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Assessing the effect of proactive maintenance scheduling on maintenance costs and airline profitability: The case of Turkish Airlines Technic



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ABSTRACT

This study mainly aims to examine the perception of Turkish Airlines Technic staff about the effect of proactive maintenance scheduling (PMS) on maintenance costs (MCs) and airline profitability (AP). Another purpose of the study is to reveal if perception of the staff changes according to demographic features and experience of the staff. As far as it is known, there is no direct study addressing the effects of PMS on MCs and airline profitability. The study is considered to be a first in this context. In the study, Turkish Airlines-THY was chosen as the company that was handled. The fact that the company has a separate special maintenance & repair group (Turkish Airlines Technic-THYT) was effective in the selection of this company. Some additional qualifications (very rooted, with corporate governance, Turkey's top largest & full-service carrier, member of IATA and Star Alliance, and a listed company (in BIST) were also among other factors affecting the selection. Methodologically, it was used a quantitative survey with a sample of 133 THYT staff. Staff has been chosen among departments that takes place actively/directly in maintenance. Besides questions that aim to measure the perception of THYT staff on the effects of PMS to MCs and AP, some demographic and experience related questions were asked in order to find out if perception of the staff changes according to their qualifications. The data were collected by online survey method and analyzed with SPSS version 22. Necessary tests together with Chi-square and Fisher's tests were carried out to analyze the results. It was concluded that there is a strong correlation between PMS and the MCs. The study proved that PMS has a great decreasing effect on MCs and a great increasing effect on AP. The study also revealed that THYT personnel is like-minded that PMS reduces MCs and increases AP as well.

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Introduction

The aviation industry has been in a continuous development since its establishment. The high-accelerated development trend that the industry is going through has created an intense competitive environment among airlines. In recent years, it has been observed that in the airline sector around the world, there is a highly intense and fierce competition among airline companies. Intense competition in the sector and the great decline in profit rates have increased the importance of reducing expenses and costs in addition to management of incomes. Airlines have had to find ways to cut their overall expenses while increasing their profits. Furthermore, the Covid-19 time that we are currently experiencing has enhanced the complication of this search for companies.

In this context, airlines try and implement various methods to reduce their own costs. Maintenance costs are one of the cost items that have an important place in the total costs. The maintenance costs of commercial aircraft also make a significant contribution to the cost of ownership of an aircraft (Wu et.al. 2004). Subjecting direct and indirect costs, including maintenance costs, to serious analysis will enable shareholders and top management to take the necessary corrective, preventive, remedial managerial decisions and to implement optimal financial management strategies (Babashamsi et.al. 2022).

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As with all other cost items, various methods are tried to reduce maintenance costs. It has been seen that some of these methods have a positive effect on decreasing the costs and have begun to be implemented. Proactive maintenance scheduling, on the other hand, is one of the methods aimed at reducing maintenance costs and thus increasing airline profitability and is actively used by many airlines. Proactive maintenance scheduling is a very effective and beneficial method for this purpose.

With the proactive maintenance scheduling method, it is aimed to minimize the ground time that affects the maintenance costs, to reduce the man-hour expenditure required for maintenance, to minimize the time required for solving ongoing troubles and component replacements and reducing the waste of materials. Turkish Airlines is among the few companies that are effectively using proactive maintenance scheduling management. In addition, maintenance planning is also a critical factor in terms of the short- and long-term procurement and organization chain of maintenance tools and workforce and aircraft spare parts that airlines need in the aviation industry (Weide, Deng, & Santos 2022).

However, some proactive maintenance scheduling practices are seen as a controversial issue in the sector. Turkish Airlines Technic is an industry leader in proactive maintenance scheduling, for this reason this study was needed to be carried out to make a perceptual analysis on the Turkish Airlines Technic employees. Thus, considering the experience in the sector and the positions they work in, the perceptual analysis of some proactive maintenance scheduling practices (such as early maintenance as a preventive action). By conducting this study on Turkish Airlines Technic personnel, it is aimed to brighten and get the most accurate results on the effect of proactive maintenance scheduling on maintenance costs and airline profitability.

Continuity of airworthiness and maintenance expenditures account for a significant share of total airline expenses in the civil aviation business. The impact of proactive aircraft maintenance scheduling on maintenance costs and airline profitability will be investigated and Turkish Airlines (THY) was selected as the company to be handled in the study. The fact that Turkish Airlines has its own specific maintenance and repair group (Turkish Airlines Technic) had a role in the company's choosing. Additional qualifications (extremely rooted, with corporate governance, Turkey's largest airline, full-service carrier airline, member of IATA and the global airline confederation-Star Alliance, and a publicly traded/listed corporation (Borsa Istanbul-BIST) were also considered in the decision of choosing Turkish Airlines.

This study mainly aims to measure the perception of Turkish Airlines Technic staff about the effect of proactive maintenance scheduling on maintenance costs and airline profitability. Additionally, another aim of the study is to find out if perception of the staff changes according to demographic features and experience of the staff. As far as it is known, there is no direct quantitative study assessing the impacts of proactive maintenance scheduling on maintenance costs and airline profitability for airlines. So the study is considered to be a first in this context.

Research model has been created to reveal the changes of perception of Turkish Airlines Technic staff about questions regarding the effects of proactive maintenance scheduling on maintenance costs and airline profitability in terms of demographic features of the staff. Two hypothesis H1 and H2 below are prepared for realising 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.

Remaining 16 hypothesis which are H3, H4, H5, H6, H7, H8, H9, H10, H11, H12, H13, H14, H15, H16, H17, H18 aims to show the changes according to demographic features. 12 hypothesis shown in related section, regarding demographic features are proved by analyzing the demographic questions together with H1 and H2.

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

The organization of the study is as follows: The study consists of four parts. Throughout the study, harsh conditions and difficulty of making profit in the airline business will be examined first. The first section is devoted to the introduction. In the second section of the study, which is basic concepts and theoretical background, emergence of proactive maintenance scheduling is introduced and a brief information about Turkish Airlines and Turkish Airlines Technic is given. The importance of maintenance costs will be explained in detail and the burden of aircraft maintenance costs the airline financials will be handled as well. Importance of a proper aircraft maintenance scheduling will be explained and justified in terms of costs and the operation. In this section, previous studies about airline finance and aircraft maintenance will be discussed as well. In the third section, research and an application, the method for obtaining and processing the data will be explained in detail. The fourth section, empirical results and analysis, introduce and interpret the results obtained from the questionnaire applied and the analysis. Finally, conclusion part will wrap up the topic and shows what is acquired from the study.

Literature Review

Conceptual and Theoretical Background

Financial Difficulties in Airline Business

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 revenues are very high, being able to make profit is a difficult job for airlines. The main reasons for low profit rates are very high expenses. Fuel, maintenance, labor, traffic costs, general administrative, depreciation and amortization can be considered as the main cost drivers of an airline. From 1950 to 2015, the average airline industry net profit margin after debt and tax was only 0,2% (IATA, 2016). For example, total revenue of global aviation business was \$754B in 2018 while the total profit was only about \$3,8B (IATA, 2019).

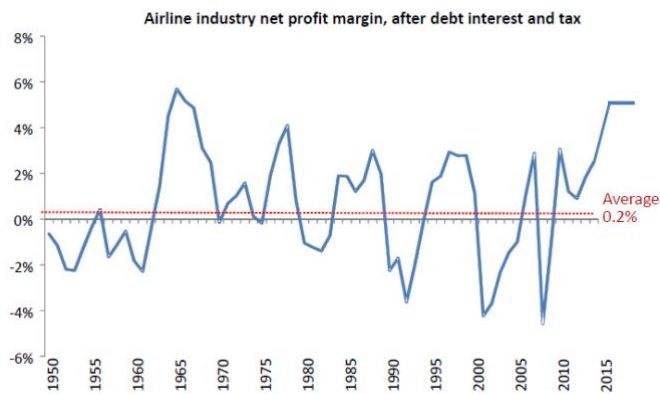


Figure 1: Airline Industry Net Profit Margin After Debt Interest and Tax; *Source:* (IATA, 2016)

In an industry where 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.

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 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 is an important cost driver which is essential to be considered for decisions taken by airlines. Like every other cost drivers, airlines are trying to find out new ways of lowering the maintenance costs since they are a series of expensive costs. 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 actuality, there are several shared expenditures in the various areas of maintenance. The cost of maintenance includes not just normal maintenance and inspections performed between flights or overnight, but also more costly periodic overhauls and significant inspections. They cover two significant expense categories. The first is the considerable use of labor and the costs associated with all levels of personnel involved in maintenance tasks, whether directly or indirectly. Maintenance personnel expenses at out-stations should be segregated from station expenditures and included under maintenance if practicable. Second, there is a significant expense associated with spare component use. Most components of each engine and airframe have a useful life that is measured in block hours or flight cycles, or landings and takeoffs.

Doganis (2002) described how each part of maintenance costs affect 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.

Deng et. Al. (2021) states 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, inventory optimization, and maintenance tool coordination. According to maintenance planners' experience, AMP is not as demanding for small airlines and may be done manually. Maintenance costs constitute an important amount of total airline costs.

Deng et. Al (2021) also states 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. It is possible to make an inference that Aircraft Maintenance Planning is a very important concept that helps airlines reduce maintenance costs according to sources utilized above.

Table 1: Cost of Sales of Turkish Airlines in 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
Full expenses	1,853	872	1,308	323
Depreciation and amortisation charges	1,229	420	1,176	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 services 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
Total	<u>5,864</u>	<u>2,414</u>	<u>4,873</u>	<u>1,399</u>

Source: Turkish Airlines Financial Statements, 2021

Table 1: Cost of Sales of Turkish Airlines in First Nine Months of 2021, shows the expenses of Turkish airlines in the first nine months of 2021. Expenses are sorted from the 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 indicates the greatest expense among others.

However, maintenance expenses of Turkish Airlines in the first nine months of 2021 is exactly 385 million dollars. While the financial report of Turkish Airlines indicates the total expenses for the first nine months of 2021 as \$5,864,000,000 while the total maintenance costs for the same period is \$385,000,000. According to the financial statements and calculations, maintenance costs of Turkish Airlines constitute 6,56% of total expenses.

Maintenance Scheduling

Aircrafts should undergo some periodic maintenance checks which are defined by the 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 prevent further 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. And he categorized the scheduled checks to four main parts which are letter checks (A, B, C, D checks). 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 for ways to improve their maintenance program. Such programs are enhanced by utilizing proactive maintenance scheduling. Many other ways of enhancing and developing the maintenance scheduling process are constantly tried and implemented by airlines.

Maintenance Cost Items

There are some items that defines the cost of aircraft maintenance. Although it will be stated in detail below, some of them are material expenses, man-hour (labor) expenses, component replacement, ground times. Also, some subjects like the age and type of the aircrafts determine the maintenance cost. The aviation sector is a highly competitive industry. Airlines are attempting to reduce

their operating costs in order to compete in the market (Lin, et.al. 2019). The design and manufacturing phase expenses of an aircraft are normally well understood, as there is some historical evidence for such predictions, however, long-term costs and operating cycle drivers and factors are sometimes concealed. This hiding process does not mean ignoring, on the contrary, all these cost elements and factors are subjected to a comprehensive, detailed and rigorous analysis. In the light of these analyzes, determining the root cause of increased maintenance expenditures, especially at the operational stage, will help airlines review their maintenance procedures, make necessary innovative improvements and better manage their companies' maintenance plans.

Mofokeng et. Al. (2020) states that the design, manufacture, operating, and decommissioning phases of an aircraft's life cycle are separated. The design must take into account the needs for manufacture, operation, and disposal. The aircraft's performance, safety, dependability, manufacture, and assembly are all factors in its design. On freshly designed aircraft, it is impossible to predict upcoming problems, thus manufacturers trust upon data provided during their operations.

The operating 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 fails 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 operating phase, the maintenance process focuses on increasing aircraft dependability and lowering maintenance costs. The decommissioning step involves the aircraft's safe disposal or recycling.

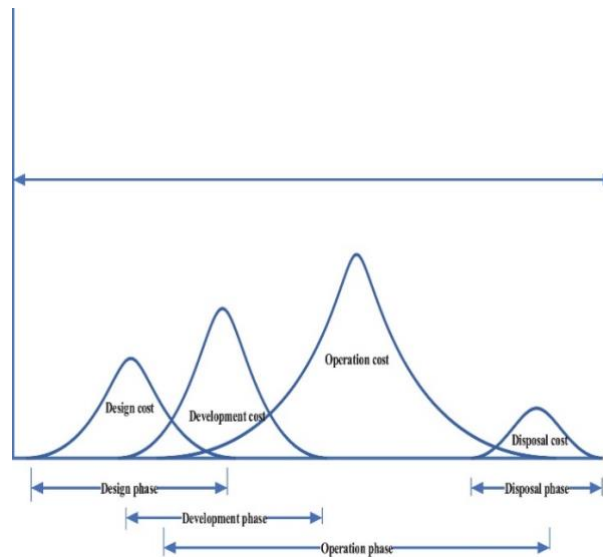


Figure 2: Aircraft Life Cycle Costs; Source: (Mofokeng et. Al., 2020)

According to Figure 2: sourced from Mofokeng et. Al. (2020) operation 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 expenses and costs of the aircraft life cycle are directly or indirectly affected by aircraft design, duration and conditions of use, human factors, ease of maintenance, the intensity, difficulty and complexity of the operation, and dependability, as shown in Figure 4. below, maintenance planning, spare parts availability, 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 airplane in a serviceable and dependable state for creating income, to avoid physical and mechanical degradation in order to decrease operating costs and expenditures due to failure, and to comply with internal/external/regulatory requirements (Dincer et al., 2017). Disruption of aircraft maintenance has the potential to cause problems in terms of compliance with all these requirements. Various checks (ie A-checks, C-checks, D-checks, daily maintenance checks) can be cited as examples of aircraft maintenance services (Lapesa, 2022).

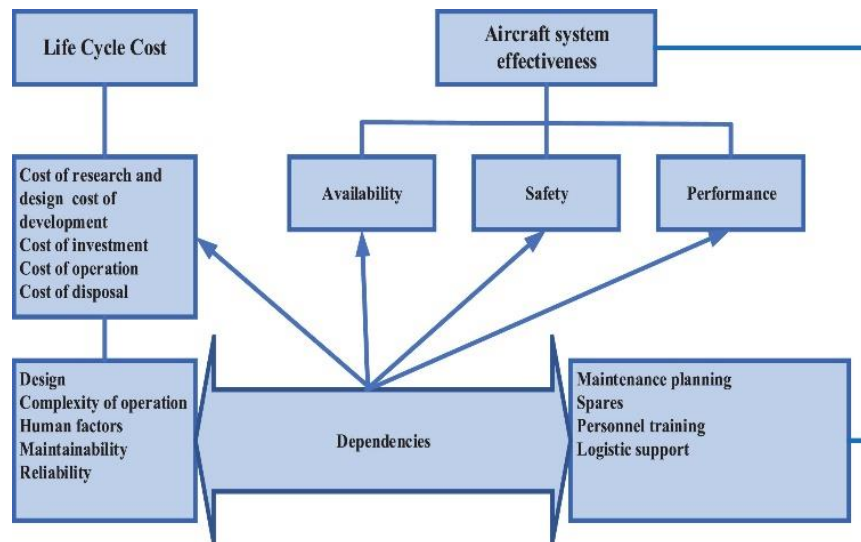


Figure 3: Link between life cycle cost and airplane system effectiveness; Source: (Mofokeng et. al., 2020)

A-checks are done biweekly to monthly and consist of a visual inspection of the aircraft's interior and exterior. Operational testing, inspection, filter change, lubrication, checking and servicing oil are all A-check tasks. Operational testing, inspection, filter change, lubrication, checking and servicing oil are typical examples of A-check tasks (Mofokeng et. Al., 2020). A-check maintenance takes place usually overnight, when airlines do not schedule flights, in the hangar for 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 indicates that these routine controls are vital to the maintenance process and life cycle of the aircraft and that routine C-checks take place in the hangar every 12 to 20 months, depending on the kind of airplane, flight hours, flying cycles and calendar months. For a single aircraft, C-checks take something from 3 days to 1 week. Routine D-check activities include peeling paint off aircraft exteriors, removing panels, inspecting the wings, landing gear, airframe structure, engines, and the majority of structurally critical elements, among others. Many of the airplane's interior components are checked, overhauled, and repaired during D-check. Every 6 to 12 years, D-checks are done in the hangar and are dependent on the airplane type, flying hours, flight cycles, and calendar months. D-checks are usually carried out for one month.

Daily maintenance checks, in addition to the aforementioned, 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 1 hour. Scheduled and unscheduled maintenance are two types of aircraft maintenance. Maintenance is scheduled based on calendar period, flight cycles and flying hours. Reported faults, technical failures, and problems discovered during inspection trigger unscheduled maintenance. Another important basic component to consider is flight hours. Flight hours are the number of hours flown by an airplane over a specific time period, from the time the wheels lift off the ground during take-off to the time the wheels touch the ground during landing (FH). Flight Cycles usually contain take-off and landing runs (FC). It covers the complete duration from engine start to engine shutdown, regardless of flying conditions (Mofokeng et. Al. 2020; Lapesa, 2022).

Mokofeng et. Al (2020) briefly summarizes the maintenance as an inevitable necessity. Maintenance planners, who are heavily involved in aircraft maintenance, guide aircraft maintenance checks. 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 unplanned categories by planners. Visual control/inspection, operating checks, lubrication, restoration, deep inspection, and disposal are all scheduled tasks. In addition to scheduled activities, unscheduled tasks are also among the maintenance activities that are of great importance in the maintenance process. Non-scheduled jobs include faults reported by the flight crew (Mofokeng et. Al. 2020; Lapesa, 2022).

For the purposes of analysis, aircraft are separated into fundamental areas known as Air Transport Association (ATA) systems and sub-systems. By evaluating all functions and faults, this technology allows the airplane to be managed. The manufacturer publishes maintenance requirements to airworthiness authorities before a new airplane enters service. Although airline maintenance procedures differ, the starting necessities are the same. The maintenance process covers activities such as planning, preparation, management, execution, assessment, and improvement that are necessary during airplane maintenance. The technique shown below is a general airplane maintenance procedure used by several airlines (Ackert, 2012):

- i. A commercial airplane arrives in the hangar for maintenance (ie. A-check, C-check, or D-check).

- ii. Flight logs and task cards are reviewed for faults that have been reported.
- iii. Technicians remove the panels to obtain access to sections that need to be serviced.
- iv. Operational tests are carried out to verify alleged sub-system flaws.
- v. Aviation maintenance and repairs are carried out in accordance with aircraft maintenance instructions.
- vi. All replacement components are double-checked for leakage and installation integrity.
- vii. Operational tests are performed to prove the airworthiness of an airplane, such as flight controls, ground run, or thrust reversers.
- viii. In the next phase, the aircraft is released for service following the signing of the aircraft documents (Mokofeng et. Al., 2020).

Proactive Maintenance Scheduling

The airlines and maintenance organizations have always tried to lower the maintenance costs. As a result of this effort, new methods have been developed. Proactive maintenance scheduling, so called preventive maintenance, is a way of maintenance scheduling which aims to lower the maintenance costs and increase the airline profitability by taking precautions against possible malfunctions in an aircraft. Proactive aircraft maintenance scheduling 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. So that the filter will not clog in an out station. Not like reactive maintenance, proactive maintenance provides some advantages and profits to airlines.

Arnaiz et. Al. (2010) Maintenance is undergoing significant changes in all sectors of activity today, 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. To meet this issue, the maintenance concept must undergo numerous fundamental modifications that include proactive considerations, such as changing old "fail and repair" maintenance techniques to "predict and avoid" e-maintenance tactics. 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.

The lifespan of an aircraft in commercial aviation is usually around 30 years. During this time, the aircraft needs maintenance to remain in service. The cost of maintenance, repair and overhaul (MRO) activities is a significant part of operations, accounting for approximately 10% of all cost factors (Delen, et al. 2017). Maintenance activities can account for up to 20% of an operator's direct operating expenses, according to recent civil aerospace research, and 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 if the situation is not resolved in a timely way (Lapesa, 2022).

Since airline industry mostly depends on touristic activities, it is a highly cyclical business. Cyclicity of airline may affect them in a number of ways. Airline operators change their maintenance plans in accordance with seasons. So that flight times and ground times of aircrafts may also vary.

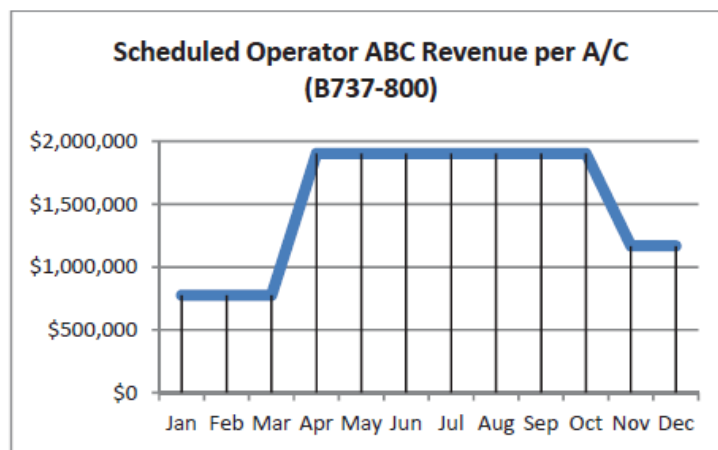


Figure 4: Scheduled Operator ABC Revenue per A/C; **Source:** (Saltoglu et. Al., 2016)

As it can be clearly seen in the Figure 4 above, airlines are making most of their profits in a specific time of the year. Revenue information of a B737-800 aircraft has been given in the figure. According to graph, revenue per aircraft increases after April and stays high until November, which is called high season. On the other hand, airlines do not prefer flying their aircraft in the low season. Airline companies value the low season by performing very long checks.

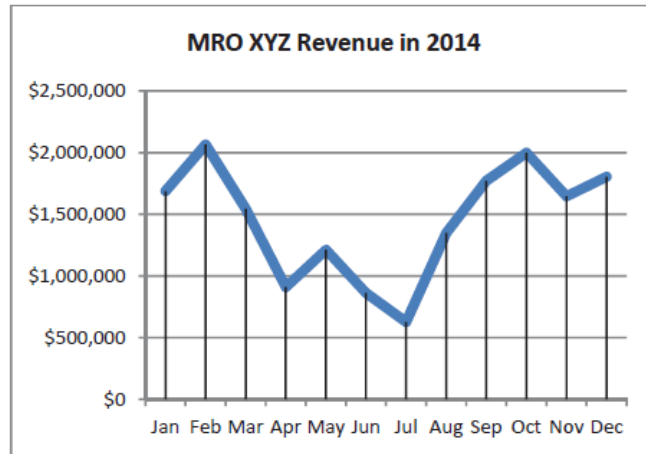


Figure 5: MRO XYZ Revenue from base maintenance in 2014; *Source:* (Saltoglu et. Al., 2016)

The two figures shared above, indicate that airline companies prefer flying their aircraft in the high season (summer season) and perform the required maintenance applications in the low season (winter season). This is a perfect example maintenance scheduling, and it might be considered as the basis of proactive maintenance planning.

Emergence of Proactive Maintenance Scheduling

As the years have passed after the first flight of wright brothers on 17 December 1903, (Smith, 2004) aviation industry kept growing continuously. When the regulations got into the business, aircraft maintenance scheduling became more detailed and serious. In order to increase the profitability, new methods like proactive maintenance scheduling have been developed. By implementing proactive maintenance scheduling into the airline business, low maintenance costs and high profitability have been aimed. As a result of this effort, airlines started to take proactive actions in terms of maintenance scheduling. They scheduled maintenance tasks earlier than they should be performed to prevent possible malfunctions.

Frolova et. Al. (2019) states 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, methods of aircraft maintenance, and current aircraft repair. The multidimensionality of the mentioned changes made the maintenance process and maintenance costs one of the elements that should be handled in the most efficient way by airlines. 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 completing measures for aircraft repair, both in current and factory circumstances.

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

Importance of Proactive Maintenance Scheduling

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 proactive maintenance scheduling, 25 people are enough for a specific type of task which normally requires 40 people. It is proved that less people can deliver the same work by a proper scheduling. This was an action which increased the efficiency of manpower in maintenance organizations (Smith and Hawkins, 2004).

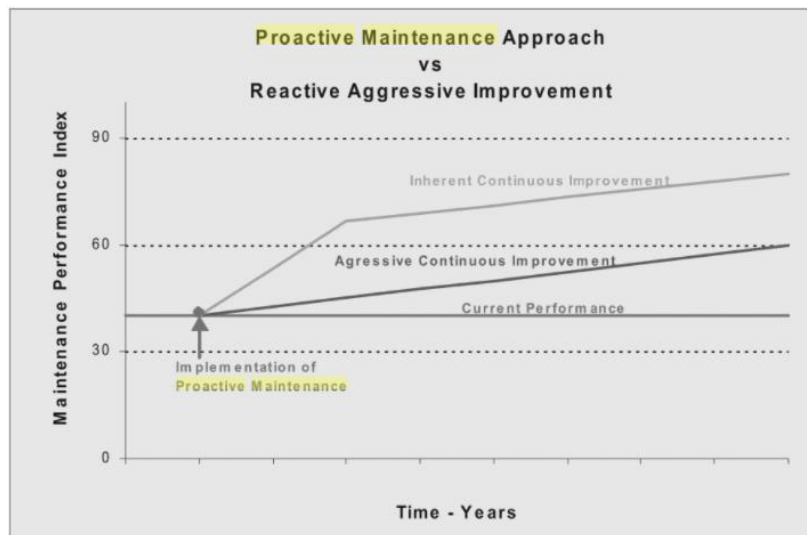


Figure 6: Proactive Maintenance Approach vs Reactive Maintenance Approach; Source: (Smith and Hawkins, 2004)

The effect of proactive maintenance approach to the maintenance performance index can be seen in the Figure 6 above. Graph shows that proactive maintenance approach causes the maintenance performance index to increase. Proactive maintenance scheduling has become an indispensable term and an approach to maintenance applications.

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. On May 20, 1933, Turkish Airlines took to the skies as the State Airlines Administration. Fesah Evrensev, Turkey's first aviator and top executive, led the way with only 30 employees and five planes. It made its first international flight in 1947, from Istanbul to Athens, proudly flying the Turkish national flag. It increased its fleet to 33 aircraft in 1951 and began flying to new destinations including as Nicosia, Beirut, and Cairo. In 1955, under the name Turkish Airlines, it signed a memorandum outlining its remarkable achievements. Furthermore, its name has been 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 gathering place and a hub for thousands of unforgettable 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 Manioli in 1959, a fitting image given that geese can fly up to 9,000 feet. 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 their website in 1998. In 2001, it took over the phone center. Purchasing tickets became a lot easier after the introduction of e-tickets and check-in in 2003. The new interface for Turkish Airlines' corporate website, turkishairlines.com, was introduced. Customers can now visit the company's website in English, German, Japanese, French, Italian, Spanish, Portuguese, Korean, Chinese, and Russian, among other languages. Customers can also book tickets in under a minute using the company's easy-to-use smartphone app, which is used by millions of people every day. (Turkish Airlines, 2021)

Turkish Airlines states its main focus as customer happiness, and it takes for Turkish Airlines a great effort to ensure that passenger's travel goes as smoothly as possible. Turkish Airlines Miles&Smiles to its passengers in the year 2000, giving them exceptional benefits. Turkish Airlines became a member of the Star Alliance, a worldwide airline alliance, in 2008. Upgrades to its catering services aimed at making passengers' trip more enjoyable. its partnership with Turkish Do&Co provides travellers with delectable meals prepared by the flying chefs above the skies. Turkish Airlines' in-flight entertainment system is jam-packed with the newest movies, music, games, and more, ensuring a pleasant and enjoyable voyage for its customers. Additionally, its in-flight Wi-Fi service allows travellers 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 had 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 its unequalled route network, youthful and modern fleet, comfortable seats, and delectable food.

It travels to practically every country on the planet with enormous 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 interesting sponsorships and ads from around the world. Turkish Airlines' rising enthusiasm has won them the distinction of being the airline that travels to the majority of

the world's countries. With a youthful fleet of 373 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 its adventure on May 20, 1933, with only five planes and less than 30 people, and it has become the airline that flies to the most countries in the globe, commemorating its 87th year. Turkish Airlines' 87-year success story is distinguished by the resilience they have developed in the face of adversity.

Turkish Airlines Technic

Turkish Airlines Technic has been leading the MRO market since the year it was founded. With its strong foundations, young, innovative and determined personnel, Turkish Airlines Technic keeps growing by providing top quality MRO services to its customers.

Turkish Airlines Technic has been providing customers with rapid and dependable aircraft repair services since its establishment. The corporation is spread across two continents, with 576.000 m² of enclosed area, eight hangars, and cutting-edge technological facilities. Turkish Airlines Technic performs A, B, C, and D maintenance for all aircrafts within company capabilities, thanks 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)

Brief History of Turkish Airlines Technic

The first civil aviation institution of Turkey was established in 1933 and named as State Airlines (Devlet Havayolları). Name of the first civil aviation institution of Turkey was changed from State Airlines to Turkish Airlines in 1955. Company started aircraft maintenance operations on 1957 at Yesilkoy Facilities of the company. In 1959, then company made an agreement with Lockheed International for undertaking the maintenance operations for Turkish Air Force and foreign airline operations. In 1960, company gained the complete ability to perform maintenance, repair and revision work on piston and turboprop aircrafts by developing the capacity of its shops.

In 1963, maintenance workshops has become able to perform maintenance, repair, alteration and revisions operations on all aspects of body, engine and accessories of the aircraft. In 1973, facilities of the company has been affirmed that they comply with the international standards by achieving 820-1F numbered FAA Certificate. In 1977, first base maintenance facility has been opened to service. In 1996, the company acquired the Joint Aviation Requirements (JAR) certificate from EU Joint Aviation Authority (JAA). In 1999, second base of the company which has 13.000 m² of closed space and 67.200 m² total using area with additional building sections was opened to service.

In 2006, Turkish Airlines Technic was established with 100% of its shares belonging to Turkish Airlines. In 2010, HABOM project (Aviation Maintenance Repair and Modification Center) was brought into life and in 2014 HABOM emerged with Turkish Airlines Technic Sabiha Gökçen facilities and began its operations. HABOM project ended in 2015 and it emerged with Turkish Airlines Technic. In 2019 after Turkish Airlines relocated to Istanbul Airport, Line Maintenance Hangar of Turkish Airlines Technic was brought into the service. In 2021 CD hangar were put into the service. (Turkish Airlines Technic, 2021)

Capabilities of Turkish Airlines Technic

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

Turkish Airlines Technic also has the ability to perform major and minor modifications on aircrafts. Turkish Airlines Technic always immediately responds to requests of its customers and conduct both modification and maintenance operations rigidly. Turkish Airlines Technic is able 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.

Aircraft types found in our capability:

AIRBUS	BOEING	CESSNA	GULFSTREAM	BOMBARDIER	DIAMOND
A300	727	172/F172	G-IV	CL600	DA40
A310	737 CL-NG	510	GV-SP		DA42
A320 Family	757				
A330	767				
A340	777				

Aircraft types found in our capability:

CFMI	IAE
CFM56-5C/7B	V2500

* Within our affiliate TEC

Figure 7: Turkish Airlines Technic Capabilities; Source: (Turkish Airlines Technic, 2021)

Above Figure contains information about Turkish Airlines Technic’s maintenance capabilities on aircrafts and engine types. Turkish Airlines Technic provides both line and base maintenance with top quality. 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).

Related Studies on maintenance scheduling on maintenance costs and airline profitability

In this part of the study, previous studies about the subject takes place. In the following paragraphs, previous studies will be examined and interpreted. There are a number of studies about proactive maintenance scheduling and its benefits on maintenance costs, aircraft ground times and airline profitability.

In the study (Fedorov and Pavlyuk, 2020); it was pointed out that the maintenance costs for the aviation industry constitute a significant part of the economic expenses, and the development of data-based diagnostics, prognosis and health management techniques and increasing the efficiency of the maintenance and repair organization activity have a reducing effect on airline maintenance costs. In addition, a methodology on how to support predictive maintenance projects of a maintenance and repair organization at macro, semi-macro and micro levels was proposed in the study.

In a paper published by Arnaiz et. Al. (2010) it is stated that airlines are converting into proactive approaches in order to increase the effectiveness of the maintenance process and increase the profitability. The article describes a new proactive feature that will be introduced to today's line aircraft repair turn-around-time (TAT) procedure, 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 will be 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 the study performed 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. In the study of Senturk, methods for reducing the scheduled maintenance downtime of an aircraft are examined. In his study, he developed a more flexible structure to do it all the time it 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 labour 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 another study, airline maintenance, repair and overhaul (MRO) operations were modeled with the system dynamics approach in the light of the Turkish Airlines maintenance unit example. This model, which can offer opportunities to test the workload and fleet expansion policy alternatives of various MRO operations, has demonstrated that MRO operations have a direct impact on the number of available airworthy aircraft and available fleet seat capacity (Delen, et.al. 2017).

In a study conducted by Cömert (2010) it is studied that organizations and systems need to use their resources effectively and efficiently to meet the demands expected from them. In this context, a production facility or a system aims to fulfil its objectives, it is extremely important that it plans with maintenance activities that will ensure its activities can be continued continuously. Cömert

(2010) also indicated that, a maintenance planning model was created by using integer linear programming technique in a public enterprise where aircraft maintenance is carried out at the factory level. The model was run in the LINGO program and the results were evaluated.

In another study, it was argued that maintenance costs in airlines change over time, need more frequent and more expensive checks as the aircraft ages, and airlines show more interest in cost analysis due to increased costs. In addition, a dynamic maintenance model was developed in the study so that airlines can choose between buying new aircraft or maintaining old aircraft and determine the impact and rising costs of aging aircraft, indicating that costs and revenue will change over time as aircraft age and wear increase (Fouladi, et.al.2016).

In another study, Zorbacı (2011) carried out a research about minimizing the maintenance costs by optimizing maintenance plan. She stated that the intense preference of 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 has led to an increase in the number of flights and an increase in the need for aircraft maintenance. Considering the size of the amount paid to technicians and aircraft parts in the aircraft maintenance process, it is clear how large 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 improvement suggestions were made for the existing management system by making computer-aided application studies in the aircraft maintenance company.

In a study by Lin, et.al. (2019), a fleet maintenance decision making model based on condition-based maintenance was developed with a collaborative optimization (CO) algorithm for fatigue structures to minimize airline maintenance costs and maximize fleet availability, and the results showed that the proposed algorithm and costs were reduced.

There are also studies carried out about proactive maintenance activities. Detecting the possible defects and damages and taking proactive actions against them is a widespread method used by airlines and maintenance organizations. Korkmaz (2010) investigated a proactive maintenance method, Non-destructive Inspection Techniques, to find possible corrosion formation on aluminium structures on aircrafts. Korkmaz (2010) 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 about the issue. In the study, Uludağ (2002) set forth that proactive maintenance approaches were applied in jet engine maintenance activities in order to determine the importance of fatigue damages 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 prepared 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 aircrafts. 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. (2019) also express 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 deteriorations in the cable system and its bundles and their levels were determined, and the risks of the analyses obtained within the scope of MIL-HDBK-525 regarding the general visual inspection, detailed inspection and a combination of these, were evaluated in order to take preventive actions.

Another analogous study carried out by Alper (2000) proves the importance of aircraft maintenance planning from another point of view. He examined the case of Turkish Air Force and the maintenance plan applied to F16 aircrafts in the inventory. The effectivity of maintenance plan is examined in terms of actual conditions in the country. And effectiveness of current maintenance plan has been found inappropriate and the need for a change in the maintenance plan for country requirements is realized.

In a study conducted by Atik (2019) it was touched upon the ancillary revenues of airlines which aims to provide extra income and increase profitability. Ancillary income is described in the aviation industry as money made as part of the travel experience through sales to passengers directly or indirectly prior to, during, or after 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. Only two Turkish airlines (Turkish Airlines and Pegasus) are available to the public, these two airlines are chosen for the study.

In another study carried out by Dongling (2010), air cargo revenues are taken into consideration. As a strong source of income for airlines, importance of air cargo and revenues obtained from carrying cargo by aircrafts has been in detail examined. Integration of short-term and long-term revenue management models have also been examined and introduced to readers by Dongling (2019).

As two of the widest business models in the airline industry, sustainability of full service carriers and low cost carriers are compared by Köse (2020). Turkish Airlines and Pegasus Airlines are examined, and detailed analysis are done concerning the business model of these two airlines. In the period of 2014-2018 decisions of these two airlines are examined and interpreted in terms of sustainability.

In another study (Aksoy and Bas, 2021), 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). Two Authors carried out an empirical study of cost drivers in the U.S. airline industry. In the study it is stated that according to 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 labour hours, or machine hours, are said to yield skewed and significantly misleading cost estimates for pricing and product line choices. Baltagi, Griffin and Rich (1995) carried out a research concerning the cost drivers of airlines and methods utilized for decreasing them. Using a panel data set of airlines, this research examines cost changes in the US airline business throughout the pre- and post-deregulation era. It aims to separate cost variations caused by technological improvement, economies of scale and density, and input costs. Baltagi, Griffin and Rich also calculate and study the drivers of a purely generic indicator of 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 a research about the operating costs and capacity costs of the airlines. Using activity-based costing, this research demonstrates 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 defines each airplane's and flight's primary activity items and drivers. It also provides a case study to show how production variation, marketing variance, and predicted idle passenger capacity are calculated in the airline business. This is important information to have when buying or leasing an airplane with idle capacity. Tanner and Cook (2011) made research concerning European airline delay cost reference values. The paper of authors 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 goals of providing future airspace users with solutions that are centered on the "optimal commercial outcome." It contains thorough expense tabulations as well as instructions on how to use them. Zou and Hansen (2012) carried out a research that examines the impact of operational performance on air carrier cost structure by concerning evidence from US airlines. Authors used an aggregate, statistical cost estimating technique, the influence of operational performance on airline cost structure is empirically studied. As justifications, two separate sets of operational performance indicators are produced and used into airline cost models. Both delay and schedule buffer are key cost drivers, according to the results of modelling 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 cost savings to airlines of "perfect" operational performance using anticipated cost models, resulting in a range of \$7.1–13.5 billion for 2007. Demiral, F.G. (2006) examined an application of aircraft maintenance system development by lean thinking. The goal of the thesis written by Demiral is to show how an aircraft company utilized lean thinking concepts to boost production and cut waste. As an example of lean thinking, an existing aircraft maintenance system was analysed, new procedures were developed, and a new maintenance planning tool was offered. Despite the fact that considerable amounts of garbage have been discovered, there are several 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 (air tickets, etc.) and side (air excess luggage, meals, etc.) operations. Rival companies in the same industry intensify rivalry among clients 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 the evidence-based profit sector based on the manager's expertise rather than the highest level. In this literature, revenue management is seen, which is different from yield management. In this investigation, "document analysis" was used.

In a thesis written by Hacıoglu (2011) importance of revenue management is 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 of their ways for increasing profitability and income. Airline firms that operate in a competitive market as a result of globalization 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 in 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 firms' declining profits and revenue in a competitive environment, has become an essential system in aviation companies in Turkey, particularly at the beginning of the 1980s.

Research and Methodology

This part presents the details of a research and application conducted on Turkish Airlines Technic for the perceptual analysis of the impact of proactive maintenance scheduling on maintenance costs and airline profitability. In addition, research model, hypotheses, methodology, data collecting, analysis and necessary tests are also discussed in detail in this section. There are many concrete results that proves the benefits of proactive maintenance scheduling however it is still considered as 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 benefits and harms of proactive maintenance scheduling but also show the innovativeness level of Turkish Airlines Technic personnel about the new trends in the airline industry.

This study aims to make an analysis of the effect of proactive maintenance scheduling on maintenance costs and airline profitability on Turkish Airlines Technic staff. After analysing the effect of proactive maintenance scheduling on maintenance costs and airline profitability on Turkish Airlines Technic staff, this study is made to answer following questions:

- i. To analyse if Turkish Airlines Technic staff thinks proactive maintenance scheduling have a decreasing effect on maintenance costs.
- ii. To analyse if Turkish Airlines Technic Staff thinks proactive maintenance scheduling have an increasing effect on airline profitability.
- iii. To analyse if demographic features of Turkish Airlines Technic staff affect their opinion about the first two research questions.

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

The aim of the study is to focus on the effects of proactive maintenance scheduling on maintenance costs and airline profitability. This study includes not only the perceptive analysis of the effect of proactive maintenance scheduling on maintenance costs and airline profitability on Turkish Airlines Technic staff but also benefits of proactive maintenance scheduling to airline industry. Latest developments in the airline industry and proactive maintenance scheduling trends are also examined in this study. In other words, this study's main goal is to explore whether Turkish Airlines Technic personnel thinks proactive maintenance scheduling is beneficial for maintenance costs and airline profitability or not. Another aim of this study is to explore if demographic features of Turkish Airlines Technic staff affect their opinion about the issue. Results of questions will be examined in terms of every demographic feature of participants. And hypothesis created for determining the demographic changes will be examined in terms of two type of answers which are "Accepted" and "Refused".

Significance of the Research

As far as it is known, this study is the first in which the effect of proactive maintenance scheduling on maintenance costs and airline profitability in aviation with special reference to Turkish Airlines Technic. So for this reason, it is hoped that this research will contribute to the literature.

Research Model and Hypothesis

Research model has been created to reveal the changes of perception of Turkish Airlines Technic staff about questions regarding the effects of proactive maintenance scheduling on maintenance costs and airline profitability in terms of demographic features of the staff. Two hypothesis H1 and H2 are prepared for realising the opinion of Turkish Airline Technic staff on the subject. Remaining 16 hypothesis which are H3, H4, H5, H6, H7, H8, H9, H10, H11, H12, H13, H14, H15, H16, H17, H18 aims to show the changes according to demographic features. 12 hypothesis regarding demographic features are proved by analysing the demographic questions together with H1 and H2. The main hypotheses (H1, H2) that measures the perception covered in this study and other hypotheses related to demographic characteristics are as follows:

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

H2: Proactive aircraft maintenance scheduling 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 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 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.

Data Collecting and Analysis

In the research, questionnaire form has been preferred as the data collecting method. In the questionnaire, 10 questions regarding the effects of proactive maintenance scheduling to maintenance costs and airline profitability has been asked besides the demographic questions to the participants. Results of questionnaire have been analysed 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 assumed that the participants who were surveyed had basic competencies and that they answered the survey questions in a sincere and impartial manner.

In order to analyse the results, the Chi-Square and Fisher's Exact tests have been utilized to understand the two main hypothesis H1 and H2. After determining the results of H1 and H2 hypothesis. The frequency distributions between H1, H2 and demographic features have been examined by using the Chi-Square and Fisher's Exact tests. Both test are used for determining frequency distribution between two independent categorical variables. Fisher's Exact test is more accurate than Chi-Square test on small samples and Chi-Square test is more accurate than Fisher's Exact test. In order to get the most accurate results out of survey data, both Chi-Square and Fisher's Exact test have been used during the analysis of the results. Both results are showed in the table and results of Chi-Square test are showed with "X²" symbol and results of Fisher's Exact tests are showed with "P" symbol in the tables.

Chi-Square Test

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 (Xu, et.al. 2022). Unlike many other non-parametric and some 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. McHugh (2013) states that the A key metric to be followed by a strength meter is the Chi-square statistic. The 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.

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. 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 (Kim, 2017).

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 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. 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 5, 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 analyses 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 linear positive correlation between proactive aircraft maintenance scheduling and airline profitability. The study indicated that 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 the airline profitability as well

Findings and Discussions

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

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 below in detail.

Table 2: 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
	Postgraduate	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

According to the table above, 68,4% of participants are male and %31,6 of them are female. %1,5 of them is graduated from an elementary school, %13,5 of them is graduated from a high school, %20,3 of them have an associate degree, %43,6 have a bachelor's degree and %21,1 of them are post-graduates. %10,5 of the participants is between 18-24, %26,3 of them is between 25-35, %26,3 of them is between 36-45, %26,3 of them is between 46-55 and %10,5 of them are 55 or more.

Table 3: 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 with fleet planning	Yes	39	29,3
	No	94	70,7

Findings on the Experience of Participants

In this section, the analysis of the Experience of Participants in The Area of Maintenance as a demographic characteristics of Turkish Airlines Technic personnel covered in the study is given below in detail.

Table 4: 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 with fleet planning	Yes	39	29,3
	No	94	70,7

According to the table above, 12,8% of participants have 1 year or less experience, 19,5% of them have 2-4 years, 30,1 of them have 5-9 years, 26,3% of them have 10-15 years and 11,3% of them have 16 years or mor experience in the field of aviation. 12,8% of them are working in managerial positions (chief, manager, director), 26,3% of them are working as engineers or specialists, 30,8% of them are working as technicians, 14,3% of them are working as clerks and 15,8% of them are working as planning personnel position.

39,0% of the participants have only worked in 1 position, 31,5% of them worked in 2 positions, 14,3% of them have worked in 3 positions, 9,0% of them have worked 4 positions and 6,0% of them 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 directly involved with maintenance. In addition, and not like maintenance activities, 29,3% of the participants have taken place 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 because Turkish Airlines Technic is interested more in the maintenance part when compared with the fleet planning of aircrafts.

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 5: 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
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 as negative answers and participants are thought to disagree with the statements. The variables “I partially agree”, “I agree”, “I definitely agree” will be considered as positive answers and participants are thought to agree with the statements.

According to the table above, “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” 84,2% of the participants agreed with the statement of “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 of “Proactive aircraft maintenance scheduling makes the management of the maintenance process more efficient and reduces maintenance costs.” While 8,3% of them disagreed. 90,2% of participants agreed with the statement of “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% of them disagreed. 90,9% of participants agreed with the statement of “Proactive aircraft maintenance scheduling has the effect of reducing maintenance costs by preventing material waste during maintenance.” While other 8,1% of them disagreed. 95,5% of the participants agreed with the statement of “Proactive aircraft maintenance scheduling reduces maintenance costs by making man-hour planning more efficient.” While other 4,5% of them disagreed with the related statement.

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

In this section, the analysis of the Impact of Proactive Aircraft Maintenance Planning on Airline Profitability has been analysed below in detail.

Table 6: 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
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

According to the table above, Distribution of Data on the Impact of Proactive Aircraft Maintenance Planning on Airline Profitability” 97,5% of participants agreed with the statement of “Proactive aircraft maintenance scheduling has a positive impact on increasing airline profitability” while 2,5% of them disagreed. 91,7% of them agreed with the statement of “Proactive aircraft maintenance scheduling positively impacts airline profitability by reducing maintenance costs” while 8,2% of them disagreed. 93,2% of participants agreed with the statement of “Proactive aircraft maintenance scheduling increases airline profitability by increasing and facilitating the efficiency of fleet planning.” While 6,8% of them disagreed. 97,7% of participants agreed with the statement of “Proactive aircraft maintenance scheduling increases airline profitability by increasing and facilitating the efficiency of fleet planning.” While 2,3% of them disagreed. 94,8% of the participants thought that 9 previous questions introduced in the Table 5 “Distribution of Data on the Impact of Proactive Aircraft Maintenance Planning on Airline Profitability” and Table 6 “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” are directly related with maintenance costs and airline profitability.

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 of "Proactive Aircraft Maintenance Planning Has a Positive Effect on Increasing Airline Profitability" with Demographic Variables has been analysed below in detail.

Table 7: Comparison of Participants' Answers on the Statement of "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 column has been taken

According to the table above, no significant difference was found between the gender of the employees and the perception of the effect of proactive aircraft maintenance scheduling of them on airline profitability. ($p > 0,05$). A significant difference was found between the age of the employees and the perception of them on 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 the perception of them on effect of proactive aircraft maintenance planning on airline profitability ($p > 0,05$).

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

In this section, the analysis of the Statement of "Proactive Aircraft Maintenance Planning Has a Positive Effect on Increasing Airline Profitability" with Experience-Related Variables has been analysed below in detail.

Table 8: Comparison of Participants' Answers on the Statement of "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)	X²=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)	X²=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)	X²=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)	X²=8,12* P=0,01	
	No	11	(0,52)	2	(0,25)	23	(0,22)		
Employees' involvement in fleet planning activities	Yes	18	(0,14)	8	(0)	68	(0,65)	X²=7,01* P=0,03	
	No	3	(0,86)	0	(1)	36	(0,35)		

* Pearson Chi-Square

** Fisher's

Percentage of column have been taken

According to the table above, a significant difference was found between the experience period of the employees in the aviation sector and the perception of them on 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 on 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 an experience time of more than 16 years on the sector, fully agreed with the statement. A significant difference was found between the employees' working position and the perception of them 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. And it can also be seen that those who work in managerial positions fully agreed with the statement. Technicians are the less of those who did not agree with the statement. A significant difference was found between the number of positions participants have worked in and the perception of them on 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 on effect of proactive aircraft maintenance planning on airline profitability ($p < 0.05$). While the rate of agreement of the personnel directly involved in aircraft maintenance activities that proactive aircraft maintenance scheduling has a positive effect on airline profitability is 0.78, this ratio is 0.22 for those who are 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 participate in 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 who are not involved in fleet planning activities is 0.35.

Findings on the Statement of "Proactive aircraft maintenance planning positively affects airline profitability by reducing maintenance costs" with Demographic Variables

In this section, the analysis of the Statement of "Proactive aircraft maintenance planning positively affects airline profitability by reducing maintenance costs" With Demographic Variables has been analysed below in detail.

Table 9: Comparison of Answers of Participants on the Statement of “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)	
Education	High school or below	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 column has been taken

According to the table above, 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 ($p > 0.05$).

Findings on the Comparison of Answers of Participants on the Statement of “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 of “Proactive aircraft maintenance planning positively affects airline profitability by reducing maintenance costs.” with Experience-Related Variables has been analysed below in detail.

According to the table below, 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 experience 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 in those working in 5 positions. A significant difference was found between the participants' involvement in maintenance activities in the aviation sector and their perceptions 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 perceptions of the positive impact of proactive aircraft maintenance scheduling on airline profitability by reducing maintenance costs ($p < 0.05$).

Table 10: Comparison of Answers of Participants on the Statement of “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)	X²=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)	X²=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)	X²=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)	X²=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)	X²=5,49* P=0,01
	No	21	(0,81)	15	(0,88)	58	(0,64)	

* Pearson Chi-Square

** Fisher's

Percentage of column has been taken

Conclusions

To conclude, the conditions of airline industry are very harsh, so making profit is proportionally difficult. In this context, management of costs and decreasing the cost items stand out as important actions in airline financials. And maintenance costs indicate an important portion of total airline costs. As well as any other cost items, airlines are constantly trying to decrease the maintenance costs. As it has been stated in the above parts of the thesis, there are several factors that affect the maintenance costs. Ground times, man-hour costs, material costs are some important ones of them. In order to decrease these costs, a proper maintenance scheduling is of great importance. At this point, proactive maintenance scheduling is proved to be a beneficial method for decreasing the maintenance costs and increasing the airline profitability.

In this study, three hypotheses were created. First hypothesis measures if Turkish Airlines Technic staff think proactive maintenance scheduling is helpful for decreasing maintenance costs. Second hypothesis measures if Turkish Airlines Technic staff think proactive maintenance scheduling is helpful for increasing airline profitability. Other hypothesizes measure if perception Turkish Airlines Technic staff changes according to their demographic features and their qualifications about their jobs. In order to find out the opinion of Turkish Technic Airlines staff, a quantitative survey has been carried out on 133 personnel who are chosen from departments that actively takes place in maintenance. Results of the survey has been analysed on SPSS version 22. Chi-Square and Fisher’s methods have been utilized in order to compare two independent variables which are first two hypothesizes and demographic features. First two hypothesizes are accepted by the staff. While the demographic features like age, gender and education did not affects their perception, their qualitative features like experience, job position, their activities in aviation affected the results of the hypothesizes.

According to the findings, there is a substantial link between maintenance schedule and maintenance expenses. According to the findings, proactive maintenance scheduling has a significant impact on maintenance expenses. At this point, it was also discovered that taking a proactive approach to maintenance scheduling and planning helps to reduce maintenance expenditures. Furthermore, the study found that proactive aircraft maintenance scheduling has a beneficial impact on airline profitability. In other words, proactive maintenance scheduling has and increasing effect on airline profitability (Aksoy and Okan (2021).

This study revealed that proactive aircraft maintenance scheduling has become a must for airlines that aims to decrease their maintenance costs and increase airline profitability. It has been proven that proactive aircraft maintenance scheduling contributes to decreasing maintenance costs and increasing airline profitability in a number of important contexts. Decreasing the ground time, man-hour spent for the maintenance, material spent for the maintenance are some important of them. On the other hand, it has also been proven that proactive maintenance scheduling makes the management of maintenance process more effective. When all things

are considered, and previous studies are examined, many successful airlines and maintenance organizations are utilizing proactive maintenance scheduling very effectively. As UKEssays (2020) states Lufthansa Technik provides airlines with excellent maintenance planning, shops for maintenance execution, and management techniques for properly operating an aircraft. The management technique offered by Lufthansa integrates several maintenance activities that can consolidate and centralize asset management tool.

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