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FINANCIAL IMPACT OF IMPLEMENTATION ARTIFICIAL INTELLIGENCE AND NEW TECHNOLOGIES IN THE AVIATION INDUSTRY A CASE STUDY OF THE TURKISH AIRLINES

Summary

Purpose: Artificial Intelligence (AI) has long been a focal point of discussions and research within the technological realm, with many heralding it as the future of computer science. At its core, AI represents a form of computer programming that grants machines the ability to "learn," thereby enabling them to execute tasks that would otherwise pose significant challenges or even be impossible for humans to undertake. Artificial Intelligence and new technologies have been a topic of fascination and research for decades, changing the way industries operate by allowing machines to learn, adapt, and perform tasks that once required human intelligence.

In light of the evolving perceptions of new technologies and the implications of automation and robotisation in various areas of the company, including the pursuit of enhancement or, where feasible, comprehensive transformation and interchangeability of relevant processes, a comprehensive research study was conducted into the projects implemented in the aviation sector by Turkish Airlines and their impact on the entity's financial results.

Running an airline today is about more than flying passengers from one place to another. Behind every flight lies a series of financial decisions shaped by rising fuel costs, unpredictable demand, and strong global competition. In this challenging environment, Turkish Airlines looks for smart ways to cut spending, improve operations, and grow revenue. Over the past few years, the airline has introduced new technologies to stay efficient and competitive. From smarter ticket pricing and better route planning to automated maintenance checks and streamlined staffing, these tools help the company save money and work more effectively. Additionally it makes companies easier to react quickly to changes in the market.

The aim of this article is to explore and analyse how the aviation sector as exemplified by Turkish Airlines used technology to improve its financial performance. The period taken for analysis is between the year 2020 and 2022. Based on financial figures from financial reports and practical examples of AI employment, it shows how digital solutions helped the airline recover after the pandemic period and strengthen its position in the aviation sector.

Methodology: This study applies a mixed-method case study approach to examine how AI and selected digital technologies reported by Turkish Airlines align with changes in financial performance over 2020–2022. The design combines quantitative financial statement analysis and qualitative content analysis of publicly available company disclosures describing technology initiatives.



Financial information was collected from Turkish Airlines' publicly available annual reports and/or audited financial statements for the fiscal years 2020, 2021 and 2022. The following statements were used where available: statement of financial position, statement of profit or loss and other comprehensive income, statement of cash flows, and notes to the financial statements. Values were extracted directly from the published documents and used consistently across years. Evidence on AI and digital technology implementation was collected from publicly available Turkish Airlines materials that describe digital transformation projects, including annual report narrative sections, investor presentations, strategy and sustainability documents, and official company communications. Only sources explicitly referring to technology deployment (e.g., AI, machine learning, advanced analytics, automation, digital platforms) and clearly attributable to Turkish Airlines were included.

The analysis period (2020–2022) includes pandemic disruption and recovery, as well as external drivers such as fuel price movements and foreign exchange effects. Therefore, the study does not claim causal attribution of financial outcomes to AI adoption. Instead, it provides an evidence-based assessment of alignment between reported AI-enabled initiatives and observed changes in financial indicators, with alternative explanations explicitly considered in the discussion. To evaluate Turkish Airlines' financial performance for years 2020–2022, the study uses trend analysis and selected financial ratios grouped into four categories. Ratios including profitability ratios, liquidity ratios, leverage ratios, efficiency ratios were calculated consistently across the three years using figures from the published financial statements¹.

Conclusions: This paper contributes to three strands of the research. First, it contributes to the literature on the impact of artificial intelligence enabled technologies on economic decision making, particularly on their potential to reduce expenditures and by this the improvement of financial situation of the entity. Second, this study contributes to research pertaining the general effect of usage of AI tools on the processes involved in airport services, customer satisfaction, their behaviour connected with that. Third, the paper analysis the financial impact of implementation of AI and new technologies on the examined entity within the tangible recommendation for the further development. Investment in AI technologies is becoming a key element of survival strategies in an air travel market that is becoming increasingly competitive.

Implications: AI mechanisms can be implemented in various aspects of aviation, including flight control, route planning, as well as in the design phase and to ensure an appropriate level of service. Consequently, companies that successfully implement it in their products (both physical and service-related) will gain a significant competitive advantage. The implementation of artificial intelligence will facilitate the overcoming of the limitations associated with the shortage of aviation personnel, whilst optimising aircraft construction to increase transport efficiency. This will result in reduced costs for the industry as a whole. Furthermore, the company is committed to reducing its emissions of substances that are harmful to the environment.

¹ Ratios were excluded where the required components were not disclosed consistently across all three years.

Originality/contributions: Emphasis was placed on the influence and benefits resulting from implementation of AI tools, solutions, and principles in the aviation sector, outlining the importance of activities undertaken in this area in order to improve the financial stability of the company after the consequences caused by Covid-19 outbreak. Among adopted tools and individual elements of new technologies contributed to the business, the level of cost and the financial profitability was examined and analysed.

Keywords: Artificial intelligence, new technology, financial performance, cost savings, revenue growth, digital transformation, aviation industry, AI-driven decision-making, efficiency, profitability, automation.

ANALIZA FINANSOWEGO WPŁYWU WDROŻENIA SZTUCZNEJ INTELEGENCJI I NOWYCH TECHNOLOGII W SEKTORZE LOTNICZYM NA PRZYKŁADZIE TURECKICH LINII LOTNICZYCH

Streszczenie

Cele: Sztuczna inteligencja (AI) od dawna stanowi główny przedmiot dyskusji i badań w dziedzinie technologii, a wielu uznaje ją za przyszłość informatyki. W swej istocie sztuczna inteligencja to forma programowania komputerowego, która nadaje maszynom zdolność „uczenia się”, umożliwiając im tym samym wykonywanie zadań, które w innym przypadku stanowiłyby dla ludzi poważne wyzwanie, a nawet byłyby niemożliwe do zrealizowania. Sztuczna inteligencja (AI) i nowe technologie od dziesięcioleci są przedmiotem fascynacji i badań, zmieniając sposób funkcjonowania branż poprzez umożliwienie maszynom uczenia się, dostosowywania się i wykonywania zadań, które kiedyś wymagały ludzkiej inteligencji.

W świetle zmieniających się postrzegania nowych technologii oraz implikacji automatyzacji i robotyzacji w różnych obszarach działalności przedsiębiorstwa, w tym dążenia do usprawnienia lub, tam gdzie to możliwe, kompleksowej transformacji i zamienności odpowiednich procesów, przeprowadzono kompleksowe badanie dotyczące projektów wdrożonych w sektorze lotniczym przez Turkish Airlines oraz ich wpływu na wyniki finansowe podmiotu.

Prowadzenie linii lotniczej to dziś coś więcej niż tylko przewożenie pasażerów z jednego miejsca do drugiego. Za każdym lotem kryje się szereg decyzji finansowych, na które wpływają rosnące koszty paliwa, nieprzewidywalny popyt oraz silna globalna konkurencja. W tym wymagającym otoczeniu Turkish Airlines poszukuje inteligentnych sposobów na ograniczenie wydatków, usprawnienie działalności operacyjnej i zwiększenie przychodów. W ciągu ostatnich kilku lat linia lotnicza wprowadziła nowe technologie, aby zachować wydajność i konkurencyjność. Od inteligentniejszego ustalania cen biletów i lepszego planowania tras po zautomatyzowane kontrole konserwacyjne i usprawnione zarządzanie personelem – narzędzia te pomagają firmie oszczędzać pieniądze i pracować efektywniej. Ponadto ułatwiają one firmom szybkie reagowanie na zmiany na rynku.

Celem niniejszego artykułu jest zbadanie i analiza sposobu, w jaki sektor lotniczy, którego przykładem są Turkish Airlines, wykorzystał technologię do poprawy wyników finansowych. Okres objęty analizą to lata 2020–2022. Na podstawie danych finansowych pochodzących ze sprawozdań finansowych oraz praktycznych przykładów zastosowania sztucznej inteligencji pokazano, w jaki sposób rozwiązania cyfrowe pomogły linii lotniczej w odbudowie po okresie pandemii oraz umocnieniu jej pozycji w sektorze lotniczym.

Metodologia: W niniejszym badaniu zastosowano podejście oparte na studium przypadku z wykorzystaniem metod mieszanych w celu zbadania, w jaki sposób sztuczna inteligencja i wybrane technologie cyfrowe, o których informuje linia Turkish Airlines, korelują ze zmianami wyników finansowych w latach 2020–2022. Projekt badania łączy (i) ilościową analizę sprawozdań finansowych oraz (ii) jakościową analizę treści publicznie dostępnych informacji ujawnionych przez spółkę, opisujących inicjatywy technologiczne.

Informacje finansowe zebrano z publicznie dostępnych raportów rocznych Turkish Airlines i zbadanych sprawozdań finansowych za lata obrotowe 2020, 2021 i 2022. Wykorzystano następujące sprawozdania, o ile były dostępne: sprawozdanie z sytuacji finansowej, sprawozdanie z zysków lub strat oraz innych całkowitych dochodów, sprawozdanie z przepływów pieniężnych oraz informacje dodatkowe do sprawozdania finansowego. Wartości zostały zaczerpnięte bezpośrednio z opublikowanych dokumentów i stosowane spójnie w poszczególnych latach. Dowody dotyczące wdrażania sztucznej inteligencji i technologii cyfrowych zebrano z publicznie dostępnych materiałów Turkish Airlines opisujących projekty transformacji cyfrowej, w tym z części opisowych raportów rocznych, prezentacji dla inwestorów, dokumentów dotyczących strategii i zrównoważonego rozwoju oraz oficjalnych komunikatów firmy. Uwzględniono wyłącznie źródła wyraźnie odnoszące się do wdrażania technologii (np. sztucznej inteligencji, uczenia maszynowego, zaawansowanej analityki, automatyzacji, platform cyfrowych) i jednoznacznie przypisane Turkish Airlines.

Okres analizy (2020–2022) obejmuje zakłócenia spowodowane pandemią i proces ożywienia gospodarczego, a także czynniki zewnętrzne, takie jak wahania cen paliwa i wpływ kursów walutowych. W związku z tym w badaniu nie wysuwa się twierdzenia o przyczynowym związku wyników finansowych z wdrożeniem sztucznej inteligencji. Zamiast tego przedstawiono opartą na dowodach ocenę zgodności między zgłoszonymi inicjatywami opartymi na sztucznej inteligencji a zaobserwowanymi zmianami wskaźników finansowych, przy czym w dyskusji wyraźnie uwzględniono alternatywne wyjaśnienia.

W celu oceny wyników finansowych Turkish Airlines za lata 2020–2022 w badaniu wykorzystano analizę trendów oraz wybrane wskaźniki finansowe pogrupowane w czterech kategoriach. Wskaźniki, w tym wskaźniki rentowności, płynności, dźwigni finansowej i efektywności, zostały obliczone spójnie dla wszystkich trzech lat na podstawie danych pochodzących z opublikowanych sprawozdań finansowych.

Wnioski: Niniejszy artykuł wnosi wkład w trzy obszary badań. Po pierwsze, stanowi uzupełnienie literatury dotyczącej wpływu technologii opartych na sztucznej inteligencji na podejmowanie decyzji ekonomicznych, w szczególności ich potencjału w zakresie redukcji wydatków, a tym samym poprawy sytuacji finansowej podmiotu.

Po drugie, niniejsze badanie stanowi wkład w badania dotyczące ogólnego wpływu wykorzystania narzędzi AI na procesy związane z usługami lotniskowymi, satysfakcją klientów i związane z tym zachowania.

Po trzecie, w niniejszej pracy przeanalizowano również wyniki finansowe badanego podmiotu w ramach konkretnych zaleceń dotyczących dalszego rozwoju. W artykule podkreśla się, iż inwestycje w technologie AI stają się kluczowym elementem strategii przetrwania na coraz bardziej konkurencyjnym rynku podróży lotniczych.

Implikacje: Mechanizmy sztucznej inteligencji mogą być wdrażane w różnych aspektach lotnictwa, w tym w kontroli lotów, planowaniu tras, a także w fazie projektowania i w celu zapewnienia odpowiedniego poziomu usług. W rezultacie, firmy, które z powodzeniem wdrożą je w swoich produktach (zarówno fizycznych, jak i związanych z usługami), uzyskają znaczną przewagę konkurencyjną. Wdrożenie sztucznej inteligencji ułatwi pokonanie ograniczeń związanych z niedoborem personelu lotniczego, jednocześnie optymalizując konstrukcję samolotów w celu zwiększenia efektywności transportu. Spowoduje to obniżenie kosztów dla całej branży. Ponadto firma jest zaangażowana w redukcję emisji substancji szkodliwych dla środowiska.

Oryginalność/wkład: W niniejszym artykule zaprezentowano wpływ i korzyści wynikające z wdrożenia narzędzi, rozwiązań i zasad sztucznej inteligencji w sektorze lotniczym, podkreślając znaczenie działań podejmowanych w tym obszarze w celu poprawy stabilności finansowej przedsiębiorstwa po skutkach wywołanych przez pandemię Covid-19. Wśród przyjętych narzędzi i poszczególnych elementów nowych technologii, które przyczyniły się do rozwoju działalności, zbadano i przeanalizowano poziom kosztów i rentowność finansową.

Słowa kluczowe: sztuczna inteligencja, nowe technologie, wyniki finansowe, oszczędności kosztów, wzrost przychodów, transformacja cyfrowa, przemysł lotniczy, podejmowanie decyzji oparte na sztucznej inteligencji, wydajność, rentowność, automatyzacja.

Introduction

Airlines operate in an environment where financial performance is strongly driven by volatile demand, fuel prices, operational disruptions, and intense competition. In such conditions, digital technologies and artificial intelligence (AI) are increasingly used to improve decision-making in areas that directly affect revenues and costs, including revenue management, route and fuel optimisation, predictive maintenance, and selected automation in customer service and internal processes.

Turkish Airlines has positioned itself as a digital leader in aviation through Turkish Technology (its IT and innovation subsidiary with over 1,500 employees). The carrier has been executing an ambitious strategy to rank among the world's top three airlines for digital passenger experience, driven by a mature AI infrastructure, cross-functional adoption, and measurable business impact. For Turkish Airlines, these tools are presented as part of broader digital transformation

efforts aimed at improving efficiency and strengthening competitiveness, particularly during the post-pandemic recovery period.

Academic and industry discussions on AI adoption in aviation often describe potential operational benefits, linking technology initiatives to financial performance indicators remains fragmented. In addition, the years 2020–2022 represent an unusual context: results are influenced not only by managerial actions and technology investment, but also by pandemic-related shocks and subsequent market recovery. This creates a need for transparent, evidence-based analysis that connects reported technology initiatives to observable financial outcomes, while explicitly acknowledging the limits of causal inference.

The purpose of this article is to evaluate how the implementation of AI and selected new technologies at Turkish Airlines is associated with changes in the company's financial performance over 2020–2022. The analysis addresses the following important research questions:

RQ1: Which AI-enabled initiatives reported by Turkish Airlines during 2020–2022 relate most directly to key revenue and cost drivers (e.g., pricing, fuel, maintenance, labour/process efficiency)?

RQ2: How did Turkish Airlines' financial performance evolve in 2020–2022, as reflected in trend analysis and key financial ratios (profitability, liquidity, leverage and efficiency)?

RQ3: What plausible mechanisms link the reported technology initiatives to the observed financial trends, considering major external factors (demand recovery, fuel prices and foreign exchange movements)?

To answer these questions, the study uses a mixed-method design. First, it applies quantitative analysis based on publicly available financial statements of Turkish Airlines for 2020–2022, including ratio and trend analysis to capture changes in financial condition over time. Second, it uses qualitative content analysis of company disclosures and publicly available materials (e.g., strategy presentations and related documents) to identify technology initiatives and map them to expected financial channels (revenue enhancement, cost reduction, or risk/efficiency improvements). Due to the presence of strong external drivers in the analysed period, the article does not claim strict causality; instead, it evaluates alignment between the initiatives and observed financial outcomes.

The article is divided into five sections. The first section is intended to provide a comprehensive overview of the origin and definition of artificial intelligence and the new technologies that are currently in development. The second section provides an overview of the relationship between AI and emerging technologies in law. In third section a comprehensive overview of publications pertaining to the intersection of artificial intelligence and emerging technologies, drawing from an array of academic and industry research was delivered. Section four of this paper provides an overview of areas in which artificial intelligence and

associated technologies had been implemented within the business sector in the analysed period. The last part of this paper sets out to examine the impact of artificial intelligence and emerging technologies on the company's financial results and market position, with particular reference to Türk Hava Yollari.

1. Origin and definition of artificial intelligence and new technologies

Artificial Intelligence has been a topic of fascination and research for decades, changing the way industries operate by allowing machines to learn, adapt, and perform tasks that once required human intelligence. While the idea of intelligent machines dates back to ancient history, AI began in 1956 when John McCarthy coined the term. AI is perceived as an 'approach' to solving complex and complicated problems, logical reasoning and inference identical to that which occurs in human brains². Nevertheless, it showed more the purpose and direction of scientific research in this area than actual applications³. Robert J. Schalkoff, a professor at the University of Virginia in the United States, presented AI as one of the methods of solving problems, proposing that computer programmes be used for activities modelled on natural behaviours and cognitive processes found in humans⁴. Whereas, Jack Copeland described artificial intelligence as the ability of a digital computer or computer-controlled robot to perform tasks usually associated with intelligent beings⁵.

All of the definitions proposed by various scientists, describe this concept in different ways, but these definitions have something in common. AI has been reduced each time to a computer programme or a machine that functions under the control of a computer programme. When exploring the common part, one of its key elements should be highlighted, namely the implementation of functionalities that are characteristic of humans. In particular, attention has been paid to processes that are characteristic of humans. When exploring the common ground, it is important to highlight one of its key elements, which is the implementation of functionalities that are characteristic of humans. In particular, attention has been paid to cognitive processes, logical reasoning, inference identical to that which occurs in human brains, and, to a large extent, the workings of the mind. Since that time also, AI has evolved from a theoretical concept into a

² Artificial intelligence is perceived as an 'approach' to solving complex and complicated problems, logical reasoning and inference identical to that which occurs in human brains. McCarthy J., *What is Artificial Intelligence?*, 2007, p. 2, jmc.stanford.edu/articles/whatisai/whatisai.pdf

³ Warszycki M., *Wykorzystanie sztucznej inteligencji do predykcji emocji konsumentów*, Studia i prace Kolegium Zarządzania i Finansów Szkoły Głównej Handlowej w Warszawie 2019, nr 173, s. 111–121.

⁴ Schalkoff R.J., *Artificial Intelligence: An Engineering Approach*, McGraw-Hill Education, USA, 1990, p. 2.

⁵ <https://www.britannica.com/technology/artificial-intelligence>, [accessed: 23.08.2025].

powerful tool that influences business, healthcare, aviation, finance, and other industries⁶.

AI can be classified into weak AI - designed for specific tasks like virtual assistants (Siri, Alexa) and strong AI, which aims to mimic human reasoning, such as self-driving cars. AI, in essence, involves the emulation of human intelligence through software-coded methods. Its classification spans a spectrum, ranging from analytical AI, which focuses on data analysis and logical reasoning, to human-inspired AI, which draws from human cognitive processes and problem-solving strategies. Additionally, there is humanized AI, which endeavours to imbue machines with social intelligence and emotional understanding, fostering interaction and empathy akin to human behaviour. However, AI is not just about humanoid robots; it is embedded in everyday technology, optimizing banking systems, medical diagnostics, cybersecurity, and even air travel operations⁷.

Artificial intelligence in this article is understood in a practical, business-oriented way: as data-driven computational techniques- most commonly machine learning and advanced analytics- that enable systems to learn from data and support or automate decision-making. The paper does not rely on broad historical narratives or philosophical definitions of “human-like intelligence”; instead, it focuses on AI as embedded functionality within operational and commercial processes. In the aviation context, AI-enabled tools are typically applied where decisions have direct financial consequences, including revenue management and dynamic pricing, demand forecasting, route and fuel optimisation, predictive maintenance, and selected automation of customer service and internal workflows.

From a financial perspective, these applications can affect performance through three main channels:

- revenue enhancement (e.g., improved yield and load optimisation),
- cost reduction (e.g., fuel efficiency and reduced unscheduled maintenance),
- operational efficiency (e.g., faster processes and lower disruption-related costs).

This definition provides the analytical lens used in the subsequent sections, where reported initiatives at Turkish Airlines are mapped to observable financial trends for 2020–2022.

2. AI and new technologies in law - review

Artificial intelligence and emerging technologies in aviation including autonomous systems, electric vertical takeoff and landing aircraft, advanced air mobility and unmanned aircraft systems (drones) are transitioning from pilots and

⁶ <https://medium.datadriveninvestor.com/artificial-intelligence-and-autonomous-vehicles-ae877feb6cd2> [accessed: 23.05.2023].

⁷ <https://www.brookings.edu/research/how-artificial-intelligence-is-transforming-the-world/> [accessed: 25.05.2023].

research to operational integration in aviation. Key areas of AI application in aviation from financial aspect include also flight operations, aviation safety management systems and aircraft maintenance, safety risk management, cybersecurity, and airline revenue management. The utilisation of AI services within the aviation industry is demonstrating a consistent and gradual increase in both popularity and application. Nevertheless, the repercussions of such actions extend beyond the present state of legal regulations⁸. That is why, the regulators worldwide are shifting from reactive policy to proactive frameworks focused on safety assurance, trustworthiness, and human-centric design. Adoption is accelerating in predictive maintenance, air traffic management, flight operations support, and regulatory oversight itself, but certification, liability allocation, and harmonization remain the core legal hurdles. Moreover, aviation regulators are developing AI-specific assurance methods that adapt traditional certification (deterministic, rule-based) to probabilistic ML systems. The focus is on traceability, bias mitigation, human factors, and resilience. However, the research covers the past period of the year 2020–2022, at the moment of publication of this article the law is still not fully implemented and required from institutions.

Globally, there are very distinctive discrepancies in the legislative dynamics on this issue – especially between EU countries, leading Asian countries or the United States. Establishing an effective and genuinely rights-protecting framework for the use of AI and NT, it's imperative to incorporate various safeguards. Firstly, it should unequivocally prohibit the deployment of technologies that infringe upon fundamental rights. Clear regulations should mandate what information companies must disclose regarding their products and technologies. This entails providing comprehensive details about the systems they utilize, including the data employed, development strategies, system purposes, and the conditions and entities involved in their utilization. Transparency is paramount, ensuring that individuals exposed to AI are fully informed. Systems with significant potential impact on people's lives should undergo additional auditing and be catalogued in a publicly accessible database. This would facilitate monitoring and verification of compliance with rights and freedoms by companies and government entities. Crucially, mechanisms must be in place to enable swift responses from consumer protection entities in the event of problems or infringements. Regulatory oversight is essential to ensure adherence to rules, necessitating the establishment of an independent authority equipped with adequate resources and authority. Furthermore, regulations should incorporate safeguards to shield the most vulnerable individuals. A redress mechanism should be established to enable those harmed by AI systems to lodge complaints and receive compensation for damages incurred. Additionally, employees must have the right to address invasive AI systems used by their employers without fear of reprisal. These

⁸ Dzido H., *Krajobraz wyzwań i możliwości sztucznej inteligencji w lotnictwie cywilnym*, „Przegląd Komunikacyjny”, Stowarzyszenie Inżynierów i Techników Komunikacji Rzeczpospolitej Polskiej 2024, 79(12), p. 9–12.

measures collectively constitute a robust framework for safeguarding rights and promoting ethical use of AI and new technologies.

As AI continues to evolve, its legal and regulatory challenges have come into focus. Governments and institutions have been working to find the right balance between innovation and responsibility. The European Union is at the forefront of legislation on AI and new technologies. In its latest 2022 EU Artificial Intelligence Act, it requires AI-generated content to be published to prevent copyright infringement and illegal content and abuse⁹. It sets transparency requirements and classifies AI applications into four risk categories – minimal, limited, high, and unacceptable risk – in the so-called pyramid¹⁰. The EU's GDPR is the cornerstone of the data privacy framework, significantly impacting artificial intelligence systems that process personal data. By the comprehensive and precautionary approach EU aims to ensure the ethical development of artificial intelligence and protect fundamental rights¹¹.

The UK government has taken a different approach to the EU, using its existing resources. In a 2023 White Paper from the Department for Science, Innovation and Technology, the UK government indicates that the courts are already addressing some of the emerging risks posed by AI technologies¹².

In the United States, enforcement of regulations related to artificial intelligence is more fragmented, with multiple agencies having jurisdiction over different aspects of AI applications. The less restrictive regulatory environment in the United States aims to stimulate rapid innovation and commercialisation of AI technologies. By reducing regulatory barriers, the United States seeks to maintain its leadership position in AI research and industry¹³.

The introduction of the AI Act is a groundbreaking step towards the responsible and ethical development of technology, which Poland has also been preparing to

⁹ <https://www.reuters.com/technology/money-mimicry-mind-control-big-tech-slams-ethics-brakes-ai-2021-09-08/> [accessed: 12.08.2025].

¹⁰ Art. 16. of *Council of the European Union, Proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on artificial intelligence* (Artificial Intelligence Act) and amending certain Union legislative acts – General approach SWD(2021) 206 final (21.04.2021).

¹¹ *Regulating Facial Recognition under the GDPR*, Council of the European Union, Union legislative acts 2021, s. 30.

¹² The UK government has set out five principles which will apply to AI lifecycle:

- Ensure that AI is used safely,
- Ensure that AI is technically secure and functions as designed,
- Make sure that AI is appropriately transparent and explainable,
- Embed considerations of fairness into AI,
- Define legal persons' responsibility for AI governance.

<https://www.gov.uk/government/publications/ai-regulation-a-pro-innovation-approach/white-paper> [accessed: 12.08.2025].

¹³ *Leadership in AI*, Narodowy Instytut Standardów i Technologii, U.S., Publikacje NIST, 2021, s. 10.

implement. In the European Union, the AI Act (Regulation (EU) 2024/1689¹⁴) is in phased rollout. It entered into force in August 2024 and becomes fully applicable on 2 August 2026 (with some provisions staggered to 2027). High-risk AI systems – relevant to legal practice – include tools used in justice administration (preparing court rulings), law enforcement (evidence evaluation), employment (CV screening), and access to essential services (credit scoring). These trigger obligations for risk assessment, high-quality datasets, logging, human oversight, transparency, and post-market monitoring to protect fundamental rights and minimize bias. Transparency rules (labeling AI-generated content and deep-fakes) also apply from August 2026. Poland has not yet adopted the implementing act as the implementation of AI tools has not been attracting the market as it could have been expected¹⁵. The draft is still in the preparatory stage and, as of July 2025, has not been formally submitted to parliament. This means that there is a real risk that the national AI supervision system will not be fully operational before the key provisions of the AI Act come into force¹⁶.

Contrary to this attitude, China's regulatory framework aims to balance innovation with control, ensuring that AI technologies contribute to economic development while maintaining strict oversight to prevent misuse of data. This centralised and interventionist approach contrasts sharply with the more flexible and market-oriented strategies seen in other regions, such as Japan¹⁷.

¹⁴ Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act).

¹⁵ AI adoption in Polish enterprises is characterized by a "lagging-but-catching-up" dynamic. While strict Eurostat metrics place Poland near the bottom of the EU, independent industry reports suggest a much faster, grassroots adoption rate, particularly regarding generative AI and operational integration. Eurostat data indicated only 5.9% of Polish firms (with 10+ employees) were using AI in 2024, placing it behind the EU average. However, specialized surveys revealed that up to 30% of companies had integrated AI by late 2024.

AI adoption in Poland grew by 36% over the past year. [https://www.aboutamazon.eu/news/empowering-small-business/ai-adoption-in-poland-grew-by-36-over-the-past-year#:~:text=The%20economic%20implications%20of%20Poland's%20accelerated%20AI,an%20additional%20%E2%82%AC134%20billion%20\(576%20billion%20Polish](https://www.aboutamazon.eu/news/empowering-small-business/ai-adoption-in-poland-grew-by-36-over-the-past-year#:~:text=The%20economic%20implications%20of%20Poland's%20accelerated%20AI,an%20additional%20%E2%82%AC134%20billion%20(576%20billion%20Polish) [accessed: 08.07.2025].

¹⁶ The provisions of the AI Act has come into force in their entirety 24 months after its publication, but some of the provisions are being implemented gradually and cover implementation periods of 6, 12 and 36 months respectively.

¹⁷ Snażyk T., *Chińskie podejście do regulacji AI charakteryzuje się kompleksowymi i scentralizowanymi ramami mającymi na celu zapewnienie zarówno szybkiego postępu technologicznego, jak i rygorystycznego nadzoru*, „Asia Society” 2024, <https://asiasociety.org>; Bird & Bird, 2024, <https://www.twobirds.com>, [accessed: 08.07.2025].

Japan adopts a 'soft law' approach, promoting industry self-regulation and efficient management¹⁸. Japan does not have overarching legislation on artificial intelligence, but sector-specific legislation such as the Digital Platform Transparency Act and the Financial Instruments and Exchange Act impose transparency and risk management requirements on AI applications on digital platforms and financial markets¹⁹.

As the subject of this part of article is related to Turkish company, is important to describe how new technologies and AI are regulated by law in Türkiye. Artificial intelligence is currently not regulated by Turkish law; but when AI issues arise, existing laws are applied by analogy. The official general program was not implemented in past. The law had no official regulations. The National AI Strategy of Turkey (2021–2025) aims to support research and governance, with plans to create an Artificial Intelligence Institute under TÜBİTAK to guide AI's development responsibly²⁰.

3. Overview of publications on AI and new technologies research

Research activity is a pivotal factor in determining the trajectory of artificial intelligence development. It is imperative to comprehend the rate of acceleration in the domain of AI research to facilitate the development of effective strategic interventions and governance decisions, particularly in light of the observed disparities in growth rates among pivotal stakeholders.

A comparison of the artificial intelligence research efforts of the United States and China is of particular importance, as these two nations are at the vanguard of global artificial intelligence advancement. The relative dominance in the development of artificial intelligence among these nations has implications for the future governance and global risk. While the United States has historically dominated in terms of private investment and the establishment of new start-ups, China has recently emerged as a significant contender in the field of artificial intelligence research, as evidenced by its prolific output of scholarly publications in the area.

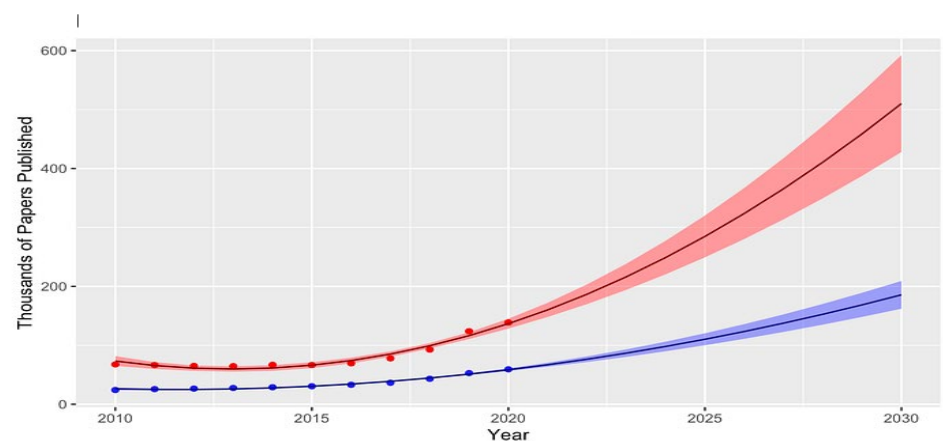
¹⁸ Snażyk T., *Japonia przyjmuje podejście „miękkiego prawa”, promując samoregulację branży i sprawne zarządzanie*, Ministerstwo Gospodarki, Handlu i Przemysłu (METI) opracowało kompleksowe wytyczne, które odzwierciedlają zaangażowanie Japonii w sztuczną inteligencję zorientowaną na człowieka i zasady etyczne, Gamma Law, <https://gammalaw.com/japans-new-ai-guidelines>, [accessed: 08.06.2025].

¹⁹ *Wytyczne dotyczące zarządzania wdrażaniem zasad sztucznej inteligencji*, Ministerstwo Gospodarki, Handlu i Przemysłu (METI) 2021; Rząd Japonii, Ustawa o przejrzystości platform cyfrowych oraz ustawa o instrumentach finansowych i giełdzie, 2021.

²⁰ Report: *Sizing the Prize: What's the Real Value of AI for Your Business and How Can You Capitalise?*, PriceWaterhouseCoopers, 2017, p. 7–11.

Figure 1 presents the total number of AI publications for each country (China and United States) during the 11-year period from 2010–2020, and extrapolates this trend to 2030²¹.

Figure 1. Comparative quantitative analysis of publications on artificial intelligence and new technologies researches in the United States and China



Source: Weed T., *The Number of AI Research Publications is Accelerating Faster in China than the U.S.*, <https://becominghuman.ai/the-number-of-ai-research-publications-is-accelerating-faster-in-china-than-the-u-s-2a1cb609f326> [accessed: 26.08.2025].

According to the research China has been publishing significantly more AI-related papers than the US since 2010. This probably doesn't indicate more actual AI research productivity in China since 2010, since the most major advances during that time occurred in the US. Moreover AI-related publication is accelerating faster in China than in the US, which could indicate that China is pulling ahead in underlying research activity, despite lower levels of private investment. Presumably, this would eventually translate to China outstripping the US in actual research productivity, and Chinese actors developing the most powerful models in the world.

In numbers, from 2010 to 2021, the highest number of papers related to artificial intelligence in the sciences and technologies were authored by researchers from China (257,000), the United States (140,000), and India (105,000). Papers by researchers from these countries accounted for a total of 45% of global publications in this field. A total of ten countries were responsible for the highest number of publications during the period 2010–2021. Among these ten countries,

²¹ Weed T., *The Number of AI Research Publications is Accelerating Faster in China than the U.S.*, 2022, <https://becominghuman.ai/the-number-of-ai-research-publications-is-accelerating-faster-in-china-than-the-u-s-2a1cb609f326> [accessed: 26.08.2025].

two were European Union countries. Germany and France have been identified as having approximately 37,000 and 29,000 publications, respectively.

196,141 scientific papers on AI were published between 2010 and 2021 in science and technology by researchers from the European Union, accounting for 21% of global publications in this field. Germany, France, Italy and Spain were the EU27 countries that produced the highest number of publications on AI in science and technology between 2010 and 2021. Researchers from these four countries were responsible for 36,900, 28,600, 27,900 and 26,600 publications respectively. Poland was also among the top five leaders (almost 14,000 publications), followed by the Netherlands (10,800). At the other end of the spectrum, with the lowest total number of publications (less than 1,000) in the EU27 group, were countries with relatively small populations: The following countries were ranked 288th, 616th, 804th and 914th: Malta, Latvia, Estonia and Luxembourg respectively²².

Between 2010 and 2021, a total of nearly 14,000 publications in science and technology related to AI were identified. These publications were written by scientists affiliated with institutions in Poland. These works accounted for 7.2% of EU publications and 1.2% of global publications in this field during this period. This activity resulted in Poland ranking 5th and 19th in the EU and globally, respectively, for the total number of scientific papers on AI in science and technology published between 2010 and 2021²³.

As far as the research publications on AI and emerging technologies in the aircraft sector are concerned, its number has surged dramatically, reflecting the technology's transition from experimental pilots to lifecycle-wide integration. Pavlyuk D. presents in his paper a systematic literature review of AI technologies in aircraft maintenance, highlighting its challenges and prospects. An extensive literature search resulted in a final dataset of 696 publications, covering the 40-years period from 1984 till 2024 and describing AI applications in airworthiness management, aircraft health monitoring, and maintenance, repair, and overhaul operations. These publications were analysed to identify key AI technologies and related aircraft maintenance processes, identifying trends, popular research venues, and underexplored areas²⁴.

According to research on publications on IA in aviation, the scientists Victor E. Morales, Jose Sanchez, Jonathan Escalera, Vivek Sharma, Brooke E. Wheeler,

²² Raport, *Sztuczna inteligencja: osiągnięcia publikacyjne z zakresu nauk ścisłych w latach 2010–2021*, Ośrodek Przetwarzania Informacji Państwowy Instytut Badawczy, MEN, 2023, p. 15–17.

²³ Raport, *Stan badań and sztuczną inteligencją w Polsce. Rozwój sztucznej inteligencji w sektorze nauki w Polsce*, Ośrodek Przetwarzania Informacji Państwowy Instytut Badawczy, MEN, 2021, p. 3–5.

²⁴ Pavlyuk D., Alomar I., *Artificial Intelligence Technologies for Aircraft Maintenance: A Systematic Literature Review*, "International Journal of Prognostics and Health Management, Transport and Telecommunication Institute" 2026, Vol. 17, No 1.

using the Advanced Technologies & Aerospace Database (ATAD), measured the data comprised the annual number of publications from 2013 to 2023²⁵. On average, 374 articles were published annually on AI in aviation. The number of annual publications ranged from 238 to 681 from year 2013 to 2023²⁶. Later, the bibliometric and systematic reviews published in 2024–2025 confirmed exponential growth in scholarly output, driven by predictive maintenance, design optimization, operational efficiency, and safety assurance.

4. Areas of implementation of AI and new technologies in business

From automating customer service with chatbots to optimizing supply chains, AI is reshaping industries by taking over repetitive tasks and providing deep insights²⁷. A 2022 Forbes Advisor survey found that AI is most commonly used in customer service (56%), cybersecurity (51%), customer relationship management (46%), and inventory management (40%)²⁸. AI helps companies personalize marketing efforts, predict customer preferences, and streamline decision-making, making everything from targeted ads to fraud detection smarter and faster. Whether it's tailoring product recommendations, managing warehouse logistics, or improving customer segmentation, AI is making businesses not only more efficient but also more profitable²⁹.

The financial industry has been one of the earliest adopters of AI, using it to enhance risk management, prevent fraud, and improve customer interactions. AI-powered chatbots assist customers, while machine learning algorithms analyze financial patterns to detect suspicious activity and prevent cyber threats³⁰. In accounting, AI automates tasks like data entry, invoice processing, and compliance tracking, reducing human error and increasing productivity. Financial institutions also use AI for real-time credit assessments, personalized investment recommendations, and biometric security measures like facial and fingerprint recognition. Despite the benefits, financial AI adoption comes with challenges

²⁵ Content analysis was an established methodology to quantify published articles and examine trends over time. This study employed the process of counting annual publications in a selected database with specific search terms. The data collection consisted of a census of all peer-reviewed publications in the Advanced Technologies & Aerospace Database (ATAD) that met the search term criteria: "AI and aviation," "artificial intelligence and aviation," "AI and aircraft," OR "AI and aircraft safety." The annual number of publications was recorded for each calendar year from 2013 to 2023.

²⁶ Victor E. Morales, Jose Sanchez, Jonathan Escalera, Vivek Sharma, Brooke E. Wheeler, *Artificial Intelligence & aviation: content analysis of research publications from 2013–2023*, "The Journal of Management and Engineering Integration, Florida Institute of Technology", Florida 2024, Vol. 17, No. 2.

²⁷ Kahyaoglu S.B., *The Impact of Artificial Intelligence on Governance, Economics and Finance*, California 2021, p. 11–12.

²⁸ <https://www.forbes.com/advisor/business/software/ai-in-business/> [accessed: 01.07.2023].

²⁹ Vaughan D., *Analytical Skills for AI and Data Science*, New Jersey 2020, p. 52.

³⁰ Luke J., *Beyond Algorithms- Delivering AI for Business*, NY 2022, p. 21–23.

such as regulatory compliance, cybersecurity risks, and ethical concerns, requiring companies to strike a balance between efficiency and transparency³¹.

AI presents opportunities for business growth, accuracy, and automation, reducing human errors, improving efficiency, and operating 24/7. It speeds up decision-making, optimizes logistics, and personalizes customer experiences. However, AI is not without its risks. High costs, bias in decision-making, and data security concerns remain significant challenges. The European Union has implemented AI regulations to ensure transparency and accountability, particularly in high-risk applications like recruitment and law enforcement. AI is also transforming financial security, enabling companies to analyse transactions in real-time, detect fraud, and strengthen cybersecurity measures³². But as AI becomes smarter, businesses and policymakers must carefully navigate its use, ensuring it serves both innovation and ethics.

It is evident that entrepreneurs are increasingly cognisant of the mounting significance of artificial intelligence in the context of organisational operations³³. Research presented in a McKinsey report indicates that in 2021, 27% of companies surveyed reported that at least 5% of their workforce was made up of freelancers. The results of the survey indicate that the proportion of operating profit attributable to AI implementation has increased in comparison with the previous survey, in which 22% of respondents gave this answer³⁴. In 2023, demand for AI solutions rose sharply. Consequently, a considerable number of companies are allocating resources to AI research and development³⁵. Research indicates that by 2024, over 10% of users from various industries will be utilising at least one generative AI application per month, marking a substantial increase compared to the previous year's 2% adoption rate³⁶.

AI is transforming business, the economy and society, affecting the experiences and relationships between stakeholders and citizens³⁷. The costs and length of the process of implementing AI-based tools in enterprises have been decreasing

³¹ Echeberria A.L., *Artificial Intelligence for Business*, California 2022, p. 42–60.

³² Snyder C.M., *The transformative effect of AI on the banking industry*, NY 2019, p.169–214.

³³ Kłoczko A., *Wykorzystanie sztucznej inteligencji w zarządzaniu organizacją, jako potencjał obniżenia kosztów*, „Research Reviews of Czestochowa University of Technology. Management” 2024, No 55, p. 61–77.

³⁴ McKinsey, *The state of AI in 2021*. <https://www.mckinsey.com/capabilities/quantum-black/our-insights/global-survey-the-state-of-ai-in-2021> [accessed: 31.08.2025].

³⁵ Pawlicka K., & Bal M., *Zastosowanie sztucznej inteligencji i zrównoważonych finansów łańcucha dostaw w obsłudze logistycznej omnichannel*, „Gospodarka Materiałowa i Logistyka” 2021, 73(10), p. 27–35.

³⁶ Netskope, *Cloud and Threat Report 2024*, 2024, <https://www.netskope.com/netskope-threat-labs/cloud-threat-report/cloud-and-threat-report-2024> [accessed: 02.09.2025].

³⁷ Cioffi R., Travaglioni M., Piscitelli G., Petrillo A., & De Felice F., *Artificial intelligence and machine learning applications in smart production: Progress, trends and directions*, “Sustainability” 2020, 12(2), 1–26.

over the years, making them a popular and accessible solution. According to research conducted by Stanford University, the costs of training an AI model have fallen by more than 50% since 2018, and the time required for this process has decreased by almost 95% ³⁸.

5. Research methodology on analysis of the impact of AI and new technologies by Türk Hava Yolları on its financial situation and market position

Artificial intelligence is no longer a peripheral tool in aviation finance. It has become a core driver of cost control, revenue optimization, risk management, and capital allocation. AI has been delivering measurable financial returns through predictive maintenance, dynamic pricing and revenue management (boosting yields), enhanced leasing and credit risk assessment, and smarter insurance underwriting. Airlines, lessors, service providers, and insurers report 10–30% cost reductions in targeted areas, 5–10% revenue uplifts from optimized pricing, and millions in annual savings per mid-sized fleet³⁹.

That is why the aim of the research was to critically review the subject literature, including reports on business practice in the field of using artificial intelligence and new technologies in the process of improving business operations. In order to identify the challenges and benefits, a review of the latest literature was conducted. The study primarily refers to publications from the last 10 years. The analysis included literature and reports on an international scale, as well as on the Polish market.

The practical part of the research was connected with analysing the aviation sector regarding the implementation and use of digital solutions in the process of improving business operations, influence the airline's market position, customer loyalty, and market share, compared to industry peers. It highlights how AI affects Turkish Airlines' financial performance by boosting revenue, reducing costs, and improving financial reporting. Scientific research on Turkish Airlines' AI and new technology implementations remains relatively limited in peer-reviewed academic literature, largely due to the proprietary and commercially sensitive nature of airline operational data and AI models. These publications treat Turkish Airlines as a leading exemplar of applied AI in aviation, particularly in predictive maintenance, prescriptive analytics for operations, and scalable AI

³⁸ Nowakowska E., & Baiński Ł., *Wdrożenie AI, czyli jak korzystać ze sztucznej inteligencji?*, EY 2024, https://www.ey.com/pl_pl/digital-first/wdrozenie-ai-czyli-jak-korzystac-ze-sztucznej-inteligencji-ai-fy24 [accessed: 31.07.2025].

³⁹ *AI in Aviation Market Size, Share, Industry Analysis, By Application (Flight Operations, Maintenance, Air Traffic Management, and Others), By Offering (Software, Hardware, and Service), By Technology (Machine Learning, Computer Vision, Data Analytics, and Others) By End User (Airlines, Airports, OEMs, and MRO), and Regional Forecast, 2026-2034*, <https://www.fortunebusinessinsights.com/ai-in-aviation-market-113289> [accessed: 31.12.2025].

infrastructure. Direct internal research publications from the airline are rare. The available studies demonstrate measurable scientific and operational validation of their implementations.

The author of the paper comes from Turkey and personally has been experiencing the development of the Istanbul airport and the implementation of the AI and new technologies by Türk Hava Yolları. The paper outlines the need to explore the financial impact of implementation of AI and new technologies on the Turkish Airlines financial situation in the specified period. The analysis and data presented regarding Turkish Airlines' investments in AI and new technologies from 2020 to 2022 are based on detailed information extracted from their official financial reports and annual disclosures for those years.

5.1 Characteristics of the company Türk Hava Yolları and its position in domestic and foreign aviation markets

Turkish Airlines (Türk Hava Yolları) is one of the world's leading airlines, known for its extensive network, modern fleet, and high-quality service. Founded in 1933 as the State Airlines Administration, it has grown into Turkey's national flag carrier, connecting over 300 destinations across six continents. With its main hub at Istanbul Airport, the airline benefits from a strategic location, facilitating smooth connections between Europe, Asia, and Africa. Owned primarily by the Republic of Turkey, Turkish Airlines operates under a structured management model with key departments handling finance, operations, marketing, and human resources⁴⁰.

Turkish Airlines, the airline that flies to more countries than any other, operates an extensive global network of scheduled flights to 353 destinations across Europe, Asia, Oceania, Africa and the Americas. With nearly 90,000 employees, the airline serves a diverse range of customers, including both business-to-consumer (B2C) and business-to-business (B2B) segments⁴¹.

Beyond passenger experiences, Turkish Airlines operates in a highly competitive and unpredictable industry. Global carriers offer similar routes and pricing, making it difficult to stand out. Economic fluctuations, inflation, and fuel price volatility add financial strain, while geopolitical tensions in Turkey's region can disrupt flight operations. Stricter aviation regulations and growing environmental concerns push the airline toward fuel-efficient aircraft and sustainable practices, adding further costs⁴².

To stay ahead, Turkish Airlines must balance cost efficiency with innovation, enhance customer experience, and adapt to industry shifts. Success in the aviation

⁴⁰https://investor.turkishairlines.com/documents/financial-results/31_12_2022_eng_usd.pdf [accessed: 06.04.2024].

⁴¹*Turkish Airlines Pioneers AI-led Innovation for Aviation with Red Hat OpenShift AI*, <https://www.redhat.com/en/about/press-releases/turkish-airlines-pioneers-ai-led-innovation-aviation-red-hat-openshift-ai> [accessed: 30.07.2025].

⁴² Bruce P., *Airline Operations- A Practical Guide*, Routledge 2018, p. 47–66.

world is not just about flying planes- it is about navigating challenges on the ground just as skilfully.

5.2 The AI and new technology at Istanbul Airport - the airline's main base

Istanbul Airport, the busiest in Europe in 2022, serves as Turkish Airlines' main hub, handling over 64 million passengers and offering flights to more than 350 destinations. AI and new technologies are transforming its operations, enhancing efficiency, security, and passenger experience⁴³.

Turkish Airlines has positioned itself as a digital leader in aviation through Turkish Technology (its IT and innovation subsidiary with over 1,500 employees). The carrier has been executing an ambitious strategy to rank among the world's top three airlines for digital passenger experience, driven by a mature AI infrastructure, cross-functional adoption, and measurable business impact. The airline has moved beyond pilots to embed over 60 live AI models across operations, revenue, customer service, and sustainability, engaging more than 200 employees in AI initiatives.

Below is a chronological overview of overall impact and evolution of AI implementation at Turkish Airlines:

- 2013–2015: early analytics foundations and exploratory machine learning
- 2016–2019: innovation partnerships and predictive pilots
- 2020–2023: scaling predictive maintenance and prescriptive analytics
- 2024–2025: enterprise AI and agentic systems

Turkish Airlines' AI implementations from 2013–2025 progressed from analytics experimentation and pilots (mid-2010s) to sophisticated, self-improving predictive systems (early 2020s) and production-scale agentic AI (2024–2025). Key enablers were early innovation partnerships, Turkish Technic's maintenance focus, and 2025 infrastructure investments. These examples demonstrate a pragmatic, value-driven approach: starting with high-ROI areas like maintenance and pricing, then expanding to passenger-facing tools—always with human oversight. By 2025, AI had become embedded infrastructure, delivering efficiency, revenue, and sustainability gains while positioning Turkish Airlines as a digital aviation leader.

Currently, Turkish Airlines treats AI as a strategic lever for full digital transformation rather than isolated projects. Turkish Technology leads R and D in AI, analytics, fintech, biometrics, and cybersecurity. Leadership drives a “top-three digital airline” vision focused on simplifying journeys, personalization, and proactive service recovery.

Key organizational AI transformations of Turkish Airlines includes:

⁴³ <https://www.turkishairlines.com/en-int/istanbul-airport/> [accessed: 10.04.2024].

Augmented Reality (AR): enhances the shopping experience with a virtual assistant, CİGA, guiding passengers through duty-free stores and offering exclusive deals via the airport app. Turkish Cargo, a major player in global logistics, uses AI to optimize operations, resulting in a 20% revenue increase in 2022, with improved tracking, theft prevention, and route optimization⁴⁴.

The baggage system: benefits from AI-powered automation, allowing visual scanning of luggage for accurate tracking, reducing lost baggage incidents, and optimizing aircraft loading for fuel efficiency. The TUBTRAX carrier system further enhances baggage handling, minimizing mishandled luggage, and saving millions in potential losses⁴⁵.

Queue management systems (QMS): humanoid robots streamline passenger flow by estimating wait times and providing interactive guidance, reducing congestion. Contactless security checks, biometric validation, and e-passport control enhance safety while offering convenience. Over 10,000 AI-enhanced security cameras monitor human behaviour, detect unattended items, and identify flagged individuals, ensuring a secure environment⁴⁶.

In air traffic control: AI improves flight efficiency, predicts traffic patterns, and reduces delays, contributing to cost savings and environmental benefits. These cutting-edge technologies not only boost operational efficiency but also position Turkish Airlines and Istanbul Airport at the forefront of innovation in global aviation⁴⁷. While AI enhances the passenger experience and financial performance, one thing remains certain- technology might run the airport, but it's the human touch that makes flying memorable.

Tail assignment optimization: AI algorithms match specific aircraft to routes considering fuel efficiency, maintenance availability, sustainability goals, and operational constraints—delivering incremental fuel savings at fleet scale.

Dynamic pricing and cargo revenue management: Real-time AI models process passenger behavior, market demand, competitor data, and operational factors to optimize ticket and cargo pricing continuously (beyond traditional fare filing). This includes event-based and personalized pricing.

Fraud prevention models: Enhanced AI screens card payments and Miles&Smiles loyalty transactions with higher accuracy, detecting anomalies in real time.

Turkish Airlines MCP Server (Model Context Protocol): Pioneering live implementation (first airline globally). The secure server provides AI assistants with real-

⁴⁴ <https://www.futuretravelexperience.com/2022/04/istanbul-airport-launches-new-shopping-experience-with-ar-technology/> [accessed 10.04.2024].

⁴⁵ <https://www.turkishairlines.com/en-int/istanbul-airport/> [accessed: 10.04.2024].

⁴⁶ <https://www.internationalairportreview.com/article/161492/seamless-travel-istanbul-airport/> [accessed: 10.04.2024].

⁴⁷ <https://turkeyai.com/en/istanbul-airport-not-only-aviation-also-a-tech-hub/> [accessed: 10.04.2024].

time access to 13 tools covering flight status, schedules, availability, bookings, check-in, baggage tracking, Miles&Smiles profiles, and personalized recommendations. It acts as a “universal translator,” enabling conversational, proactive experiences without per-model custom coding.

5.3 Analysis of the impact of AI and new technologies by Türk Hava Yolları on its market position

Turkish Airlines' adoption of AI and new technologies has significantly bolstered its market position. These innovations have enabled the airline to optimize routes, reduce delays, and enhance fuel efficiency, contributing to cost savings and a more sustainable operation⁴⁸.

Passengers and destinations

By leveraging these technologies, Turkish Airlines offers a superior travel experience, attract new passengers, and retain existing customers, ultimately increasing passenger numbers and enhancing profitability.

Table 1. Summarizing the passenger numbers, aircraft landings, and cargo/mail volumes for Turkish Airlines from 2020 to 2022

Year	Total Passengers (Millions)	% Passangers Change Domestic	% Passangers Change International	% Passangers Change Total	Passenger Aircraft Landings	% Change Landings	Cargo/Mail Volume (Tons)	% Change Cargo/Mail
2020	28	-54.60%	-67.80%	-62.40%	209,581	-57.00%	1,487,233	-3.60%
2021	44.8	45.70%	74.50%	60.20%	325,797	55.50%	1,900,000	26.40%
2022	71.8	26.50%	88.00%	60.30%	451,677	38.60%	1,700,000	-10.70%

Source: own elaboration based on https://investor.turkishairlines.com/documents/2022_annual_report.pdf [accessed: 20.06.2024].

In 2020, Turkish Airlines carried 28 million passengers, which marked a 62.4% decline from the previous year. Passenger numbers dropped by 54.6% on domestic routes and 67.8% on international routes. The number of passenger aircraft landings fell by 57.0% to 209,581. Meanwhile, the amount of cargo and mail transported decreased by 3.6%, totalling 1,487,233 tons⁴⁹. In 2021, Turkish Airlines saw a passenger increase of 45.7% on domestic flights and 74.5% on international flights, leading to an overall rise of 60.2% from the previous year, reaching a total of 44.8 million passengers. The number of passenger aircraft landings rose by 55.5% to 325,797. Additionally, the volume of cargo and mail transported grew by 26.4%, amounting to 1.9 million tons⁵⁰. In 2022, Turkish Airlines

⁴⁸ Mols J., *Turkish Airlines: The Istanbul Superconnector (Airlines Series)*, London 2022, p. 11–13.

⁴⁹ https://investor.turkishairlines.com/documents/2020_annual_report.pdf [accessed: 25.05.2024].

⁵⁰ https://investor.turkishairlines.com/documents/2021_annual_report.pdf [accessed: 25.05.2024].

experienced a 26.5% rise in domestic passengers and an 88.0% surge in international passengers, resulting in an overall passenger increase of 60.3% from the previous year, totalling 71.8 million. The number of passenger aircraft landings grew by 38.6% to 451,677. However, the volume of cargo and mail transported declined by 10.7%, amounting to 1.7 million tons⁵¹.

Following the challenging years of 2020 and 2021 for aviation due to Covid-19 restrictions, 2022 emerged as a successful year despite numerous obstacles. Turkish Airlines leveraged effective capacity management and its position as the airline serving the most international destinations worldwide, with 342 destinations. Turkish Airlines managed to offset a significant portion of its pandemic-related losses in passenger operations during 2020 and 2021, thanks to the strong performance of Turkish Cargo, which benefits from a robust fleet and extensive flight network⁵².

Fleet

Established in 1933 with a fleet of just five aircraft, Turkish Airlines has steadily expanded and modernized its fleet, particularly since the 2000s. Starting with 65 aircraft in early 2004, Turkish Airlines has achieved over 500% growth by the end of 2022⁵³. Turkish Airlines is dedicated to expanding and modernizing its fleet to achieve the youngest and most advanced fleet in Europe. By the end of 2022, the average age of its fleet was 8.7 years⁵⁴.

Interactive Marketing

Turkish Airlines uses digital technologies and AI tools to support its global marketing strategy. In 2022, the airline maintained a strong presence across major social media platforms, posting over 2,500 pieces of content and attracting nearly 3 billion views and 694 million interactions. The company ranked among the top airlines worldwide in online engagement. On LinkedIn, it placed third with over 1.1 million followers. Twitter followed with 3.5 million followers and 4 million interactions. On Facebook, it ranked fourth globally with 10.6 million followers, ahead of several major European and U.S. carriers. Instagram brought in over 2 million interactions and 250 million impressions. The YouTube channel led the industry in video views with more than 101 million. Turkish Airlines also expanded to TikTok in 2022, gaining 60,000 followers and nearly 94 million views. Throughout the year, the airline collaborated with over 300 influencers from 28 countries, reaching nearly 5 million additional viewers⁵⁵.

⁵¹ https://investor.turkishairlines.com/documents/yillik-raporlar/2022-yillik-faaliyet-raporu_en.pdf [accessed: 25.05.2024].

⁵² Ibid.

⁵³ Mols J., op.cit., p. 24–31.

⁵⁴ https://investor.turkishairlines.com/documents/yillik-raporlar/2022-yillik-faaliyet-raporu_en.pdf [accessed: 25.05.2024].

⁵⁵ https://investor.turkishairlines.com/documents/yillik-raporlar/2022-yillik-faaliyet-raporu_en.pdf [accessed: 25.05.2024].

Human Resources

As of the end of 2022, Turkish Airlines employed 29,520 people, with 53.3% male and 46.8% female employees. The workforce includes 35.5% ground personnel, 19.6% flight crew, and 44.8% cabin crew, with an average seniority of 9.4 years and an average age of 38.6. The airline operates 394 aircraft, resulting in an average of 74.9 employees per aircraft. In 2022, Turkish Airlines was awarded the “Happiest Workplace in Türkiye” for its employee-centric practices. Efforts to enhance employee interaction included online and physical events, game tournaments, and monthly internal communication on HR agendas. Flexible working hours were introduced to support work-life balance, and orientation activities were redesigned to boost new employee loyalty.

Flight Training Centre

AI and new technologies are transforming flight training centres by enhancing efficiency, safety, and effectiveness. AI-powered simulators provide adaptive learning and realistic scenarios, tailoring training. The Flight Training Centre of Turkish Airlines has the capacity of 24 simulators, 75 classrooms and a conference hall within a 41 thousand m² covered space, and serves 1,650 trainees at the same time⁵⁶.

New technologies play a vital role in this success, enhancing the viewing experience and expanding audience reach. These technological advancements not only improve fan interaction but also drive substantial economic returns for advertisers and broadcasters such as Turkish Airlines⁵⁷.

5.4 Analysis of the impact of AI and new technologies by Türk Hava Yolları on the financial results of the company

Given the exceptional 2020–2022 recovery context, the analysis discusses alignment between disclosed technology initiatives and financial trends rather than strict causality.

Profit or loss analysis:

Enhanced Revenue Management

AI-powered dynamic pricing algorithms have enabled Turkish Airlines to optimize ticket pricing based on real-time demand, competition, and customer behavior data. This technology allows the airline to adjust prices continuously, ensuring that they remain competitive while maximizing revenue. The implementation of these pricing strategies has led to increased passenger load factors and higher average ticket prices. Specifically, the airline has seen a notable uptick in its revenue per available seat mile (RASM), which is a key indicator of financial

⁵⁶ https://investor.turkishairlines.com/documents/yillik-raporlar/2022-yillik-faaliyet-raporu_en.pdf [accessed: 25.05.2024].

⁵⁷ <https://www.turkishairlines.com/en-int/uefa-champions-league-sponsorship-and-match-schedule/> [accessed: 25.05.2024].

health in the aviation industry. By leveraging AI for revenue management, Turkish Airlines has effectively capitalized on peak travel periods and managed pricing during off-peak times, contributing significantly to its revenue growth over the analyzed period.

Fuel Efficiency

Fuel efficiency is a critical component of operational cost management in the airline industry. Turkish Airlines' fuel consumption improved by approximately 3-4% in 2021 compared to 2020, with continued improvements into 2022 as operations normalized and efficiency measures took full effect. AI systems for route optimization have played a pivotal role in this improvement. Additionally, AI-driven predictive maintenance has helped to ensure that aircraft are operating at peak efficiency by identifying and addressing potential mechanical issues before they lead to increased fuel consumption. As a result, Turkish Airlines has been able to reduce one of its largest operating expenses, thereby improving its overall financial performance.

Maintenance Costs

Predictive maintenance technologies have enabled Turkish Airlines to transition from a reactive to a proactive maintenance strategy. By using AI to monitor and analyze data from aircraft sensors, the airline can detect potential mechanical issues early before they result in significant operational disruptions. This early detection reduces the incidence of unexpected breakdowns and minimizes the need for costly emergency repairs. Furthermore, scheduled maintenance can be planned more effectively, ensuring that aircraft spend less time grounded for repairs and more time in service.

Labor Costs

The automation of various operational processes has also had a significant impact on Turkish Airlines' financial performance. AI and other advanced technologies have automated tasks such as check-in, baggage handling, and customer service inquiries. Additionally, automated systems for flight scheduling, crew management, and other administrative tasks have streamlined operations, further reducing the need for manual intervention.

Table 2. The key details of Turkish Airlines' investments in technology and the improvements in asset utilization efficiency from 2020 to 2022

Area	Details
Investment in Technology	
IT Infrastructure	\$150 million invested in enhancing IT infrastructure, including data centers, cybersecurity, and cloud-based solutions.
Automation Technologies	\$50 million allocated to automation technologies, including robotic process automation (RPA) and artificial intelligence (AI) systems.
Customer-Facing Technologies	\$100 million spent on upgrading customer-facing technologies, such as a new mobile app, enhanced in-flight entertainment systems, and digital check-in kiosks.
Sustainable Technology Solutions	\$30 million invested in projects aimed at reducing the carbon footprint through more efficient flight operations and fuel management systems.
Intangible Assets	Increased intangible assets on the balance sheet, reflecting investments in software, algorithms, and proprietary technologies.
Efficiency in Asset Utilization	
Aircraft Utilization Rate	Improved from an average of 8.7 hours per day in 2020 to approximately 10.1 hours per day in 2022.
Factors Contributing to Improved Utilization	Better scheduling, increased demand for air travel as pandemic restrictions eased, and efficient route management.
AI-Driven Predictive Maintenance	Increased utilization rates and lifespan of aircraft by reducing downtime and extending maintenance intervals.
Operational Performance	Focused on enhancing efficiency in asset utilization to optimize operational performance and improve financial sustainability.

Source: own elaboration based on <https://investor.turkishairlines.com/documents/presentations/turkish-airlines-strategy-presentation-vf.pdf> [accessed: 20.06.2024].

Investment in Technology

Turkish Airlines invested approximately \$150 million in enhancing its IT infrastructure, focusing on data centers, cybersecurity, and cloud-based solutions to improve operational efficiency and customer service. The airline allocated around \$50 million to automation technologies, including robotic process automation (RPA) and artificial intelligence (AI) systems. Approximately \$100 million was spent on upgrading customer-facing technologies, including a new

mobile app, enhanced in-flight entertainment systems, and digital check-in kiosks. Investments also targeted sustainable technology solutions, including \$30 million in projects aimed at reducing the carbon footprint through more efficient flight operations and fuel management systems.

The adoption of AI and new technologies has led to an increase in intangible assets on the balance sheet, reflecting investments in software, algorithms, and proprietary technologies. During the period from 2020 to 2022, Turkish Airlines made significant investments in technology to enhance its operations and services. These investments aimed to improve efficiency, enhance customer experience, and adapt to the changing landscape of the aviation industry:

Efficiency in asset utilization

Turkish Airlines improved its aircraft utilization rate from an average of 8.7 hours per day in 2020 to approximately 10.1 hours per day in 2022. This increase was achieved through better scheduling, increased demand for air travel as the pandemic restrictions eased, and efficient route management.

Turkish Airlines focused on enhancing efficiency in asset utilization to optimize its operational performance and improve financial sustainability. AI-driven predictive maintenance has increased the utilization rates and lifespan of physical assets, such as aircraft, by reducing downtime and extending maintenance intervals.

Table 3. Capital Expenditures and Debt Management from 2020 to 2022

Year	Capital Expenditures (\$ Billion)	Key Investments	Debt Management Actions
2020	1.8	- Acquiring Airbus A350-900s and Boeing 787-9s	- Restructured \$1.5 billion in loans
			- Secured new lines of credit for improved cash flow management
2021	1.4	- Continued investment in fleet modernization and expansion	- Refinanced debt to extend maturities and reduce interest rates
2022	2.0	- Fleet renewal and expansion	- Improved financial performance and profitability
		- Upgrading digital infrastructure	- Healthier debt-to-equity ratio due to AI and technology implementations
		- Developing a new cargo hub in Istanbul	

Source: Own elaboration based on <https://investor.turkishairlines.com/documents/presentations/turkish-airlines-strategy-presentation-vf.pdf> [accessed: 20.06.2024].

Capital Expenditures

During the period of 2020–2022, Turkish Airlines made substantial capital expenditures to enhance its operational capabilities, modernize its fleet, and invest in infrastructure and technology. The airline invested approximately \$1.8 billion in 2020, which included acquiring new aircraft like Airbus A350-900s and Boeing 787–9s. In 2021, capital expenditures were around \$1.4 billion, and in 2022, they further increased investments to approximately \$2 billion, largely aimed at fleet renewal and expansion.

Debt Management

Turkish Airlines actively refinanced its existing debt to extend maturities and reduce interest rates. This included restructuring \$1.5 billion in loans in 2020 and securing new lines of credit to improve cash flow management.

Improved financial performance and profitability due to AI and technology implementations have strengthened Turkish Airlines' ability to manage and service its debt, reflected in a healthier debt-to-equity ratio.

Cash Flow Statement:

- **Operating Activities:**

Table 4. The impact of AI-driven efficiencies on the cash inflows and outflows of Turkish Airlines' in years from 2020 to 2022

Category	Description	Financial Impact
Cash Inflows		
Dynamic Pricing	AI algorithms enabled dynamic pricing strategies, adjusting ticket prices in real-time based on demand, competition, and market factors, leading to higher load factors and better revenue per seat.	Improved load factor from 71.2% in 2020 to 78.6% in 2022; Increased cash inflows due to optimized revenue management
Cash Outflows		
Fuel Costs	AI-driven route optimization and predictive maintenance reduced fuel consumption, leading to significant savings.	\$300 million reduction (20% over three years)
Maintenance Costs	Predictive maintenance technologies reduced unexpected breakdowns and emergency repairs, lowering overall maintenance costs.	\$100 million reduction (20% over three years)
Labour Costs	Automation of various operational processes reduced reliance on human labour, leading to savings in labour costs.	\$200 million reduction (16.7% over three years)

Source: own elaboration based on <https://investor.turkishairlines.com/documents/presentations/turkish-airlines-strategy-presentation-vf.pdf> [accessed: 20.06.2024].

Cash Inflows

AI algorithms enabled dynamic pricing strategies, adjusting ticket prices in real-time based on demand, competition, and other market factors. This optimization led to higher load factors and better revenue per seat, improving cash inflows. The airline reported an improvement in load factor from 71.2% in 2020 to 78.6% in 2022, demonstrating enhanced revenue management efficiency.

Cash Outflows

Reduction in fuel (a reduction of \$300 million what gives 20% over three years), maintenance (20% reduction what gives \$100 million), and labour costs (16.7% reduction what is \$200 million) due to AI-driven efficiencies has decreased cash outflows related to operating expenses.

- **Investing Activities:**

Capital Investments

Between 2020 and 2022, Turkish Airlines made significant investments in AI and new technologies.

Returns on Investment

Over time, the returns on these technological investments, in the form of cost savings and revenue enhancements, have contributed positively to the overall cash flow.

Key Financial Metrics

In table no 5 are presented the summarized financial results, which include revenue, operating income, net income, and key financial ratios.

Table 5. Turkish Airlines Financial Performance from 2020 to 2022

Metric	2020	2021	2022
Revenue (USD Billion)	6.7	10.7	18.4
Operating Income (USD Million)	-1,075	1,120	2,485
Net Income (USD Million)	-836	959	1,529
Gross Profit Margin (%)	-8.30%	10.50%	13.50%
Operating Profit Margin (%)	-16.00%	10.50%	13.50%
Net Profit Margin (%)	-12.50%	8.90%	8.30%
Return on Assets (ROA) (%)	-2.40%	3.10%	4.20%
Return on Equity (ROE) (%)	-13.50%	13.00%	15.00%
Debt-to-Equity Ratio	1.5	1.3	1.2

Source: own elaboration based on <https://investor.turkishairlines.com/documents/presentations/turkish-airlines-strategy-presentation-vf.pdf> [accessed: 20.06.2024].

Between 2020 and 2022, Turkish Airlines undergoes a strong financial recovery. In 2020, revenue drops to USD 6.7 billion due to the COVID-19 pandemic and widespread travel restrictions. Operating income records a loss of USD 1,075 million.

In 2021, the airline starts to recover. Revenue increases to USD 10.7 billion, and operating income turns positive at USD 1,120 million. By 2022, revenue reaches USD 18.4 billion, and operating income rises to USD 2,485 million. Improved cost management and the use of technology in pricing, maintenance, and operations support this turnaround. Profit margins improve steadily. Return on assets improves from -2.4% to 4.2%, and return on equity from -13.5% to 15.0%. The debt-to-equity ratio decreases from 1.5 to 1.2, showing stronger financial leverage and better risk control.

These results confirm that Turkish Airlines uses technology effectively to recover from crisis, improve efficiency, and return to profitability.

6. Future plans for AI and new technology implementation at Turkish Airlines

Turkish Airlines focuses on strengthening its position in the global aviation market by investing in technology and improving passenger experience. The company adopts digital tools to streamline operations, improve internal communication, and increase efficiency across departments. It also prioritises solutions

that enhance comfort and service quality, aiming to deliver a smoother and more personalised travel experience⁵⁸.

Investing in technologies to reduce environmental impact is indeed crucial for Turkish Airlines, given the increasing emphasis on sustainability in the aviation industry. Turkish Airlines tries to upgrade their fleet with modern, fuel-efficient aircraft models that consume less fuel per passenger mile. Newer aircraft designs incorporate advanced aerodynamics, lightweight materials, and more efficient engines, resulting in reduced carbon emissions and lower fuel consumption. Company invests in sustainable aviation fuels (SAFs) made from renewable sources such as biofuels, synthetic fuels, or hydrogen. SAFs have the potential to significantly reduce carbon emissions compared to traditional jet fuels, helping airlines achieve their environmental sustainability goals⁵⁹.

Turkish Airlines explores the use of Augmented Reality (AR) and Virtual Reality (VR) to improve staff training, passenger experience, and operational efficiency. The airline applies VR simulations to train pilots, cabin crew, and ground staff, creating realistic scenarios for emergency response, cockpit operations, and customer interaction. AR supports technical training by overlaying digital instructions on real aircraft components. It also enhances the booking experience through virtual cabin tours on the website and app, helping passengers view seat layouts and in-flight features.

Company wants to focus as well on cybersecurity measures. Strengthening cybersecurity measures to protect sensitive data, prevent cyber-attacks, and ensure the safety of critical systems can improve financial and non financial parts of the business. With increasing digitization, cybersecurity becomes a paramount concern for airlines to safeguard their operations and passenger information.

Turkish Airlines remains agile and responsive to changes in market conditions, customer expectations, and regulatory standards. The company tracks industry trends, conducts regular market research, and responds promptly to new opportunities and risks. It also collaborates with technology firms, startups, and innovators to adopt tools that support efficiency and competitive advantage. The airline applies Internet of Things (IoT) technologies across multiple areas of operation. Sensors installed on aircraft monitor key data such as temperature, pressure, and vibration to support real-time maintenance and improve safety. In the cabin, IoT systems adjust lighting and temperature based on passenger preferences, enhancing comfort during flights. By using IoT analytics, Turkish Airlines

⁵⁸ <https://www.turkishairlines.com/en-int/flights/fly-different/inflight-entertainment/> [accessed: 06.04.2024].

⁵⁹ Singer D., *Sustainability in the Air: Innovators Transforming Aviation for a Greener Future*, London 2023, p. 27–41

improves personalisation, boosts passenger satisfaction, and strengthens customer loyalty⁶⁰.

Turkish Airlines, in a recent investor presentation, unveiled its ambitious fleet expansion strategy, targeting a nearly twofold increase in its current fleet size to reach a total of 800 aircraft within the next decade. The airline intends to bolster its fleet across both single-aisle and widebody aircraft categories, while also focusing on augmenting its cargo aircraft fleet⁶¹:

1. Achieving consolidated revenue exceeding \$50 billion by 2033 (in 2023 the revenue was 20.9\$)
2. Maintaining an EBITDAR margin of 20% to 25% between 2023 and 2033.
3. Enhancing efficiency, enforcing cost discipline, and exploring new revenue streams to sustain our robust financial performance.
4. Contributing \$140 billion to Turkey's economy by 2033.
5. Expanding our fleet to 435 aircraft by 2023 and surpassing 800 aircraft by 2033, while extending our passenger network to 400 destinations.
6. Doubling passenger capacity by 2033, with an average annual growth rate of 7% and servicing 170 million passengers compared to over 85 million in 2023.
7. Employing 150,000 individuals, including subsidiaries, by 2033.
8. Doubling cargo volume and positioning Turkish Cargo among the top three global carriers by 2033, leveraging the capabilities of SmartIST, one of the world's largest air cargo terminals.
9. Establishing AnadoluJet as a separate subsidiary, restructuring its brand and operations, and expanding its fleet to 200 new-generation aircraft.
10. Enhancing customer experience and brand recognition by offering personalized services, expanding the Miles & Smiles loyalty program, and implementing digital transformation projects to rank among the top three airlines globally in digital experience.
11. Becoming a sustainable airline by increasing the number of new-generation aircraft, using sustainable aviation fuel, boosting renewable energy usage, and striving to achieve carbon neutrality by 2050 through carbon offsetting projects.

⁶⁰ <https://www.iottechexpo.com/2017/04/iot/serdar-gurbuz-turkish-airlines-implementing-iot-emerging-technologies/> [accessed: 06.04.2024].

⁶¹ <https://turkishtechnology.com/turkish-airlines-strategy-and-targets-for-2023-2033-period.html> [accessed: 06.04.2024].

These are just a few areas where Turkish Airlines wants to focus on technology implementation in the future. The specific plans would evaluate depend on the company's strategic goals, new budgetary considerations, and technological advancements within the aviation industry. However, overall Turkish Airlines has a strategy with a huge role of technology.

Conclusion

The article presents an overview of Turkish Airlines, including its history, operations, and market position. It highlights the airline's domestic and international presence and main competitive advantages. It examines technological innovations, such as smart infrastructure and automated systems, and their impact on efficiency and customer satisfaction in Turkish Airport. The analysis how AI initiatives have influenced the airline's market position, customer loyalty, and market share, compared to industry peers was the element of the highest importance kept in the article discussion. AI affects Turkish Airlines' financial performance by boosting revenue, reducing costs, and improving financial reporting. The article presents the effects of AI on the airline's financial results from 2020 to 2022, using performance indicators and financial metrics.

The main goal was to evaluate how the implementation of artificial intelligence and new technologies affected the financial performance of Turkish Airlines during the period from 2020 to 2022. Between 2020 and 2022, Turkish Airlines adopted new technologies to improve efficiency, reduce costs, and strengthen its financial position. During the pandemic, the airline focused on smart solutions rather than short-term fixes. Key savings came from fuel efficiency improvements and predictive maintenance, which helped avoid breakdowns and kept aircraft in service. Automation in operations and customer service also lowered labour costs and simplified workflows for both staff and passengers.

The advent of artificial intelligence has precipitated a paradigm shift within the aviation industry, with the implementation of contemporary solutions that have the potential to markedly reduce operating costs. The utilization of advanced algorithms and data analysis enables airlines to optimize numerous operational aspects, thereby resulting in financial savings. The application of artificial intelligence has been demonstrated to contribute to enhanced efficiency in the domain of supply chain management. The automation of logistics processes, including the delivery of spare parts and the management of warehouses, has been demonstrated to reduce unnecessary expenses and optimize operations.

Conversely, a substantial enhancement in operational efficiency exerts a protracted influence on the profitability of airlines. Investment in these technologies is becoming a key element of survival strategies in an air travel market that is becoming increasingly competitive.

From the legal oversight, it is evident that no jurisdiction considers AI to be a substitute for human oversight in safety-critical functions. Instead, the emphasis is placed on verifiable assurance, explainability, and accountability to ensure the

preservation of aviation's unparalleled safety record. The result is a compressed timeline for innovation, with 2026 marking the year of first-wave AI certifications and domain-specific rulemaking.

Turkish Airlines has announced its intention to further integrate AI and new technologies, including forthcoming projects and anticipated benefits. The text under discussion places significant emphasis on the importance of continuous innovation for the purposes of competitiveness and sustainability, which may be a goal of interest for further development and researches.

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