.	REJECTED
H1.2: There is a significant difference between the gender of the employees and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.	REJECTED
H2.2: There is a significant difference between the gender of the employees and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.	REJECTED
H1.3: There is a significant difference between the age range of the employees and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.	REJECTED
H2.3: There is a significant difference between the age range of the employees and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.	REJECTED
H1.4: There is a significant difference between the experience of the employees in the aviation industry and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.	ACCEPTED
H2.4: There is a significant difference between the experience of the employees in the aviation industry and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.	ACCEPTED
H1.5: There is a significant difference between the position of employees and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.	ACCEPTED
H2.5: There is a significant difference between the position of employees and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.	ACCEPTED
H1.6: There is a significant difference between the number of positions employees work in and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.	ACCEPTED
H2.6: There is a significant difference between the number of positions employees work in and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.	ACCEPTED
H1.7: There is a significant difference between the maintenance-related activities of the employees in the aviation sector and the perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.	ACCEPTED
H2.7: There is a significant difference between the maintenance-related activities of the employees in the aviation sector and the perception of the effect of proactive aircraft maintenance scheduling on airline profitability.	ACCEPTED
H1.8: There is a significant difference between the employees' involvement in fleet planning activities and their perception of the effect of proactive aircraft maintenance scheduling on maintenance costs.	ACCEPTED
H2.8: There is a significant difference between the employees' involvement in fleet planning activities and their perception of the effect of proactive aircraft maintenance scheduling on airline profitability.	ACCEPTED

CURRICULUM VITAE

Name Surname:

Berkcan OKAN

Education:

2013-2018: Bachelor’s Degree, Airframe and Powerplant Maintenance, Atılım University, Ankara

2019-2021: Master’s Degree candidate, Air Transportation Management, İbn Haldun University, İstanbul

Work Experience:

2018-.present: Turkish Airlines Technic, Aircraft Maintenance Technician