

# A Big Problem in the Aviation Industry: Sustainability

Engin Karafakioğlu 

Gendarmerie and Coast Guard Academy, Management and Organization Department, Ankara, Türkiye. (enginkarafakioğlu@gmail.com)

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Corresponding Author: Engin Karafakioğlu

## RESEARCH ARTICLE

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## Abstract

The aim of the research is to determine the studies conducted on the aviation sector and sustainable concepts at the Social Sciences Citation Index (SSCI) level, to evaluate the number and effectiveness of Turkish publications, to identify gaps in the literature and to make suggestions for new studies. The bibliometric analysis method was used in the research. The research was analyzed using the content taken from the Web Of Science database, which is the bibtex size extension of the R 4.2.2 package program. The concepts of "aviation" and "sustainability" were evaluated to collect data. 1,046 studies were accessed in the Web of Science database. 404 English articles included in the Social Sciences Citation Index (SSCI) index between 2010 and 2023 were selected. It is seen that the research on concepts was conducted in 2022 with the highest number of works with 84 works, and the average number of citations to the studies was 12.88. Among the publications on concepts, there are 4 articles that fall into the Turkey-centered review category.

This determined situation indicates that there is not enough interest in sustainability issues in the aviation field in Turkey. There are very few works on aviation and sustainability concepts in our country. This situation shows that academic interest is very insufficient. It is considered extremely important for the sustainable future of the aviation sector that such current concepts are addressed in the international literature and that researchers show interest in this subject.

## 1. Introduction

Sustainability, therefore, involves living the present moment by taking into account past experiences and evaluating the present from the perspective of the future while living the present moment (Chopra et al., 2021). The concept of sustainability aims to raise global awareness of the finite nature of resources and the need for their judicious use (Goni et al., 2021). The development of environmental awareness within the ecosystem in which living things in the universe exist is a positive development that will be reflected in sustainability. While the initial sensitivity to negative externalities emerged as a consequence of environmental awareness with this approach, it was superseded by the approach consisting of the three criteria of sustainability over time: social, environmental and economic components (Zeng et al., 2022). In accordance with the "Triple Bottom Line" theory, as pioneered by John Elkington in 1997, the absence of any one of these three components, namely social, environmental and economic dimensions, will jeopardise sustainability (Farooq et al., 2021). When sustainability is evaluated in three dimensions, it has been demonstrated to provide benefits for sectors, society, and humanity (Abdullahi et al., 2021). The present study identifies two principal reasons for the intense movement towards sustainable development. The primary objective is to enhance societal cognizance of sustainable development as a reactive measure to escalating environmental challenges (Smuts & Van der Merwe, 2022).

This phenomenon is becoming increasingly evident in the context of scarcity of resources, aggravation of social problems and increasing global responsibilities of humanity. The second strand focuses on developments in the financial sector in the context of sustainability. Responsible investors and various sectors that wish to contribute to the solution of global problems have emerged and have engaged in activities to create long-term trust demand in response to low interest rates, cyclical risks, and financial instability (Kumar et al., 2022).

The objectives of sustainable development are articulated in the United Nations document. In accordance with these objectives, numerous international organizations and states have formulated plans for the transition to the new model (Halkos & Gkampoura, 2021). Moreover, in recent years, in the context of special obligations that impose restrictions on the realization of private sector investments, there have been more dynamic voluntary efforts to promote sustainable development (Del Rio Castro et al., 2021). Such investments are designated as responsible investments (Fichter et al., 2023). According to the United Nations-supported Principles for Responsible Investment initiative, the total value of assets under management of responsible institutional investors increased from \$6.5 trillion in 2006 to \$103.4 trillion in 2023 (Chen & Chen, 2024). The observed rise in these figures is regarded as pivotal to the sustainable development model, particularly with the incorporation of environmental, social, and governance standards (ObinnaIwuanyanwu et al., 2024).

Digitalization, which gained significant momentum in the 2010s and has been identified as a key factor in global transformation, is being introduced as a tool that will accelerate the sustainability transformation. The advent of cloud computing has been instrumental in democratizing access to services by virtue of the reduction in digital infrastructure costs that it has engendered. The advent of artificial intelligence and machine learning has precipitated a paradigm shift in various sectors, thereby engendering novel capabilities (Lichtenthaler, 2021). With regard to the role of digital technology in promoting sustainability, the Internet of Things (IoT), underpinned by 5G, is anticipated to make a significant contribution to this field. This is predicated on the integration of billions of devices, thereby enhancing the intelligence of environments across homes, workplaces and industrial facilities (Mondejar et al., 2021). The acceleration of this transition to the digital age was particularly marked in the period following the pandemic (Sá et al., 2021). Multinational companies that will contribute to sustainability are facing new pressures that cause them to fundamentally review how to benefit from digitalization and sustainability while fulfilling their mission. Firstly, it is important to acknowledge that international companies are confronted with a multifaceted geopolitical environment. In order to enhance sustainability and alleviate pressures, it is imperative that these companies engage in digital global cooperation (Baka et al., 2024).

Despite the recent acceleration in the field of sustainability studies, there are still some challenges ahead. These challenges vary across the continents of Europe, Asia, Africa, the Middle East, and Oceania. Europe has been identified as the continent that has contributed the most to sustainability and made the most progress (Filho et al., 2024). There has been an increase in national strategies for sustainable development in various regions of Europe (Steurer & Martinuzzi, 2005). When sustainability studies are evaluated in terms of the South-Eastern European region, certain challenges are brought to the fore. In particular, rigid political structures, weak legal systems, weak institutions, and traditional governance are obstacles to progress towards sustainable development (Nguyen et al., 2020). In Western European countries such as Denmark, Germany, Finland, and Norway, significant progress has been made towards sustainable development (Bose & Khan, 2022).

The aviation industry's present-day objective is the sustainable operation of aircraft (Afonso et al., 2023). The concept of carbon-neutral flying has garnered increased interest as a means of addressing the global climate emergency. Air pollution represents a significant concern for the aviation industry (Abrantes et al., 2021). Despite the aviation industry's contribution to global carbon emissions being significantly lower than that of road transport (2.1% compared to 11%), its impact is of greater global significance due to contrails created by jet engines (Kärcher, 2016). Ritchie (2024) posits that by 2024, the emission contribution from aviation will increase to 2.5%, thereby adding 918 million metric tons of oxygen to the atmosphere (Ritchie & Roser, 2024). This rate increases with each additional aircraft entering service. It is recommended that manufacturers allocate resources to the development of aircraft that are characterised by reduced noise levels and enhanced fuel efficiency. Furthermore, the development of new energy sources such as solar energy, hydrogen cells, and algae is imperative (Bwapwa et al., 2017). Each sector has its own consumption models that increase emissions. As sustainability became imperative for a habitable world, certain measures and alterations in the consumption models of the sectors revealed the obligations that must be undertaken (Crippa et al., 2021). In this particular

context, notably in 2015, the United Nations adopted the "17 Sustainable Development Goals" as a reference point (Besiou et al., 2021). It is imperative for Turkey to adhere to its sustainability obligations in the aviation sector by aligning with international agreements (Raman et al., 2024). The implementation of action plans to be developed in the sustainability studies in the aviation sector in Turkey can be realised with the roadmap to be followed by public and private authorities (Sharno & Hiloidhari, 2024).

The present study underscores the significance of contributing to the field by examining sustainability in the aviation field within the scope of literature and illuminating future studies. A literature analysis was conducted for this purpose, with studies addressing the concept of sustainability in the aviation field being examined using specific criteria and a bibliometric method. Given the paucity of studies originating from Turkey, it is anticipated that the present study will contribute to the extant literature by addressing sustainability – a significant issue in all sectors, including aviation – in a comprehensive manner in terms of the environmental, economic and social dimensions.

The objective of the present study is to address the existing lacunae in the field by conducting a comprehensive examination of studies that address sustainability in the aviation sector, within the ambit of international literature. Furthermore, it is anticipated that the study will identify deficiencies in the extant international literature and provide a framework for future studies. In this respect, while sustainability continues to be a major problem in the aviation field, green aviation policies with environmental measures within the framework of stakeholder theory are foreseen as a solution to this problem. The examination of sustainability studies in the aviation field in the international context will inform the readers. The study data were obtained from the Web of Science database. In the context of data collection, the concepts of "sustainability" and "aviation" were searched and the results were analysed. The filtering system was utilised to analyse a total of 404 articles written in English and published between 2010 and 2023 in the Social Sciences Citation Index (SSCI).

## 2. Theoretical Framework

### 2.1. Sustainability

The definition of sustainability is a complex concept for many researchers to comprehend. According to established literature on the subject, sustainability can be defined as a philosophical approach or practice that guides the efficient use of resources in order to ensure that they are available and sufficient to meet the needs of present and future generations (Logachev & Zhukova, 2024). Sustainability also refers to the decisions regarding the allocation and use of resources for economic and non-economic activities in order to achieve responsible economic, social, and environmental results (Ajibo & Kaime, 2025). The initial definition of sustainable development was established in the United Nations report entitled "Our Common Future", also known as the "Brundtland Report of the World Commission on Environment and Development" in 1987. In this report, sustainable development is defined as the rational consumption of resources used today, and as being socially, environmentally and economically sensitive, with a view to leaving a more habitable world to future generations (Pelikánová, 2025). In recent years, the concept of sustainability has become a global focus of attention. In the context of mounting pressure to address

climate change and the imperative to reduce CO<sub>2</sub> emissions, global investment in research and development, and communication has become imperative (Axon & James, 2018).

In this context, a new life cycle assessment was conducted for the purpose of establishing a sustainable future, with the United Nations' 2030 sustainable development goals serving as a reference point. In 2015, the United Nations (UN) established 17 Sustainable Development Goals (SDGs) encompassing environmental, economic, and social domains (Bouraima et al., 2024). The Sustainable Development Goals (SDGs) are a continuation of the Millennium Development Goals (MDGs), which concentrated on the reduction of global poverty. The SDGs represent a seminal achievement in the realm of sustainable development, as the inaugural sustainable development framework to be endorsed at the international level. A notable aspect of the SDGs is its universal application, extending not only to developing countries but to all states. The SDGs function not only as a framework but also as a conduit for communication, facilitating the reporting of implementation outcomes (Zickafoose et al., 2024). The 17 sustainable development goals, comprising 169 targets and 232 sub-objectives, are centred on a set of criteria deemed to be of particular importance for achieving development (Muhamad et al., 2024). In comparison with the MDGs, the SDGs are characterized by enhanced levels of detail. For instance, the 8th MDG focuses on the reduction of hunger, while the 17th SDG focuses on achieving 'zero' hunger and poverty. While the MDGs concentrate on widespread challenges, the SDGs aim to address current and future challenges (Jong & Vijge, 2021). The 17 Sustainable Development Goals are presented in Figure 1.



**Figure 1.** UN 17 Sustainable Development Goals (Huan et al., 2021)

The three main components of sustainability commitment are social, environmental, and economic. From an ecological perspective, the increasing impact of human activity on ecosystems has resulted in environmental degradation, which has become one of the most significant problems of the current era. Consequently, sustainability emerged as a pivotal factor in ensuring environmental balance (Yadav et al., 2021). The significance of sustainability is evidenced by endeavours to safeguard the environment and natural resources, thereby enhancing global quality of life. It is evident that all companies endeavour to adopt sustainability practices with the objective of safeguarding resources and generating value from their utilization (Mugwanya et al., 2021).

In the 2023 study by Shaban and Barakat, the argument was made that sustainability benefits investment returns and financial performance by creating value and thus ensuring

earnings stability. The implementation of sustainability practices, both social and economic, has been demonstrated to engender financial savings, which in turn can be utilised to support economic activities and contribute to local investments (Hysa et al., 2020). Furthermore, the existence of well-developed development plans has been demonstrated to enhance their appeal to investors (Di Vaio et al., 2022). The development of effective sustainability strategies has been demonstrated to result in a reduction of costs associated with personal aspects of consumer health. Strategies devised with the objective of sustainability have been shown to engender an enhancement in employee productivity (Albizzati et al., 2024). Moreover, these strategies have been demonstrated to represent a more favorable progression with regard to the environment, production and research.

## 2.2. Sustainability in the Aviation Sector

Industries in developing economies worldwide are endeavouring to substantially curtail greenhouse gas emissions by embracing sustainable carbon neutral development practices (Kholif, 2024). As with many other sectors, the airline sector also has sustainability obligations (Karaman & Atalik, 2024). The global emissions of greenhouse gases resulting from aviation activities had been increasing on a continuous basis until 2019. Specifically, between 1960 and 2018, the total emission of CO<sub>2</sub> amounted to 1,034 Mt, with an accelerated rate of 6.8 times (Lee et al., 2021). In comparison to the late 1990s, the aviation industry has reduced its carbon footprint by 50% (Hu et al., 2022). The civil aviation sector is a significant contributor to greenhouse gas emissions, accounting for approximately 2% of the global emissions volume. However, this contribution is lower than that of electricity and heat production, which contribute to 25% of greenhouse gas emissions, and agriculture, forestry and other sectors, which contribute to about 24% of total emissions (Mayor & Tol, 2010).

As García-Olivares et al. (2020) demonstrate, sustainable practices in the aviation sector include the use of renewable fuel alternatives and new technologies such as zero-emission engine designs, particulate filters, lead traces and cirrus clouds. Despite the efforts of various sectors to reduce carbon emissions in the fight against global warming, it is projected that greenhouse gas emissions will increase substantially in the coming years due to the expansion of the airline industry (Z. Wang et al., 2019). The aviation industry has set itself a series of objectives with a view to reducing carbon emissions by 2050. These include the promotion of economic growth through the utilization of clean, sustainable energy sources and the improvement of climate conditions. The promotion of development through the creation of a corporate image that aligns with sustainable development goals in the global aviation sector has been shown to encourage sustainable operations (M Kioğlu & Güngör, 2024). The reduction of the carbon footprint in the airline industry is a challenging process, primarily due to the significant contributions of air travel to the economy, both in terms of passenger travel and the transportation of goods (Hadi-Vencheh et al., 2018). On the one hand, there is the demand for economic vitality, and on the other hand, there are the obligations to reduce carbon emissions, both of which continue to be important issues to be considered in terms of sustainability concerns for the aviation sector (Rostami et al., 2025).

The introduction of radical changes to the aviation sector necessitates continuous monitoring of aviation emissions, eco-efficiency and operational sustainability (Vela-García et al., 2020). The aviation industry's primary focus in the realm of



sustainability is biofuels, which boast minimal emission rates. In particular, the aviation sector is expected to achieve sustainable growth in the short and medium term by commercializing the limitation of harmful fuels. It is anticipated that a maximum emission reduction of 85% will be attained when the sector is fully operational with biofuels (Rafique et al., 2009). The utilization of biofuels in the aviation sector constitutes a technological transition that encompasses not only technological limitations but also constraints in terms of user applications, infrastructure, and social perceptions (Stephy et al., 2025).

In addition to the issue of fuel emissions, the issue of noise pollution caused by aircraft must be considered in the context of environmental problems (Falk & Hagsten, 2020). Correia et al. (2013) found that the rate of hospitalisation due to cardiovascular disease, as well as the mortality rate from the same condition, increased by an average of 3.5% for every 10-decibel increase in noise levels at airports. While the aviation sector is responsible for 13% of carbon emissions from all transportation sources, nitrogen oxide emissions, which increase the net effect of ozone concentrations by approximately 24%, account for 5% of total emissions (Prussi et al., 2025). Consequently, it is estimated that carbon emissions in the aviation sector in 2050 will be seven to eight times higher than in 1990 (Koutsandreas & Keppo, 2025). These problems increase the external costs of the aviation industry and affect subsidies (Dray et al., 2022). The emergence of the green aviation industry can be attributed to the pressing environmental concerns that have been identified (Qiu et al., 2021). The concept of green aviation encompasses the notion of a green image, stakeholder participation, and the implementation of sustainable development practices. These practices are instrumental in facilitating the sustainable development of society and the economy. In the context of the aviation industry, the concept of green aviation signifies a development paradigm that prioritises environmental sustainability. The objective of green aviation is to minimise the adverse environmental impacts associated with the industry, with a focus on energy conservation and environmental protection (Platzer, 2023).

The sustainable development of the green aviation industry is contingent upon the protection of the ecological environment and the rational utilization of resources (Kelly & Allan, 2006). In accordance with the stakeholder theory, corporate entities are responsible for the creation of value for shareholders, whilst concomitantly increasing their profits. It is asserted that, during this process, other stakeholders are also included in the value. In accordance with the stakeholder theory, businesses can maximise value with internal and external stakeholders with a sense of social responsibility (Schaltegger et al., 2019).

The phenomenon of healthy growth in the field of sustainability in the aviation sector is not only a phenomenon dependent on the aviation sector itself. This is also a process that can be achieved with the participation of all sectors (Rogachuk & Okolie, 2024). It is hypothesised that the field of sustainability research will become more efficient and effective when it is based on stakeholder participation and management theory. It is predicted that the aviation sector will be able to reduce its difficulties in sustainability by implementing sustainability practices within the framework of this theory, with both stakeholder management and stakeholder participation (Grosbois & Fennell, 2022).

3. Method

3.1. Research Design

A significant challenge confronting the aviation sector pertains to the deleterious environmental impacts emanating from aviation-related activities, which impede sustainability objectives. In this direction, a bibliometric analysis was conducted by reviewing studies in the Web of Science database on sustainability activities in the aviation sector. The study's research design comprised a review of 404 English-language articles published between 2010 and 2023, as listed in the Social Sciences Citation Index (SSCI). Utilising the bibliometric BibTeX format, visual network structures were developed. The objective of this study is twofold: firstly, to provide a contribution to the reader, and secondly, to the existing literature.

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3.2. Universe and Sample

1,046 studies were accessed in the Web of Science database. The studies were filtered based on the review criteria and 404 English articles included in the Social Sciences Citation Index (SSCI) index that were published between 2010 and 2023 were selected. Information on the articles selected in the study universe is presented in Table 1.

Table 1. Information on Articles

Variables	Data Results
<b>BASIC INFORMATION ON DATA</b>	
Time period	2010-2023
Resources (Journals Books etc.)	97
Documents	404
Annual growth rate %	24.72
Average document age	3.2
Average number of citations per document	12.88
References	1
<b>DOCUMENT CONTENT</b>	
Keywords	985
Author Keywords	1664
<b>AUTHORS</b>	
Authors	1199
Authors of single-author documents	24
<b>AUTHOR COLLABORATION</b>	
Single-authored documents	24
Co-authors per document	3.48
International co-authorship %	26.98
<b>DOCUMENT TYPE</b>	
Article	404
Article; Book chapter	1
Article; Early access	8
Article; Presentation	14
Book Review	1

### 3.3. Data Analysis

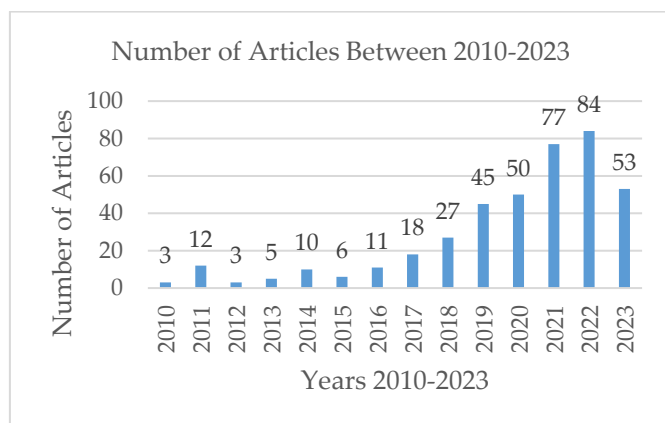
The bibliometric analysis technique has been demonstrated to facilitate the identification of alterations in the quantity and quality of numerous studies in the literature, thereby enabling the revelation of the significance of the data through its structuring on a specific subject (Saltik, 2020). The present study employs an analytical approach to explore the trends associated with the research topics, the determination of competent names, the underlying theory, and the applications pertinent to this field. In this particular context, the study employed bibliometric analysis as a methodological approach for data analysis. In bibliometric analysis, information is grouped in two techniques. The initial approach is of an evaluative nature, while the subsequent one is relational in essence. The evaluative technique employed involves the utilization of a range of criteria, including the performance of the authors, the comparison of academic studies, the number of cited articles, the total number of citations, and citations per author. The relational technique involves determining the interactions between scientific studies. Specifically, keywords, co-authorship status, co-citations, and multiple author analysis are encompassed within the relational technique (Benckendorff and Zehrer, 2013: 126). The data obtained from the review was analysed using Biblmetrix, an extension of the R 4.2.2 package program, in the BibTeX structure of the WoS database.

## 4. Findings

Bibliometric analysis is an analytical method used to qualitatively evaluate quantitative indicators by analyzing a large number of interactions and to visualize these interpretations (Van Eck and Waltman, 2010).

### 4.1. Findings Regarding Journals

A total of 404 articles was analyzed and the distribution of articles by year is visualized in Figure 2.



**Figure 2.** Article Distribution Between 2010-2023

The collected data covers the last 13 years. The examination of the distribution of 404 articles by year showed that the years with the most publications were 2021 with 77 articles and 2022 with 84. The 84 studies published in 2022 constitute 21% of the total number of publications.

Bradford's law of scattering refers to the distribution of literature on a subject by journals (Garfield, 1980: 476). As a result of the studies conducted on the law in 1934, the articles in scientific journals published on a certain subject were ranked according to their productivity, which means that the articles were ranked according to a core group within the

journals in which they were published, and divided into groups and regions. (Bradford, 1934; Hertz, 1987: 175). The data prepared in line with Bradford's law of scattering according to the productivity ranking are presented in Table 2.

**Table 2.** Journal Table of Bradford Law of Scattering

Journal Name	Frequency	Cumulative Frequency	Region
Sustainability	217	217	1
Journal Of Air Transport Management	26	243	2
Journal Of Air Transport Management	12	255	2
Transport Policy	8	263	2
Journal Of Sustainable Tourism	7	270	2
Transportation research part transport and environment	7	277	2
Energies	5	282	3
Technology in society	5	287	3
Aircraft Engineering and Aerospace Technology	4	291	3
Business Strategy and The Environment	4	295	3

Bradford's law of scattering is aimed at obtaining efficient information about a subject by focusing on journals that have made the most basic and core evaluations about a particular subject. Thus, a reader will avoid unnecessary and time-consuming research thanks to Bradford's law of scattering. (Thelwall, 2008).

**Table 3.** h/g/m Index Table of Published Journals

Journal Name	h Index	g Index	m Index	Total Citation	Number of Publication
Sustainability	18	25	1.636	1196	217
Journal Of Air Transport Management	12	25	0.857	638	26
Journal Of Cleaner Production	10	12	1.429	512	12
Transport Policy	6	8	0.6	138	8
Journal Of Sustainable Tourism	5	7	0.455	139	7
Transportation research part transport and environment	4	4	0.8	46	4
Energies	4	5	0.8	49	5
Technology in society	4	7	0.333	56	7
Aircraft Engineering and Aerospace Technology	3	4	0.5	29	4
Business Strategy and The Environment	3	5	0.333	102	5

Although the quantitative nature of the publication is an important indicator for the authors, the number of citations received for the publication and its change over time are

important criteria in the evaluation of the quality of the publications. In this context, as seen in the table, the Sustainability journal ranks first with its h index 18, g index 25 and m index 1,636, total citation number 1196 and publication number 217.

4.2. Findings Regarding Authors

Although a determination can be made by using different analysis programs in the evaluation of the productivity of authors, one of the most commonly used methods today is Lotka's Law. The author productivity table according to the Lotka's Law is presented below in table 4.

Table 4. Author Productivity Distribution According to Lotka's Law

Documents Written	Number of Authors	Authors' Ratio
1	1041	0.888
2	126	0.105
3	20	0.017
4	7	0.006
5	4	0.003
6	1	0.001

The number of authors who published one article was 1041. When this number is compared to the total number of authors, which was 1199, it constitutes 86.6%. The number of authors who published two articles was 126, the number of authors who published three articles was 20, the number of authors who published four articles was seven, the number of authors who published five articles was four, and the number of authors who published six articles was one. This is represented in Figure 3 according to Lotka's Law.

The productivity of authors and journals is evaluated based on various criteria. Table 5 visualizes the h/m/g indexes, which are the productivity of authors regarding the studies they wrote.

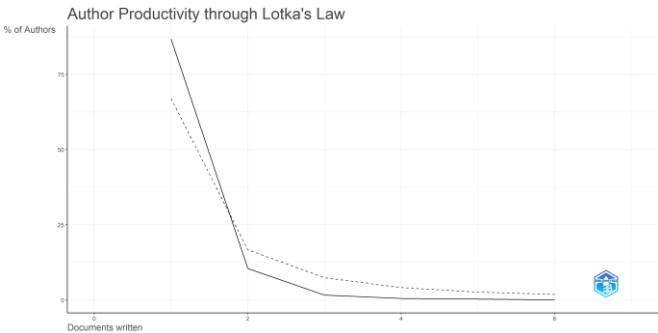


Figure 3. Lotka's Law Distribution

Table 5. Distribution of Authors' Productivity According to h/g/m Indexes

Author	h index	g index	m index	Total Citation	Total Publication Number
Budd L.	4	4	0.4	92	4
Gosling, S.	4	4	0.264	267	4
Huijuan J.	4	4	0.35	211	4
Rice S.	4	4	0.8	38	4
Di Minico P.	3	3	0.75	18	3
Forsyth P.	3	3	0.21	54	4
Sun S.	3	3	0.23	88	4
O'Connell J.F.	3	3	.275	41	4
Tuo Y.	3	3	0.11	72	4
Yang X.	3	4	0.3	59	4

Although evaluating the productivity of authors based solely on the number of publications is not a sufficient criterion, it is an important criterion to include the citations received in this evaluation. The number of articles and the citations received over time are given in terms of productivity in Figure 4.

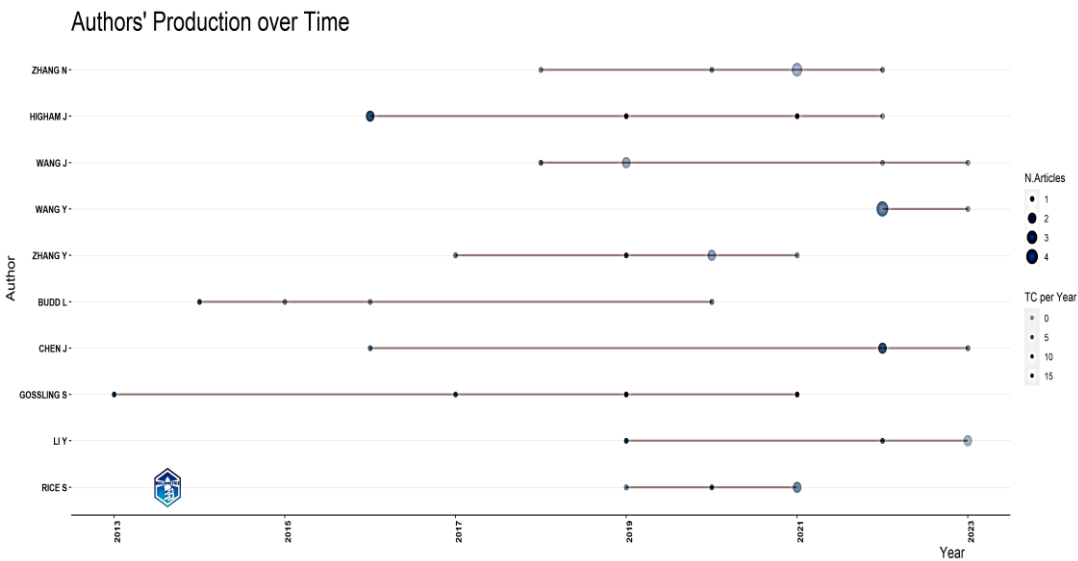


Figure 4. Productivity of Authors Over Time

As seen in the figure, the most productive author was Bud L. who published four articles between 2014 and 2020. The author received the most citations in 2014 with 68 citations. The other authors in the figure also had high citation numbers.

During the productivity phase of the articles, authors can write an article as a single author or with multiple authors. In single-authored articles, the author's effort in the creation phase of the work is much greater, while in multi-authored works, the work

creation phase is carried out with a division of labor. The impact of authors per article is given in Table 6.

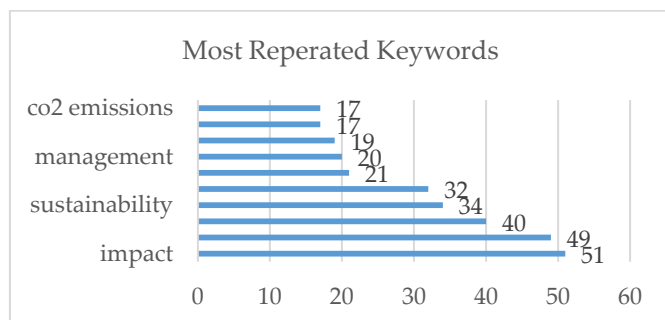
**Table 6.** Contribution of Authors Per Article

Author	Number of Articles	Author Contribution Per Article
Zhang N	6	2.5
Huijuan J	5	1.67
Wang J	5	1.88
Wang Y	5	1.06
Zhang Y	5	1.15
Budd L	4	1.25
Chen J	4	1.04
Gosling, S	4	1.42
Li Y	4	1.3
Rice S	4	1.17

The author who stood out as an individual contribution was Zhang N. As seen in the table, the number of articles of Zhang N. was six and the ratio was 2.50. Higham J. and Wang J. followed Zhang N., respectively.

### 4.3. Analysis of Words

While analyzing the words, they are subjected to a number of classifications. This classification guides the researchers and the new studies to be conducted. The findings regarding the most repeated words are given in Figure 5.



### Figure 5. Most Repeated Keywords

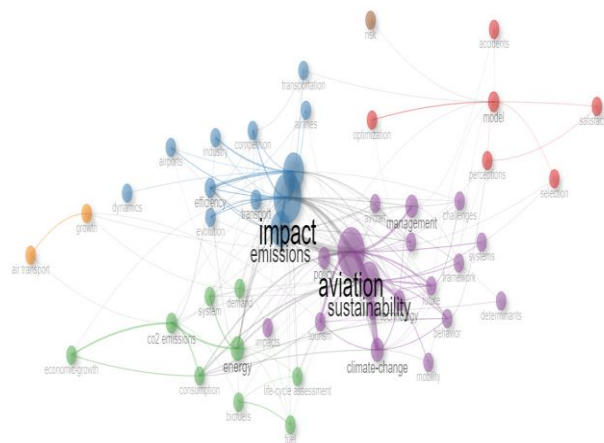
The word cloud created for a better understanding of the weight and status of the topic and words is presented in Figure 5. As seen in the figure, the most repeated word was “impact” with 51 times, and “aviation” came in second place with 49 times.

The visualized word cluster for understanding the density of the words and the status of the topic is presented in Figure 6.



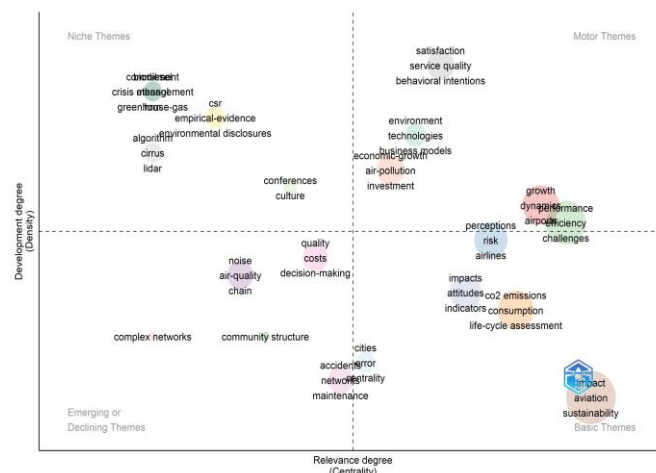
**Figure 6.** Word Cloud of Keywords

The relationships between the words are divided under two groups. In the first group, the words “impact”, “emissions”, “transport”, “airlines” are in the center, while in the second group, whereas the words “aviation”, “sustainability”, “climate change” and “management” are in the center in the second group. The distribution of the words is presented in Figure 7.



**Figure 7.** Co-occurrence Network of Keywords

When words are classified thematically, it is possible to get an idea about weight and interaction thanks to the clustering that occurs. The thematic analysis is presented in Figure 8.



**Figure 8.** Thematic Clustering According to Keywords

In the thematic network structure, growth represents 58.45 in the central position and perception represents 57.62. Aviation and sustainability are in the same cluster but have a lesser value in terms of impact.

#### 4.4. Annual Average Citation Findings

According to the annual citation analysis, it provides an idea about the national long-term academic impact and citation dynamics of the time of selected publications by presenting the annual average citations of articles published between 2010 and 2023. This situation is shown in table 7.



Table 7. Avarege Citations per Year

Year	MeanTCperArt	N	MeanTCperYear	CitableYears
2010	28	3	1.75	16
2011	37.75	12	2.52	15
2012	57	3	4.07	14
2013	41.6	5	3.2	13
2014	37.7	10	3.14	12
2015	24.5	6	2.23	11
2016	27.91	11	2.79	10
2017	21.22	18	2.36	9
2018	18.15	27	2.27	8
2019	18.18	45	2.6	7
2020	20.66	50	3.44	6
2021	6.21	77	1.24	5
2022	2.76	84	0.69	4
2023	0.43	53	0.14	3

When table 7 is examined, the table presents the average number of citations per year (MeanTCperYear) for articles published between 2010 and 2023. The data reveals significant fluctuations in citation performance over the years. Articles published in 2012 achieved the highest annual citation average with 4.07 citations per year, indicating a strong and sustained academic impact. During the 2010–2014 period, the average annual citations consistently remained above 3, suggesting that publications from these years had considerable long-term scholarly influence. A moderate decline is observed between 2015 and 2019, with annual citation averages ranging from approximately 2.2 to 2.7, reflecting a more modest impact. In 2020, a noticeable rise occurred, with the average reaching 3.44 citations per year, implying that publications from this year quickly gained academic attention. From 2021 onwards, a sharp decrease in MeanTCperYear values is evident, with the 2023 average falling to 0.14. This decline is expected and should not be interpreted as a lack of impact. Instead, it reflects the shorter time window for citation accumulation, as shown in the CitableYears column. For example, papers from 2023 have had only 3 years to gather citations.

4.5. Source Productivity Analysis

The journals that contributed the most to the studies are shown in table 8 according to the number of articles published. According to table 8, the sustainability journal stands out as the most influential source with 217 articles, playing a role in academic discussions on sustainable practices and policies. This journal is followed by the Air Transport Management Journal with 26 articles that highlight a strong research focus on sustainability in transportation. Other important journals such as the Cleaner Production Journal (12 articles) and Transportation Policy (8 articles) also make important contributions by intersecting interests and transportation methods.

Table 8. Most Relevant Sources

Number	Journal	Articles
1	SUSTAINABILITY	217
2	JOURNAL OF AIR TRANSPORT MANAGEMENT	26
3	JOURNAL OF CLEANER PRODUCTION	12
4	TRANSPORT POLICY	8
5	JOURNAL OF SUSTAINABLE TOURISM	7
6	TRANSPORTATION RESEARCH PART D: TRANSPORT AND ENVIRONMENT	7
7	ENERGIES	5
8	TECHNOLOGY IN SOCIETY	5
9	AIRCRAFT ENGINEERING AND AEROSPACE TECHNOLOGY	4
10	BUSINESS STRATEGY AND THE ENVIRONMENT	4
11	ECONOMIC RESEARCH EKONOMSKA ISTRAZIVANJA	4
12	ENERGY POLICY	4
13	INTERNATIONAL JOURNAL OF SUSTAINABLE TRANSPORTATION	4
14	NATURE SUSTAINABILITY	4
15	TRANSPORTATION RESEARCH PART A: POLICY AND PRACTICE	3

4.6. Institutional Contribution Analysis

The academic institutions that have contributed the most to the field on which the studies focused are shown in table 9.

Table 9. Most Relevant Affiliations

Most Relevant Affiliations	Articles
Civil Aviation University of China	31
Beihang University	25
Nanjing University of Aeronautics and Astronautics	23
Civil Aviation Flight University of China	22

In table 9, Civil Aviation University of China stands out as the institution that produces the most publications with a total of 31 articles. Beihang University (25 articles), Nanjing University of Aeronautics and Astronautics (23 articles) and Civil Aviation Flight University of China (22 articles) follow. These results clearly show that universities based in China are in a dominant position in the literature on the subject. This shows that the research topic has academic interest not only regionally but also globally. The publication performance of aviation and transportation-focused universities, especially in the Asian continent, reveals how the topic overlaps with regional priorities.

4.7. Analysis of Sustainability and Aviation Publications Addressed in Turkey Between 2010-2023

It is seen that the publications in the fields of aviation and sustainability in Turkey are quantitatively insufficient. Table 10 presents academic studies published by researchers from Turkey in the field of aviation and sustainability between 2010 and 2023.



**Table 10.** Sustainability and Aviation Publications Addressed in Turkey (2010–2023)

Number	Title	Authors	Journal	Year
1	Analyzing the EU ETS, Challenges and Opportunities for Reducing Greenhouse Gas Emissions from the Aviation Industry in Europe	Aksu, Bülent; İlk, Asiye K.	SUSTAINABILITY	2023
2	A Comparative Study between Paper and Paperless Aircraft Maintenance: A Case Study	İsmailoğlu, E.; Esuankal, E.A.; Karaman, K.	SUSTAINABILITY	2022
3	Using multi-criteria performance measurement models to evaluate the financial, operational and environmental sustainability of airlines	Tanriverdi, S.; Yıldız, B.; Aksu, B.	JOURNAL OF AIR TRANSPORT MANAGEMENT	2021
4	Realizing Green Airport Performance through Green Management Intelligence, Airport Reputation, Biospheric Value, and Eco Design	Yıldız, B.; Aksu, B.; Topcuoğlu, A.K.; Ozipınar, C.K.	SUSTAINABILITY	2020

When table 10 is evaluated, only four articles were published by researchers from Turkey on sustainability in the aviation sector between 2010-2023. These publications are generally concentrated in the last four years (2020-2023) and it is seen that Turkey has made a limited contribution to the international literature on sustainable aviation. The most cited study was the article published in 2023 and evaluated the EU Emissions Trading System, while other studies focused on narrower themes (e.g. paperless maintenance processes or multi-criteria performance assessment). Most of the publications were published in the journal Sustainability, which shows that the subject is evaluated within the multidisciplinary sustainability framework.

## 5. Conclusion

The present study investigates the current status of scientific studies on sustainability issues in the aviation field. The importance of sustainability studies in the aviation field is well-documented, and yet this area continues to present significant challenges. Research in the aviation field has been approached through the lens of relational and evaluative effects. The interactions between studies conducted with relational terms are targeted as keywords, co-authorship, citations and multiple author relationships. Evaluative effects are defined as criteria such as the performance of authors, the comparison of academic studies, the number of cited articles and the number of citations per author. An examination of the literature on sustainability in the aviation field reveals a paucity of studies on Turkey, particularly with regard to relational and evaluative effects. This phenomenon is exemplified by a set of four articles at the SSCI level in Turkey. It is an irrefutable fact that scientific studies to be conducted on sustainability will be beneficial in preventing negative global effects such as climate change and global warming. In this context, it is hypothesised that an increase in international studies on sustainability in Turkey will serve as a roadmap, particularly with regard to reducing emissions from aviation activities, and will also contribute to global efforts in this regard. The paucity of international publications representing Turkey is attributable to the authors' lack of interest in sustainability. A comprehensive analysis of 404 scientific studies on sustainability in aviation revealed that the year 2022 witnessed the highest number of publications, with a total of 84 studies. The total number of citations is 5202.

A significant proportion of studies on the concept have been published in the Sustainability Journal. In order to reduce emissions from aviation activities around the world and in Turkey, it is essential to take into account the international

agreements made in recent years. These agreements serve as a reference point and establish obligations that countries must fulfil. A retrospective analysis of international reports reveals a clear emphasis on the concept of sustainability as a form of change, a notion first articulated in the Brundtland Report. As Borowy (2021) argue, environmental concerns are prioritised in decision-making processes that consider multiple purposes. The conference that placed significant emphasis on environmental issues was the "Rio Conference" in 1992. At the Rio conference, the environment and economy were considered holistically, and an action plan entitled "Agenda 21" was formulated (Morin et al., 2024). The World Summit on Sustainable Development, which was held with considerable participation in 2002, focused on two fundamental documents: the Action Plan and the Political Declaration (Waldt, 2024). In 2015, the "17 Sustainable Development Goals" were established by member countries of the United Nations. These objectives pertain to targets that are expected to contribute to sustainability, with the measures and improvements to be taken in every area of life (Zakari et al., 2022). It is asserted that the realisation of sustainable practices is contingent upon the incorporation of extant international accords encompassing a broad spectrum of issues, including climate change, global warming, the alleviation of poverty, the enhancement of health conditions, and the reduction of emissions, as a fundamental framework for sustainable development (Q. Wang & Huang, 2021). The present study emphasises the importance of sustainability practices in the field of aviation within the framework of international agreements in Turkey, and the contribution of the dissemination of international scientific research to theory.

## Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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