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A Comprehensive Evaluation of Sustainable Aviation Literature: A Bibliometric Analysis Utilising R and Vos Viewer

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Abstract

Sustainable-aviation is one of the most essential and impactful foundations in the aviation industry. Moreover, the effective application of sustainable aviation practices contributes to the attainment of "sustainability," which leads to the achievement of the "sustainable development goals as given down by the United Nations." This project intends to examine and discuss the literature on "sustainable aviation." This study conducts a thorough "bibliometric analysis" of 1,040 scientific papers released between 2013 and 2025, concentrating on "sustainable aviation" as indexed in the "Web of Science database." The fact indicates a substantial rise in annual publications, demonstrating an escalation in worldwide interest in "sustainable aviation," with high-impact journals being essential in disseminating research findings. Furthermore, the "United States, China, and Germany" are the leading countries in publishing. The study identified Heyne J, Heyne JS, and Lei TZ as the primary writers, while "Washington State University, Beihang University, and the University of Illinois" were recognised as the leading institutions in the field of sustainable aviation. The findings highlight the imperative for more study and global collaborations to harness the promise of "sustainable aviation" for a low-carbon future.

Keywords: Aviation sector, Bibliometric Analysis, Sustainability, Sustainable Aviation, United Nations, Web of Science database.

1. Introduction

The aviation-industry significantly influences air quality and climate change. Due to the triggering effects of "globalisation and technological improvements, emissions from the aviation industry" have been increasing dramatically since 1990 and are predicted to increase progressively by the "middle of the century "(Perlman, 2017). As the world population continues to increase and countries have created advanced aviation networks, there is a growing number of people that use "air transportation" (Milner et al., 2019). Furthermore, as the demand for "air travel escalates, so too does the necessity for new aircraft, personnel, and airports" (Merdivenci et al., 2021; Dinçer and Yirmibeşoğlu, 2024). This results in an exacerbation of the adverse

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"environmental impacts of aviation." The escalating adverse "impacts of the aviation industry on the environment" have underscored the necessity of incorporating "environmental considerations into aviation operations." (Dinçer et al., 2024)

To mitigate the "environmental impact of aviation," there has been a growing focus on sustainable aviation concerns. "Sustainable Aviation" represents a long-term plan aimed at addressing the problem of delivering a cleaner, quieter, and more intelligent future for the aviation sector (Sustainable Aviation, 2022). It seeks to guarantee the "sustainability of progress in aviation operations" while mitigating their adverse effects (Janić, 2002). Seyam et al. (2021) indicate that "sustainable aviation" challenges have garnered the interest of both academic and industrial research to identify and alleviate the "adverse environmental impacts of aviation." Due to the "significant impact of aviation on climate change, academics" have progressively prioritised "sustainable aviation research in the relevant literature," particularly since the onset of the "21st century." Conversely, scientific study on "sustainable aviation is expanding but remains in a nascent stage. Furthermore, a review of the current "literature reveals a notable lack in the application of bibliometric methodologies within sustainable aviation research." (Dinçer et al., 2024) The goal of this study is to look at the trends and future research directions in "sustainable aviation literature" using "scientific mapping and performance analysis as part of bibliometric analysis."

The "bibliometric analysis" revealed a restricted quantity of "review papers on sustainable aviation." A total of one thousand forty studies were identified as review studies. Research on "sustainable aviation mainly focusses on sustainable aviation fuel," how it is made, and how it is used in "aviation, as well as aircraft technologies and designs that support sustainability," and life-cycle assessment. However, we have not thoroughly examined the historical aspects and trends in "sustainable aviation literature." Therefore, a detailed review of the "literature" is needed to clarify the research patterns and identify key themes. Conversely, to our knowledge, the retrospective characteristics, and trends of "sustainable aviation literature" have not been properly analysed. Consequently, an "extensive analysis of the literature" is necessary to elucidate the patterns within the research domain and identify research themes. Furthermore, the current "sustainable aviation literature needs" a thorough "mapping of published studies" to analyse prevailing and "historical trends" as well as identify potential gaps for future research. Consequently, this study was undertaken to address this deficiency in the literature. During the data-gathering phase, the "Web of Science (WoS) database" was utilised, and analyses were conducted using "Biblioshiny and VOSviewer version 1.6.19 software." The report conducted a thorough review of the "sustainable aviation sector" using "performance and science mapping analyses."

RQ1: What is the annual frequency of progress in academic paper trends within the field of "sustainable aviation"?

RQ2: Which authors contribute to the discourse on sustainable aviation, and which journals are particularly relevant?

RQ3: What is the annual distribution of production periods among writers, countries, and associations?

RQ4: What trends and modifications have been identified in the collection of research themes within the domain of "sustainable aviation"?

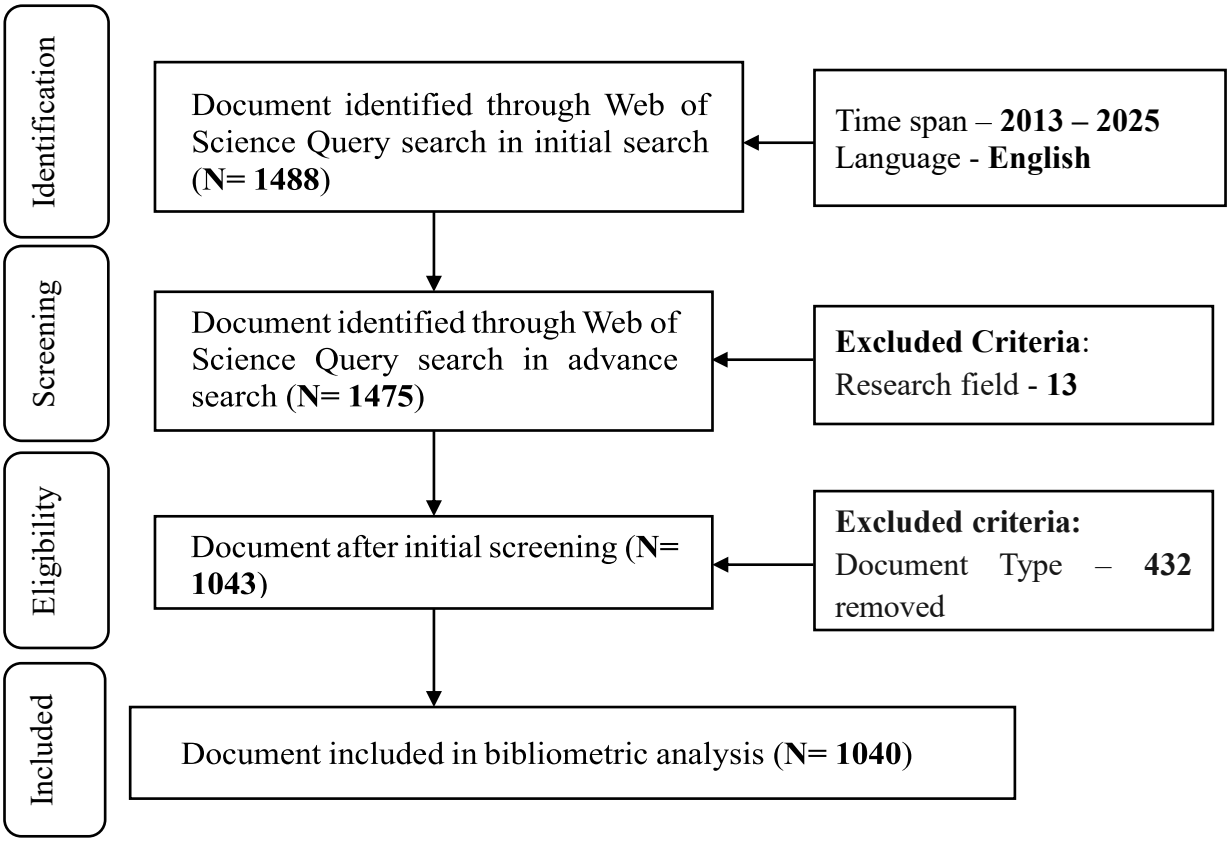

Figure - 1. The PRISMA Chart, Demonstrates the gathering of "Sustainable aviation" literature retrieved from the "Web of Science database."

2. Literature Review

With the rise in demand for "air transport and the proliferation of aircraft globally, air pollution markedly escalates." The "United Nations Framework Convention on Climate Change" states that "the aviation industry ranks among the top ten pollutants, with aviation emissions accounting for 2.1% of the global total; however, when non-CO_2 effects are considered, aviation's contribution to global warming is estimated at 4.9%" (Perlman, 2017). As per Ritchie (2024), "global aviation, encompassing domestic and international passenger and freight transport, constitutes 2.5% of global CO_2 emissions; yet, its contribution to overall global warming has escalated to 3.5%." Current projections indicate that the demand for "air passenger travel may surpass 10 billion by 2050 (Environment and Sustainability Solutions, 2023; Net-Zero Carbon

Emissions by 2050, 2021).” “IATA member airlines resolved to adhere to the Paris Agreement's stipulation of limiting global warming to 1.5°C and pledged to attain net zero carbon emissions from their operations by 2050 to mitigate the aviation industry's adverse environmental impacts and advance towards more sustainable aviation” (Net-Zero Carbon Emissions by 2050, 2021; Dinçer et al., 2024).

The adverse impacts of “the aviation sector on the environment,” coupled with the increasing number of “air travellers, heighten worries regarding the deleterious consequences of this business on climate change.” This situation needs the “implementation of measures to mitigate emissions and the pursuit of research into sustainable aviation practices.” Consequently, scholarly focus on “sustainable aviation subjects has been on the rise.” Walker and Cook (2009) affirmed this. “A significant portion of the research related to “sustainable aviation emphasises a positivistic approach to enhancing operational efficiency and technological advancements.” The literature study revealed that the research concentrated on various themes and methodologies pertaining to “sustainable aviation.” The authors primarily investigated “sustainable aviation fuel, its production, and utilisation in aviation” (Murphy et al., 2015; Peters et al., 2023; Okolie et al., 2023; Hari et al., 2014; Cruz et al., 2020; Yusaf et al., 2022; Dincer and Acar, 2016; Degirmenci et al., 2023; Undavalli et al., 2022; Hasan et al., 2021; Cabrera and De Sousa, 2022), aircraft technologies and designs in the realm of sustainable aviation (Brooker, 2006; Wang, 2014; Salem et al., 2023; Gardi et al., 2016; Ranasinghe et al., 2019; Bravo-Mosquera et al., 2022; Zhang et al., 2022), and “life-cycle assessment” (Keiser et al., 2023; Hu et al., 2022; Dinçer et al., 2024) in their research.

“Sustainable aviation fuel (SAF) is the primary word employed by the aviation sector to denote a non-conventional (fossil-derived) aviation fuel” (International Air Transport Association, 2024). Research in the pertinent literature has predominantly concentrated on “sustainable aviation fuel, its manufacture, and its application in aviation.” Murphy et al. (2015) conducted
a review on “biomass production for sustainable aviation fuels” in their regional case study and examined "various sustainability issues related to biomass production". Peters et al. (2023) examined contemporary and nascent “production systems for biomass-derived sustainable aviation fuels.” The research results have demonstrated the need to enhance current methods to mitigate “greenhouse gas emissions in the aviation sector via biojet fuel, as well as to establish new, sustainable, high-capacity avenues for the commercial utilisation of biojet fuel.” (Dinçer et al., 2024)

Okolie et al. (2023) examine the production pathways of “sustainable aviation fuel, including hydroprocessed esters and fatty acids (HEFA), gasification and Fischer–Tropsch Process (GFT), Alcohol to Jet (ATJ), direct

sugar to hydrocarbon (DSHC), and fast pyrolysis (FP) through a multi-criteria decision framework." The study's results, which assumed equal weighting for "technological and environmental factors, ranked the production routes for sustainable aviation fuel as HEFA > DSHC > FP > ATJ > GFT." Moreover, Hari et al. (2014) investigated "aviation biofuel from renewable resources" and emphasised that the industrialisation of alternative aviation fuels derived from renewable sources is essential for addressing greenhouse gas emissions. Cruz et al. (2020) examined the synthesis of "biofuels from oilseeds by utilising several thermochemical techniques." They determined that "oilseed fruits may serve as biofuels; yet, their use necessitates thermochemical advancements and innovative technologies." (Dinçer et al., 2024)

The use of "alternative fuels in the aviation sector is crucial for diminishing reliance on fossil fuels and mitigating the adverse impacts of greenhouse gas emissions" (Hasan et al., 2021). Cabrera and De Sousa (2022) assert that the use of "alternative fuels in aviation is crucial for meeting future emission objectives and diminishing reliance on fossil fuels." Furthermore, Yusaf et al. (2022) assert that "hydrogen, being plentiful, environmentally benign, and devoid of carbon emissions, constitutes an appropriate alternative fuel." "Hydrogen serves as an energy carrier that, when generated from renewable energy sources, can significantly enhance the production of drop-in sustainable aviation fuels and possesses the potential to transform into a low carbon impact fuel for future propulsion, flight, and infrastructure technologies" (Boeing, 2025).

Undavalli et al. (2022) evaluated hydrogen as a "possible rival to SAFs and a non-carbon fuel capable of achieving a 100% reduction in CO_2 emissions, yet it remains constrained by design challenges in aircraft systems, fuel storage, elevated production costs, and the necessity for new systems development." Dincer and Acar (2016) investigated the "potential use of hydrogen in aviation applications" and concluded that "hydro-based electrolysis is the most advantageous method for hydrogen production." Degirmenci et al. (2023) assert that "sustainable aviation fuels, which mitigate the environmental effects of the aviation sector, are viewed as alternatives to fossil fuels, with hydrogen, a clean energy carrier," deemed the most promising among these fuels. (Dinçer et al., 2024)

Besides the "production and utilisation of sustainable aviation fuels, the secondary focus of sustainable aviation mostly pertains to aircraft technology and designs." Gardi et al. (2016) assert that the "escalating demand for air transportation heightens knowledge and interest in economically feasible and sustainable aviation practices, resulting in substantial advancements in the design and operation of aircraft, airspace, and airport infrastructure." Gardi et al. (2016) examined "Multi-Objective Trajectory Optimisation (MOTO)

techniques" for "aircraft operations in the realm of sustainable aviation literature," highlighting the significant potential of "MOTO algorithms for real-time planning and re-planning of flight routes," optimised for both "economic and environmental factors." Brooker (2006) analysed and articulated "the design priorities of civil aircraft from economic and environmental perspectives." Wang (2014) examined "high-order computational fluid dynamic tools for aircraft design" and emphasised the significance of high-order approaches in "new generation design tools for aircraft and engines". Salem et al. (2023) conducted a critical analysis of "hybrid-electric aircraft technology and designs." They emphasised that the electrical energy utilised in "aeroplanes must be generated without CO_2 emissions, and the maximisation of renewable resources for electricity production should be prioritised to positively impact the global warming crisis." (Dinçer et al., 2024)

Ranasinghe et al. (2019) examined "low-emission technologies for sustainable aviation" and highlighted the need and necessity of "disruptive technical innovations to enhance fuel economy and reduce the adverse environmental effects of flying." Bravo-Mosquera et al. (2022) analysed "contemporary advancements in aircraft design for civil aviation through a literature analysis, highlighting the "design and development of various unconventional aircraft configurations." Zhang et al. (2022) provided insights into recent "advancements in control system design and energy management for electric aircraft propulsion systems," along with associated problems and technical obstacles. These authors assert that the emergence of "electrified aircraft propulsion technologies is driven by sustainability concerns in the aviation sector, positioning them as a possible avenue for future sustainable and decarbonised aviation." (Dinçer et al., 2024) In addition to the subjects of "sustainable aviation fuel production and its use in aviation and aircraft technologies and designs, another examined issue in the sustainable aviation literature was life-cycle analysis (or life-cycle evaluation)." Finnveden et al. (2009) state that "lifecycle assessment is a tool to evaluate the environmental impacts and resources utilised throughout a product's life cycle, namely, from raw material acquisition through production and use phases to waste management." "Life-cycle assessments are becoming increasingly vital for the aviation industry" to achieve the objective of mitigating its adverse "environmental impacts" (Keiser et al., 2023). Hu et al. (2022) investigated solutions for reducing "carbon emissions in the sustainable aviation sector using life cycle analysis and the Delphi method," developing a timeline for "low carbon technology." The results of their study suggested that the most important elements affecting "carbon emissions in the aviation industry" were demand, "technological advancement, and alternative fuels." Keiser et al. (2023) conducted a comprehensive evaluation of "life-cycle assessment in the aviation industry," focusing on the pertinent literature but excluding studies on "sustainable aviation fuels." They suggested a conceptual framework for implementing "life-cycle analysis in the aviation sector," a methodological

specification of “life-cycle analysis, and an organisational research agenda for its operationalisation within this industry.”

3. Methodology

This study uses a “quantitative research method” that focusses on analysing existing literature about “sustainable aviation through bibliometric analysis,” as explained by Di Vaio et al. (2020). The research technique consists of two phases: “data collection and bibliometric analysis.” The data-gathering phase involves the execution of “data extraction techniques,” including the identification of database selection and search strategies. The selected databases include publications on "theoretical and empirical research" related to "sustainable aviation" (Alvino et al., 2020). The “bibliometric analysis” phase utilises appropriate software and techniques—a quantitative method for evaluating scientific articles within a designated study domain—and has experienced substantial increases in academic research over the last two decades (Zhang et al., 2022). This methodology serves as a "scientific mapping" tool that visually represents collaborative efforts, "emerging trends, and prominent research areas" within a specified period (Romanelli et al., 2021).

Bibliometric-analysis is a common method for investigating a particular study domain through the assessment of “bibliographic data.” This study analyses prevailing trends in a field using “network analysis and scientific mapping techniques.” Furthermore, it facilitates the examination of the “field's progression, collaborative initiatives among scholars, and the relationships of organisations and nations through clear visual representations.” Researchers employ this tool to examine “citations, co-occurrences,” evolving lexicons, and pertinent topics within their fields of study. The researchers obtained data from “the Web of Science database” by meticulously picking keywords following a comprehensive evaluation of the literature on "sustainable aviation". The “Web of Science database” provides a comprehensive collection of “scientific papers suitable for bibliometric analysis,” validating prior research results. The initial phase of “bibliometric analysis entails the selection of keywords.” The authors utilise diverse keywords in various combinations to ensure thorough coverage of articles relevant to the designated topic. Naeem et al. (2022) include the term "sustainable aviation" in their study. The authors formulated the search string based on Dinçer et al. (2024) for “document abstraction from the Web of Science database,” making minor adjustments to meet the study's specifications.

Search String – “SUSTAINABLE AVIATION” (All Fields)

Figure 1 presents the methodology employed for “data collection.” The investigation utilised a predetermined search query within “the Web of Science database,” and the resulting data were subsequently imported into

"reference management software." The researchers developed the search string for this study by integrating commonly used terms and concepts from investigations into the relationship between "sustainable aviation." The study established these terms to encompass a broad range of topics related to "sustainable aviation" and their effects on "climate change." This approach to query construction aligns with established practices in "bibliometric analysis," ensuring a comprehensive search (Aria & Cuccurullo, 2017; Dinçer et al., 2024). The team employed multiple filters to enhance and refine the results. The initial filter established a temporal limitation, encompassing documents generated from 2001 to 2025. Due to limitations in data availability from 2001 to 2012, the team adjusted the "data period" to concentrate on the "years 2013 to 2025" to enhance accuracy. The secondary filter targeted specific subject areas, namely "economics, econometrics, finance, social sciences, business, management, and accounting." The tertiary filter utilised a document categorisation process that focused on integrating published works and articles into the final press. The primary filter is restricted to publications authored in "English" as its target language. The approaches and methods were developed for the analysis (Sadeqi-Arani & Kadkhodaie, 2023). The research by Sadeqi-Arani and Kadkhodaie (2023) categorised the investigations into three distinct groups. The analysis was divided into three distinct categories: "performance analysis, scientific visualisation, and conceptual framework analysis."

- **Performance-analysis** denotes the "process of evaluating the contributions of various components" within a specific field of study. The research by Sadeqi-Arani and Kadkhodaie (2023) supports this conclusion. The performance analysis comprises a thorough evaluation of the "most cited papers," authors, nations, "journals, and institutions" to provide a complete portrayal of research on the specified topic.

- **Scientific charting** is about looking at how different parts of research contribute to a specific area. The research by Sadeqi-Arani and Kadkhodaie (2023) shows that "scientific plotting" helps identify trends in "author keywords," points out new research areas, and creates word clouds from those keywords. The study uses "theme evolution and thematic mapping" to give a complete picture of the research topic.

- **Conceptual Structure:** This study involves examining the co-occurrence of two concepts or words within a scientific topic. A higher frequency of simultaneous occurrences of the words indicates a stronger correlation between them. (Sadeqi-Arani & Kadkhodaie, 2023).

3.1 "Descriptive Statistics" of the Information Frame.

Table – 1 Statistics of the information frame.

Description	Results
Timespan	2013:2025
Sources (Journals, Books, etc)	249
Documents	1040
Annual Growth Rate %	27.62
Document Average Age	2.81
Average citations per doc	9.543
References	1
Keywords Plus (ID)	1952
Author's Keywords (DE)	3298
Authors	3559
Authors of single-authored docs	52
Single-authored docs	54
Co-Authors per Doc	4.77
International co-authorships %	23.56
article	1040

***Source: Data from the "Bibilioshiny R Program" Author Compilation*.**

Table 1 presents a description of the data set obtained from "the Web of Science database." The dataset comprises 1,040 journal articles from various sources, collected between 2013 and June 2025. Furthermore, regarding the publication of articles in the field of "sustainable aviation," it is essential to note that from 2013 to June 2025, there has been a significant increase in the number of publications, with an overall growth rate of 27.62%. The dataset from "the Web of Science" contains 3,298 author keywords and 1,952 additional keywords. Moreover, 3559 authors have significantly contributed to the literature on "sustainable aviation," with 52 of these works authored by a single individual. Fifty-four authors have produced single-authored works, with an international collaboration rate of 23.56% in the field of "sustainable aviation."

3.1.1 Superior Search Enquiry Linked to "Sustainable Aviation" Literature.

Table – 2 The examination enquiry description pertains to "Sustainable Aviation" literature.

Description	Conditions
Search query	"SUSTAINABLE AVIATION" (All Fields) **No of documents – 1488.**
Search query after refining	"SUSTAINABLE AVIATION" (All Fields) and 2001 or 2002 or 2006 or 2009 or 2010 or 2011 or 2012 (Exclude – Publication Years) **No of documents – 1475.**
Search query after final refining	"SUSTAINABLE AVIATION" (All Fields) and 2001 or 2002 or 2006 or 2009 or 2010 or 2011 or 2012 (Exclude – Publication Years) and Proceeding Paper or Review Article or Book Chapters or Early Access or Editorial Material or News Item or Book or Meeting Abstract or Data Paper or Correction or Reprint or Retracted Publication or Retraction

	(Exclude – Document Types) and Korean or Polish or Turkish (Exclude – Languages) **No of documents – 1040.**
Query search date	June 13th, 2025
Years	2013 – 2025
Subject area	"Business, Management and Accounting, Social Sciences, Economics, Econometrics and Finance."
Source type	The search was limited to "Journals articles"
Document type	"Journal articles"
Publication stage	"Final publication"
Language	The exploration was restricted to the "English language."

Source: The author compiled the data using a search query from "Web of Science"

Table 2 delineates the methodologies employed for data filtration and the extraction of relevant keywords related to the literature on "Sustainable Aviation". The keywords were derived from Dinçer et al. (2024). An initial search in the "Web of Science database" yielded 1488 documents concerning "Sustainable Aviation", encompassing literature from 2001 to 2025. Subsequent evaluation revealed that documents from 2001 to 2012 were markedly limited. Consequently, the data process underwent additional refinement. To enhance precision and specificity in the research, the documents were classified by subject, specifically focusing on "business, management and accounting," "social sciences," and "economics, econometrics, and finance." This categorisation decreased the number of papers from 1488 to 1043. Further filtration was implemented regarding the language and origin of the documents, resulting in the selection of 1040 fully published "English-language journal articles" for "bibliometric analysis."

4. Results

The "bibliometric analysis" consists of two primary components: The initial part pertains to a "comprehensive performance analysis," while the subsequent factor addresses a "conceptual framework." Performance evaluation entails assessing "the contributions of researchers within a particular subject" (Donthu et al., 2021; Forliano et al., 2020; Sadeqi-Arani & Kadkhodaie, 2023). The authors employed "performance analyses and scientific mapping" approaches to categorise the most prominent papers, "authors, journals, and nations" based on diverse criteria. This article seeks to amalgamate notions from modern literature, specifically emphasising the release year of e-books in most research. Furthermore, it provides a comprehensive collection of authors who have examined the implications of "sustainable aviation." Identifies the countries where the joint writer has collaborated and illustrates research trends in this domain using a tree graphic. This feature encompasses frequently referenced articles and journals organised by publication volume. The researchers commenced the method by formulating the study questions

in alignment with our defined objectives. The primary inquiry posed by the literature study is, "To what extent has the relationship regarding 'sustainable aviation' been analysed over time?" The literature review analyses the crucial relationship between sustainable aviation, now being explored by scholars. This summary was created by the researchers only from publications, employing data from the "Web of Science database" and findings from a "bibliometric analysis."

- "Performance Analysis."
- "Science Mapping."
- "The conceptual structure employs co-word analysis, word cloud, and author keyword analysis."

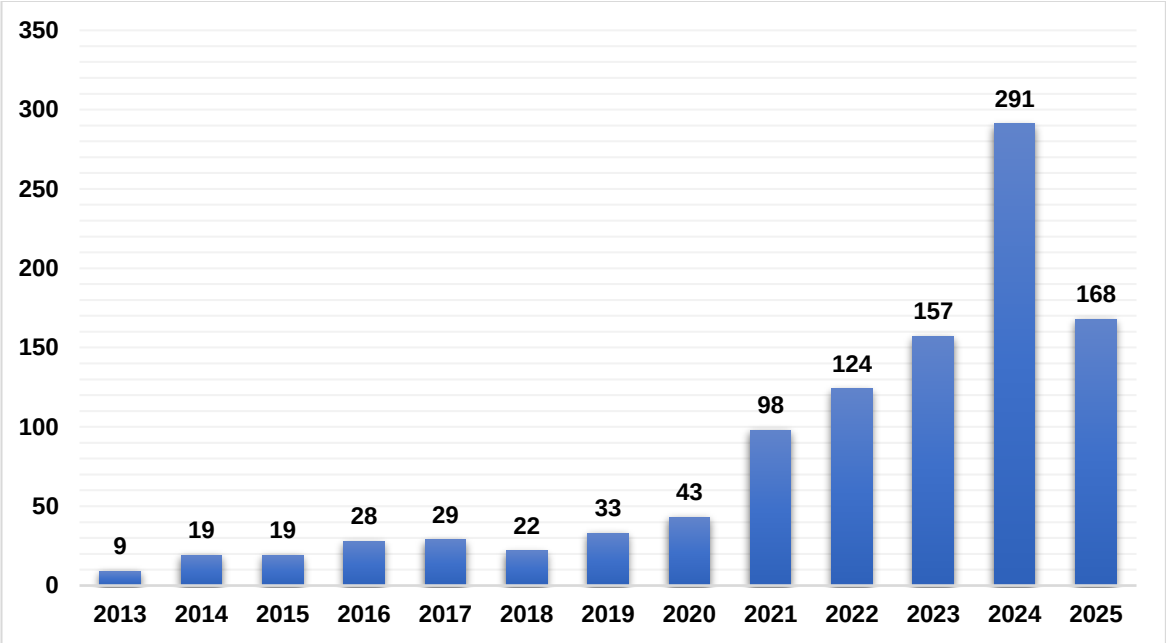

Figure – 2 The Yearly progress of Articles in "sustainable aviation."

Figure 2 primarily illustrates the annual trend in academic paper production related to "sustainable aviation." The data distinctly indicates that from "2013 to 2020," the volume of publications in this domain was markedly insufficient and erratic, comprising merely 19 per cent of the total. From "2021 to June 2025," the quantity of journals in this field has substantially escalated, resulting in an 81 per cent contribution. The "descriptive statistics" reveal that the "annual growth rate" of paper.

4.1.1 Performance Examination of Utmost Dominant "Journals."

Table – 3– Top 10 Utmost Pertinent "Journals"

Rank	Journal names	Count	%
1	"International Journal of Sustainable Aviation"	208	20%
2	"Fuel"	61	6%
3	"Energies"	38	4%
4	"Aerospace"	33	3%

5	"Energy"	28	3%
6	"Energy & Fuels"	22	2%
7	"Journal of Cleaner Production"	21	2%
8	"Energy Conversion and Management"	20	2%
9	"Frontiers In Energy Research"	20	2%
10	"ACS Sustainable Chemistry & Engineering"	18	2%

Source: Data from the "Bibilioshiny R Program" Author Compilation.

Table 3 and Figure 3 depict the leading "journals" that have substantially advanced the field of "sustainable aviation." The data indicates that the "International Journal of Sustainable Aviation" leads with 208 articles, followed by "Fuel" with 61 articles. "Energies" contributes 38 articles, while "Aerospace" has 33, "Energy" 28, and "Energy & Fuels" 22 articles. The "Journal of Cleaner Production" follows with 21 articles, and both "Energy Conversion and Management" and "Frontiers in Energy"

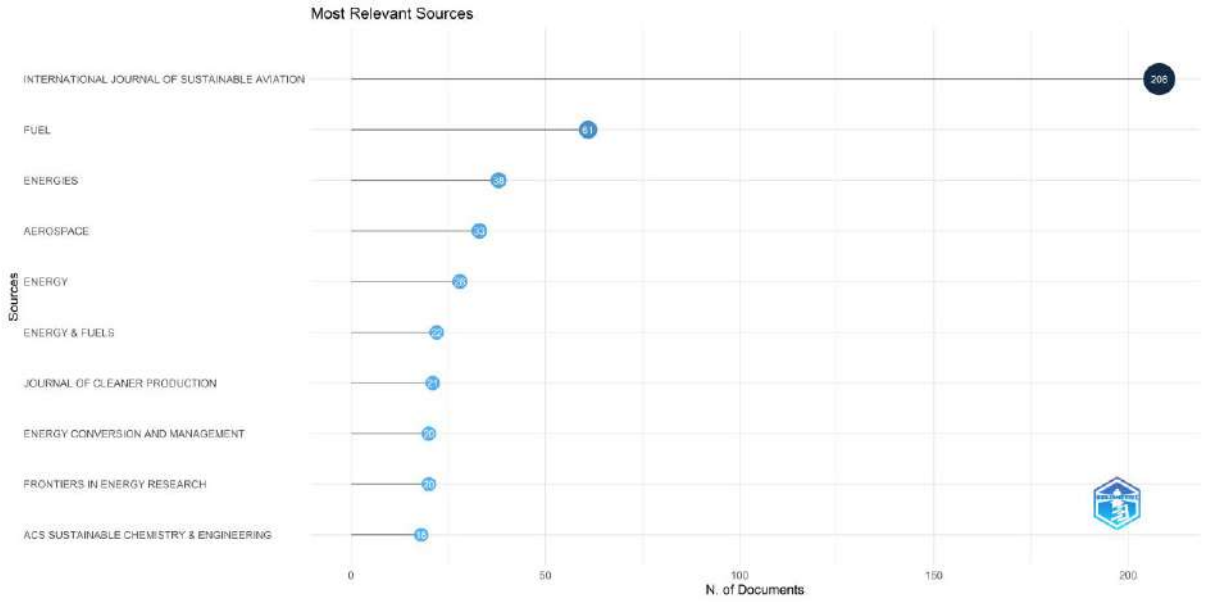

Figure – 3

The top 10 most influential journals.

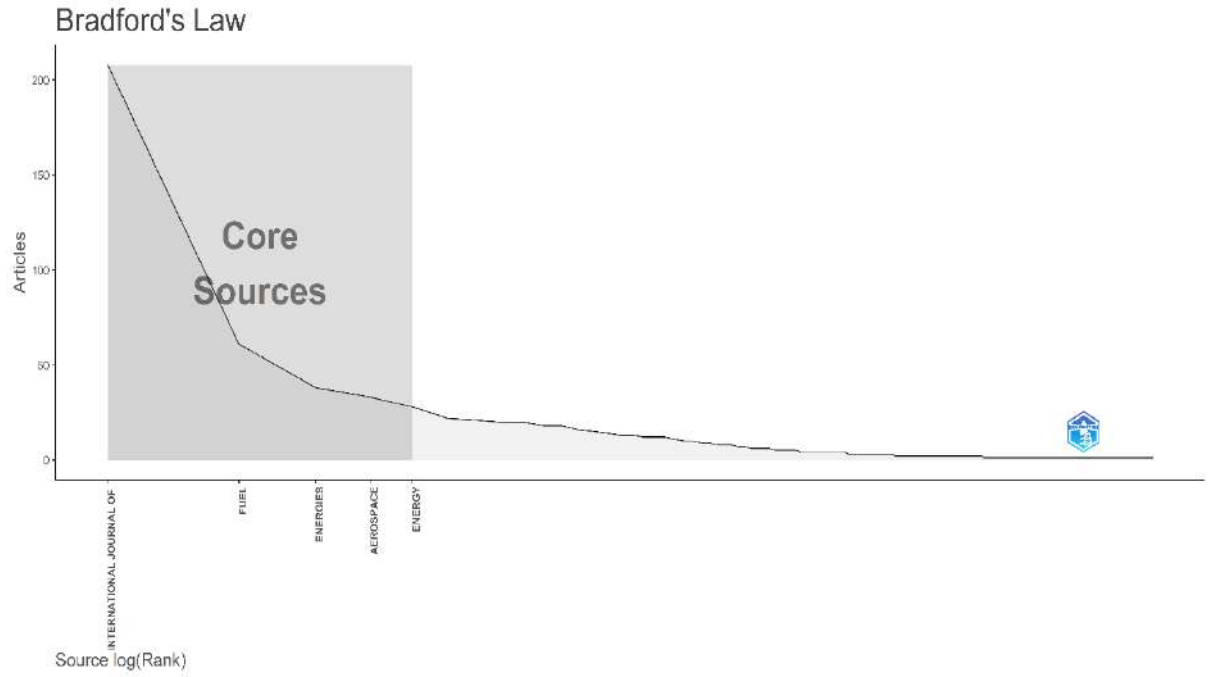

Figure – 4 Bradford's Law of core sources of journals.

"Bradford's Law" denotes a principle in bibliometrics that articulates the distribution of articles within a specific field of study. A limited number of journals account for the majority of published articles, whereas a greater number of journals contribute a smaller volume of articles. This law emphasises the concentration of academic output and is valuable for analysing research trends in particular fields. Figure 4 illustrates that 249 journals published a total of 1040 articles in the inter-collection, while five core journals accounted for 368 articles in the field of "Sustainable Aviation". "Bradford's Law aids in identifying essential journals within a particular subject, following the principles of diminishing returns and dispersion." (Sadeqi-Arani & Kadkhodaie, 2023). Each field is divided into three distinct sections. The upper 'third' ("Zone-1 or core") denotes the frequency of "citations from journals relevant to the literature," which are considered to be of significant interest to researchers in that field, as indicated by the author. The journals in the middle third, or zone 2, demonstrate a moderate citation rate, whereas those in the bottom third, or zone 3, exhibit a low citation rate and are sometimes considered peripheral to the subject area or field. "Bradford's Law" posits that the quantity of journals in the second zone is 'n', whereas the third zone is 'n^2' times larger than the first zone (Nash-Stewart et al., 2012).

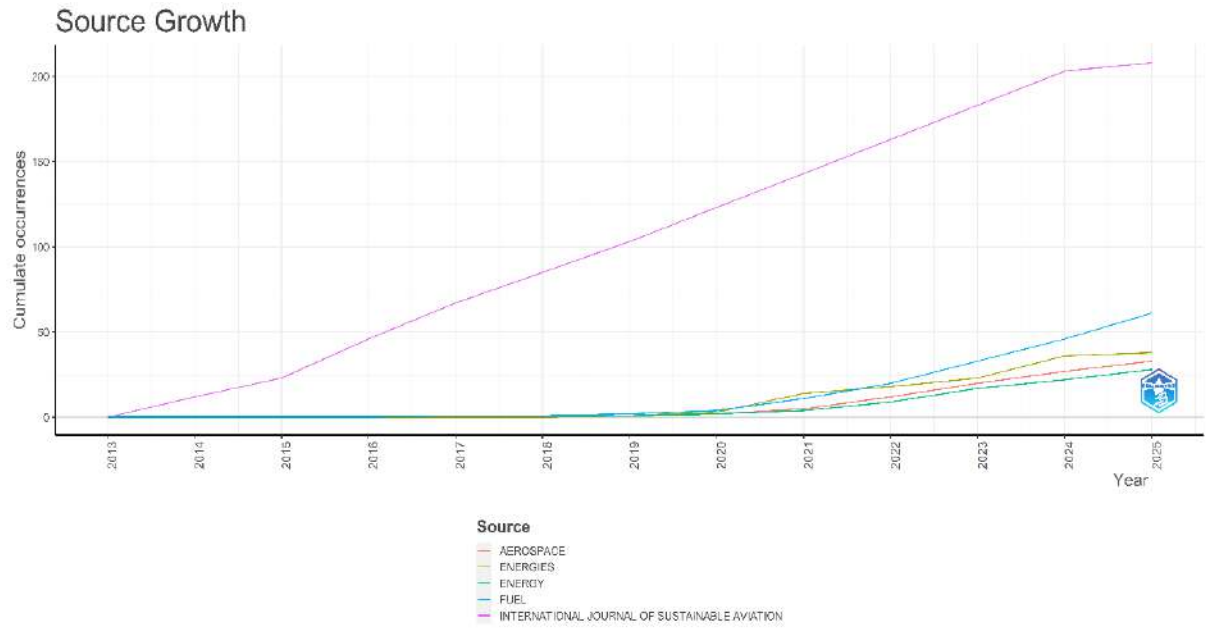

Figure – 5 The Source Growth of top journals.

Figure 5 illustrates the comprehensive rise of prominent publications, with the "International Journal of Sustainable Aviation" exhibiting the most significant performance from 2014 to 2025, with a total occurrence of 208. The following entry is "Fuel", with a total incidence of 61. Other publications, such as "Energies," "Aerospace," and "Energy," documented cumulative occurrences of 133, 102, and 89, respectively. It is evident that these distinguished publications have progressively concentrated on publishing research pertaining to "sustainable aviation" since 2021.

Table – 4 The top 10 Cited Sources of Journals

Rank	Source Name	TC
1	"Fuel"	882
2	"International Journal of Sustainable Aviation"	551
3	"Energy"	541
4	"Renewable & Sustainable Energy Reviews"	466
5	Energy Conversion and Management"	397
6	"Bioresource Technology	374
7	"Transportation Research Part D-Transport and Environment"	357
8	"Biotechnology For Biofuels"	325
9	"Journal of Cleaner Production"	296
10	"Aerospace"	292

Source: Data from the "Bibilioshiny R Program" Author Compilation.

The table (4) and figure (6) illustrate the ten most cited journals in the field of "sustainable aviation." The leading journal is "Fuel," with 882 citations, followed by the "International Journal of Sustainable Aviation," with 551 citations. The "Energy journal" has 541 citations, while "Renewable & Sustainable Energy Reviews" has 466 citations. "Energy Conversion and Management" follows with 397 citations, and

"Bioresource Technology" has 374 citations. The "Transportation Research Part D: Transport and Environment journal" with 357 citations, 325 citations with "biotechnology For Biofuels," followed by the "Journal of Cleaner Production" with 296 citations and 292 citations with the "Aerospace journal."

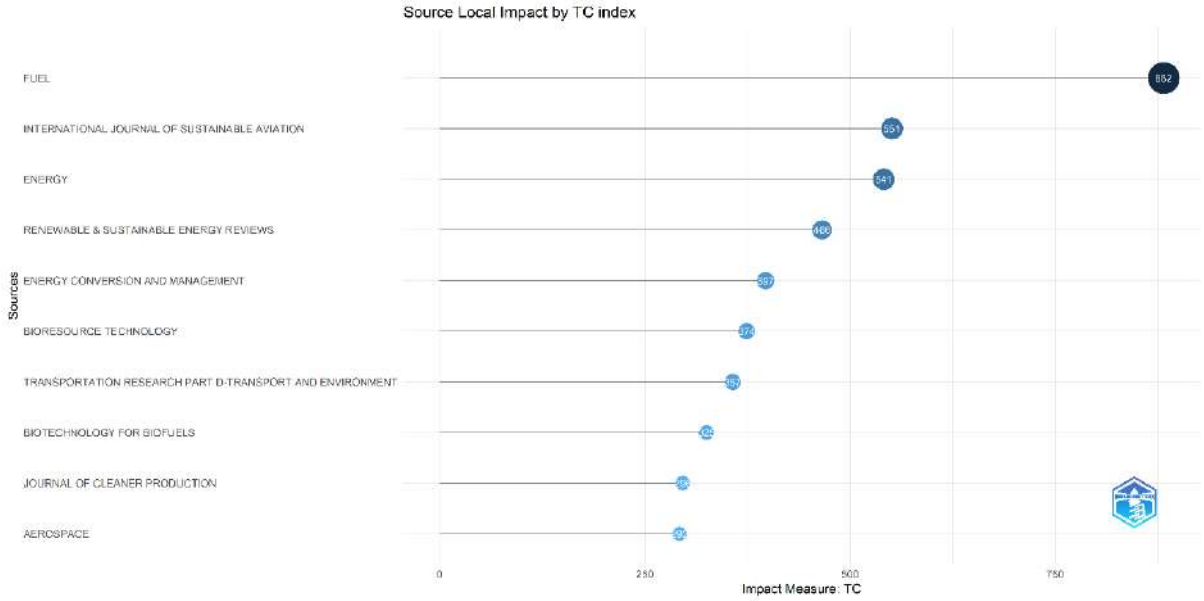

Figure – 6 The top 10 cited journals.

4.1.2 Performance Examination of Top Productive Authors, Organizations, and Countries in "Sustainable Aviation" Domain.

Table – 5 Top Productive authors, Organizations, and countries in "Sustainable Aviation" Arena.

Top Authors	TP	TC	Top Affiliations	Articles	Top Countries	TP	TC
Heyne J	14	331	"Washington State University"	46	USA	656	2375
Heyne JS	13	303	"Beihang University"	43	China	406	1663
Lei TZ	13	154	"University Illinois"	27	Germany	208	1062
Yang ZB	13	281	"Civil Aviat University China"	26	UK	139	908
Harvey BG	12	164	"Purdue University"	26	Turkey	120	363
Dwivedi P	11	104	"Eskisehir Tech University"	25	Italy	76	248
Hajiyev C	11	16	"Delft University Technol"	24	Canada	70	456
Liu P	11	145	"Natl Aviat University"	22	Australia	67	562
Bell DC	9	119	"University Dayton"	22	Brazil	66	188
Boehm RC	9	76	"University Putra Malaysia"	21	France	63	198

Source: Data from the "Bibilioshiny R Program" Author Compilation.

Table 5 and Figures 7, 8, and 9 display the primary authors, their affiliations, and the leading countries contributing to the literature on "sustainable aviation." Heyne J has made a significant contribution by producing 14 documents in the field of "sustainable aviation." Authors Heyne JS, Lei TZ, and Yang have each authored 13 documents in the domain of "sustainable aviation." Authors Harvey BG, Dwivedi P, Hajiyev C, Liu P, Bell DC, and Boehm RC have each contributed 12, 11, 11, 11, 9, and 9 documents, respectively, in the field of "sustainable aviation." "Washington State University, Beihang University, and the University of Illinois" are the three leading institutions, contributing 46, 43, and 27 documents, respectively. "Civil Aviation University of China and Purdue University" each contributed 26 documents, while "Eskisehir Technical University" provided 25 documents. "Delft University of Technology" submitted 24 documents, and "National Aviation University, University of Dayton, and University Putra Malaysia" each contributed 22, 22, and 21 documents, respectively. The list above identifies the countries with the highest article production. The "United States" leads with 656 articles, followed by "China" with 406, "Germany" with 208, the "United Kingdom" with 139, "Turkey" with 120, "Italy" with 76, "Canada" with 70, "Australia with 67, Brazil with 66, and France with 63.

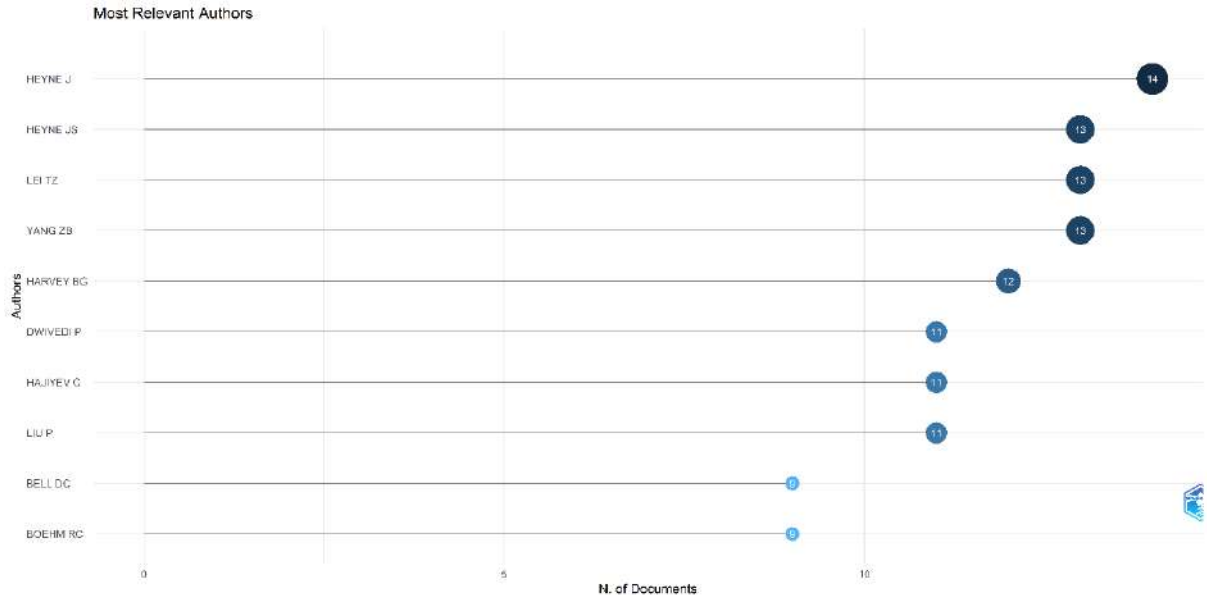

Figure – 7 Most Relevant Writers.

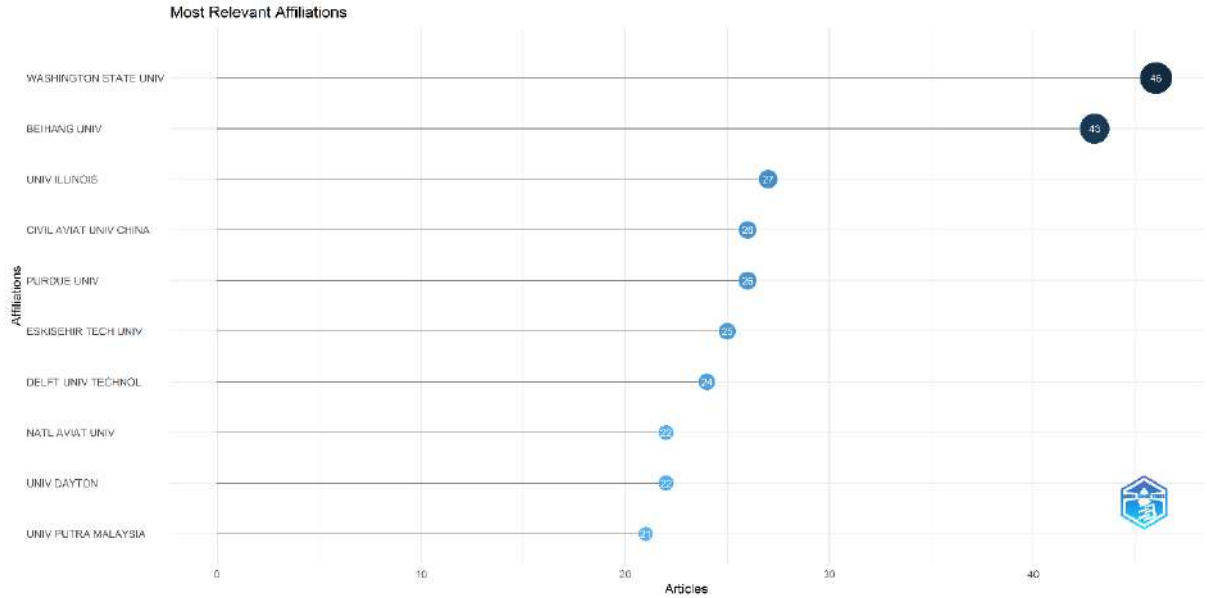

Figure – 8 Most Relevant Affiliations.

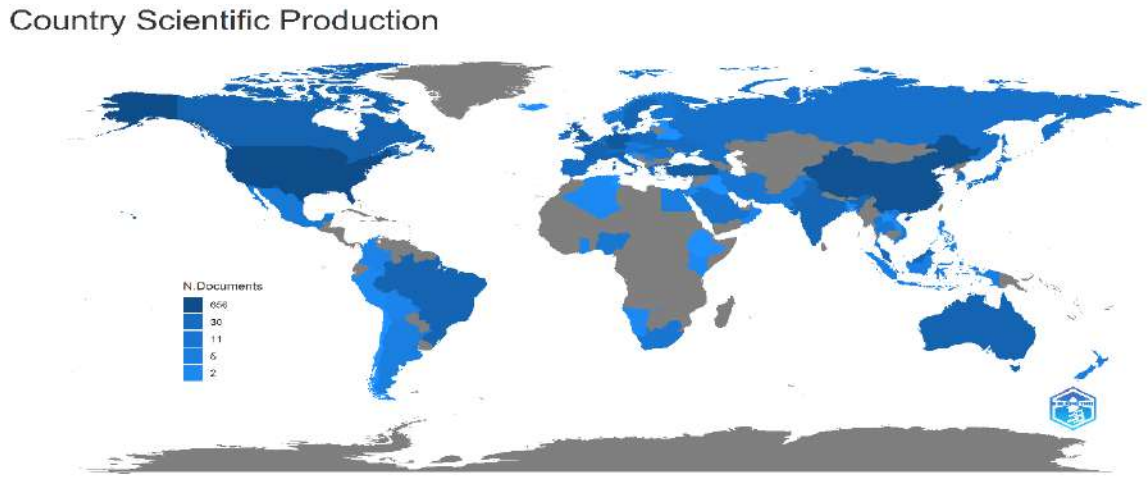

Figure – 9 Country Scientific Productions.

4.1.3 Performance Examination of Topmost Cited Prolific Writers, and Nations in "Sustainable Aviation" Domain.

Table – 6 Top Cited Prolific writers and nations.

Authors	TC	Countries	TC
Le Clercq P	343	USA	2375
Heyne J	331	China	1663
Lu XF	315	Germany	1062
Voigt C	307	United Kingdom	908
Rauch B	307	Australia	562
Heyne JS	303	Canada	456
Schripp T	303	Turkey	363
Yang ZB	281	Italy	248
Anderson BE	268	Switzerland	202
Sauer D	266	Norway	200

Source: Data from the "Bibilioshiny R Program" Author Compilation.

Table 6 and Figures 10 and 11 display the authors and nations most frequently cited in the literature on "sustainable aviation." The following authors are the most frequently cited. "Le Clercq P" is the foremost author in citations, amassing a total of 343 citations. Authors ranked by citations: Heyne J with 331 citations, Lu XF with 315 citations, Voigt C and Rauch B. each with 307 citations, Heyne JS and Schripp T each with 303 citations, Yang ZB with 281 citations, Anderson BE with 268 citations, and Sauer D with 266 citations. The leading countries in the field of "sustainable aviation," as measured by "total citations (TC)," are the "USA" with 2,375, followed by "China" with 1,663, and "Germany" with 1,062. Other significant nations include the "United Kingdom" with 908 citations, "Australia" with 562, "Canada" with 456, "Turkey" with 363, "Italy" with 248, "Switzerland" with 202, and "Norway" with 200.

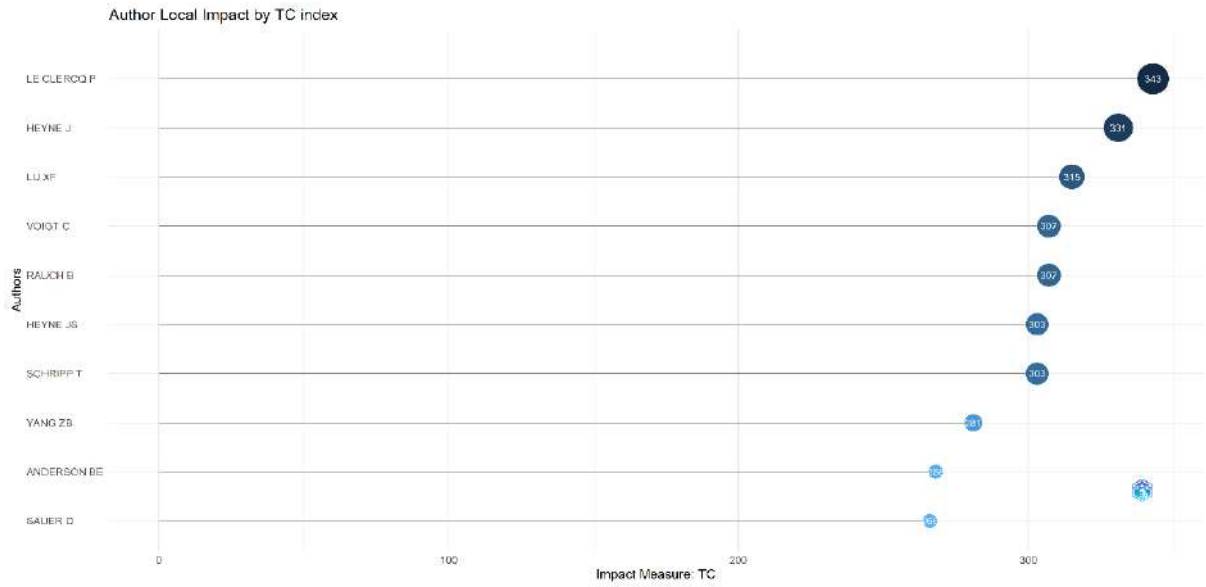

Figure – 10 Top Cited Writers.

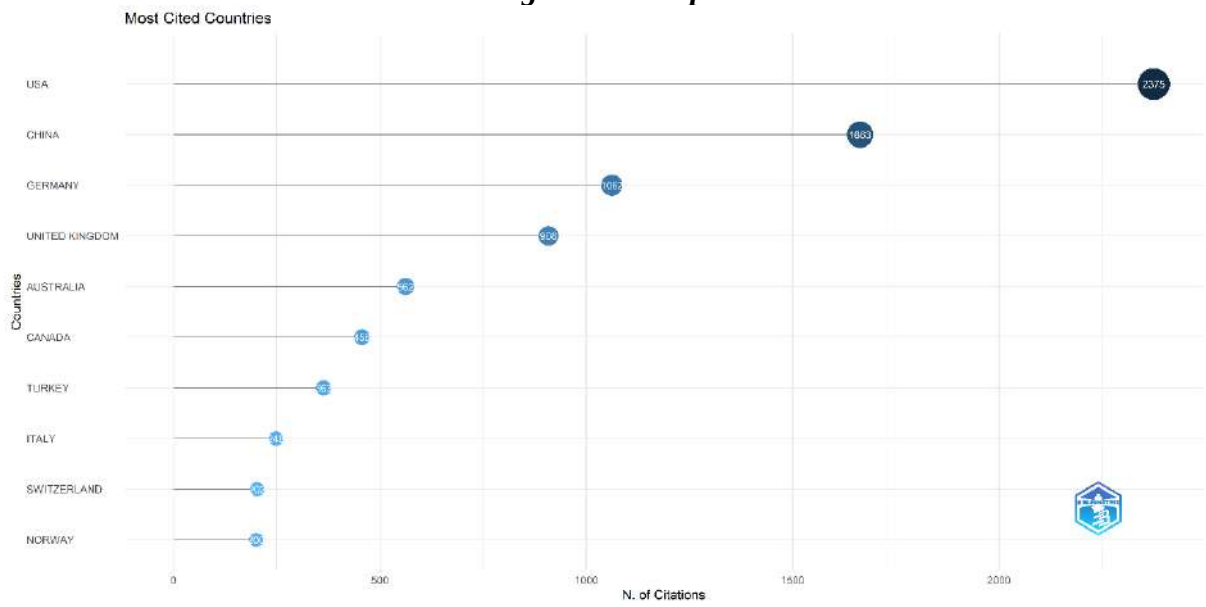

Figure – 11 Top Cited Nations.

4.1.4 Performance of Authors Under "Lotka Law."

Table – 7 Authors Frequency of Publications.

Documents written	N. of Authors	Proportion of Authors
1	2829	0.795
2	432	0.121
3	150	0.042
4	75	0.021
5	25	0.007
6	12	0.003
7	11	0.003
8	10	0.003
9	7	0.002

11	3	0.001
12	1	0
13	3	0.001
14	1	0

Source: Data from the "Bibilioshiny R Program" Author Compilation.

Table 7 and Figure 12 indicate that over 79.5% of respondents concurred to varying degrees with all the statements delineated in the table. The results indicate that 79.5% of the authors are infrequent contributors, having authored only one paper in accordance with "Lotka's law." "Lotka proposed an inverse square law," asserting that the number of writers publishing a particular quantity of articles is inversely proportionate to the number of writers publishing solely one article. This concept posits that the anticipated "beta coefficient" of "Lotka's law," which quantifies the frequency of authors' publications within a specific topic or field, is projected to be 2. "Heyne J" has written 14 articles, establishing him as a prominent contributor in the field of "sustainable aviation".

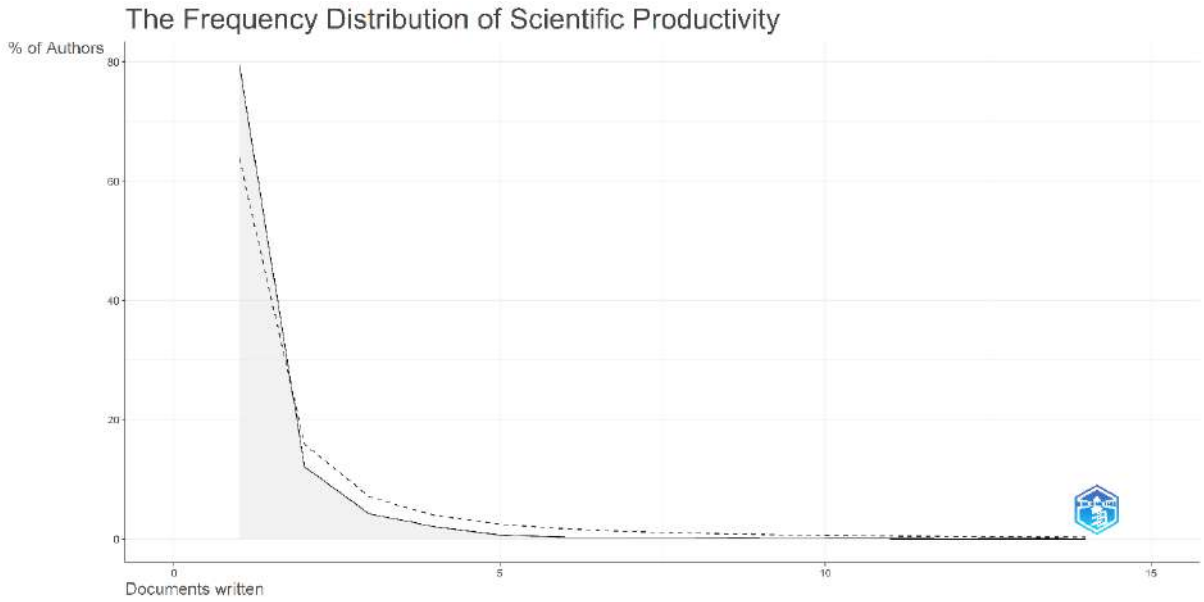

Figure – 12 Authors Frequency of Publications based upon "Lotka Law."

4.1.5 The "Top Corresponding Nations" With Reference to "Sustainable Aviation" Field.

Table – 8 Top Corresponding Country Frequency of Publications.

Country	Articles	SCP	MCP	Freq	MCP_Ratio
USA	226	190	36	0.217	0.159
China	139	111	28	0.134	0.201
Germany	89	58	31	0.086	0.348
Turkey	75	66	9	0.072	0.12
United Kingdom	53	32	21	0.051	0.396
Italy	37	26	11	0.036	0.297
Canada	36	27	9	0.035	0.25

Australia	29	22	7	0.028	0.241
India	23	16	7	0.022	0.304
Brazil	22	19	3	0.021	0.136
France	21	13	8	0.02	0.381
Sweden	19	14	5	0.018	0.263
Netherlands	17	13	4	0.016	0.235
Ukraine	17	9	8	0.016	0.471
Malaysia	14	11	3	0.013	0.214
Ireland	13	8	5	0.013	0.385
Poland	13	12	1	0.013	0.077
Hungary	12	10	2	0.012	0.167
Greece	11	6	5	0.011	0.455

Source: Data from the "Bibilioshiny R Program" Author Compilation.

Table 8 and Figure 13 indicate that the "United States" has generated 226 papers in the field of "sustainable aviation" concerning "SCP and MCP publications," while "China" has contributed 139 articles and "Germany" has supplied 89. These nations account for nearly 44% of all periodicals. Writers typically classify papers into two categories: "single-country publications (SCP)" and "multiple-country publications (MCP)." All studies within the 'SCP' are executed by researchers from the same country', 'a method referred to as intra-country research'. "MCP" is an abbreviation with a distinct and traceable origin. The involvement of writers from several nations enhances "MCP,", a concept acknowledged as global collaboration. Among the 20 countries, the United States has the highest "MCP" ratio, documented at 16%.

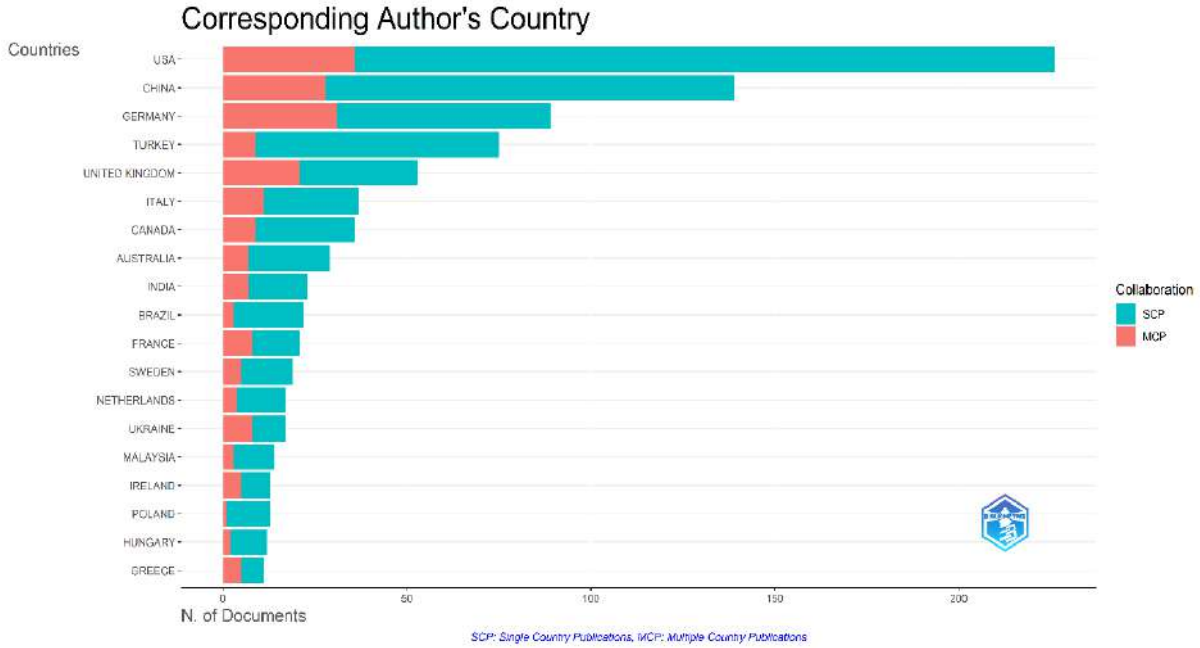

Figure – 13 Top Corresponding countries.

4.1.6 Performance of "Global Documents."

Table – 9 Topmost "Cited Articles" in "Sustainable Aviation" Research.

Rank	Year	Author	Title of the Paper	Journal Name	DOI	Total Citations	TC per Year	Normalized TC
1	2014	Ma et al.	"Evaluation of the potential of 9 Nannochloropsis strains for biodiesel production."	"Bioresource Technology"	https://doi.org/10.1016/j.biortech.2014.06.047	184	15.33	5.93
2	2021	Voigt et al.	"Cleaner burning aviation fuels can reduce contrail cloudiness."	"Communications Earth & Environment"	https://doi.org/10.1038/s43247-021-00174-y	162	32.4	7.56
3	2016	Peeters et al.	"Are technology myths stalling aviation climate policy?"	"Transportation Research Part D Transport and Environment"	https://doi.org/10.1016/j.trd.2016.02.004	162	16.2	11.43
4	2021	Ng et al.	"Global biorenewable development strategies for sustainable aviation fuel production."	"Renewable and Sustainable Energy Reviews"	https://doi.org/10.1016/j.rser.2021.111502	157	31.4	7.33
5	2013	W. Wang et al.	"Engineering cyanobacteria to improve photosynthetic production of alka(e)nes."	"Biotechnology for Biofuels"	https://doi.org/10.1186/1754-6834-6-69	156	12	2.81
6	2023	Bergero et al.	"Pathways to net-zero emissions from aviation."	"Nature Sustainability"	https://doi.org/10.1038/s41893-022-01046-9	127	42.33	12.63
7	2021	Prussi et al.	"CORSIA: The first internationally adopted approach to calculate life-cycle GHG emissions for aviation fuels."	"Renewable and Sustainable Energy Reviews"	https://doi.org/10.1016/j.rser.2021.111398	126	25.2	5.88

8	2022	Zoller et al.	"A solar tower fuel plant for the thermochemical production of kerosene from H2O and CO2."	"Joule"	https://doi.org/10.1016/j.joule.2022.06.012	112	28	7.34
9	2014	Liu et al.	"Hydrogen peroxide-independent production of α-alkenes by OleTJE P450 fatty acid decarboxylase."	"Biotechnology for Biofuels"	https://doi.org/10.1186/1754-6834-7-28	109	9.08	3.51
10	2016	Breil et al.	"Bio-Based Solvents for Green Extraction of Lipids from Oleaginous Yeast Biomass for Sustainable Aviation Biofuel."	"Molecules"	https://doi.org/10.3390/molecules21020196	103	10.3	7.26

Source: Data from the "Bibilioshiny R Program" Author Compilation.

Table 9 and Figure 14 illustrate the most frequently cited works in the domain of sustainable aviation. The foremost referenced study is titled "Evaluation of the potential of 9 Nannochloropsis strains for biodiesel production", authored by Ma et al. and published in 2014 in Bioresource Technology, with 184 citations. The second position is held by "Cleaner burning aviation fuels can reduce contrail cloudiness", authored by Voigt et al. and published in 2021 in Communications Earth & Environment with a total of 162 citations. The third position is held by the article titled "Are technology myths stalling aviation climate policy?" authored by "Peeters et al." and published in 2016 in "Transportation Research Part D Transport and Environment", which has received 162 citations. The statistics identify the three most cited papers, each of which has a total of 162 citations. The third position is held by the article titled "Are technology myths stalling aviation climate policy?" authored by "Peeters et al." and published in 2016 in "Transportation Research Part D Transport and Environment", which has received 162 citations. The statistics identify the three most cited papers, with the remaining.

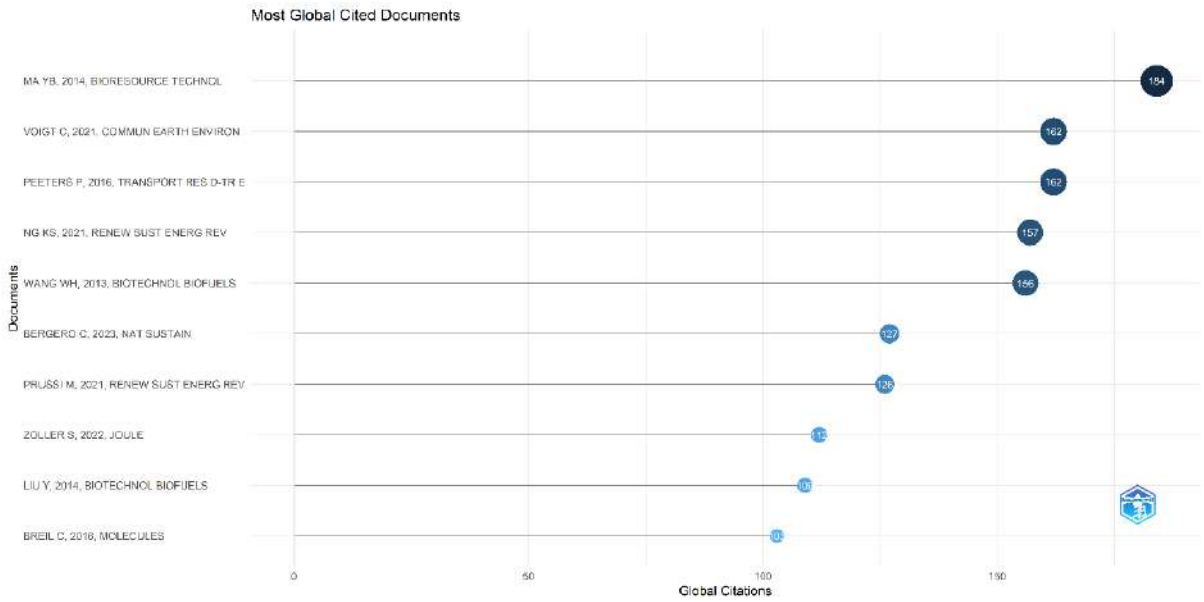

Figure – 14 Top Global Cited Articles.

4.2 Science Plotting

"Science mapping" entails the examination of the interconnections among various technical operations, including research aspects (Baker et al., 2021). This study examines the arrangement of structural linkages and the interaction of concepts in the creation of artistic creations. The study closes with a "scientific mapping" analysis to illustrate the "data, focusing specifically on the primary author keywords." Madhan et al. (2023)

4.2.1 The "Concurrence of Writer Keywords."

Figure – 15 Word Cloud

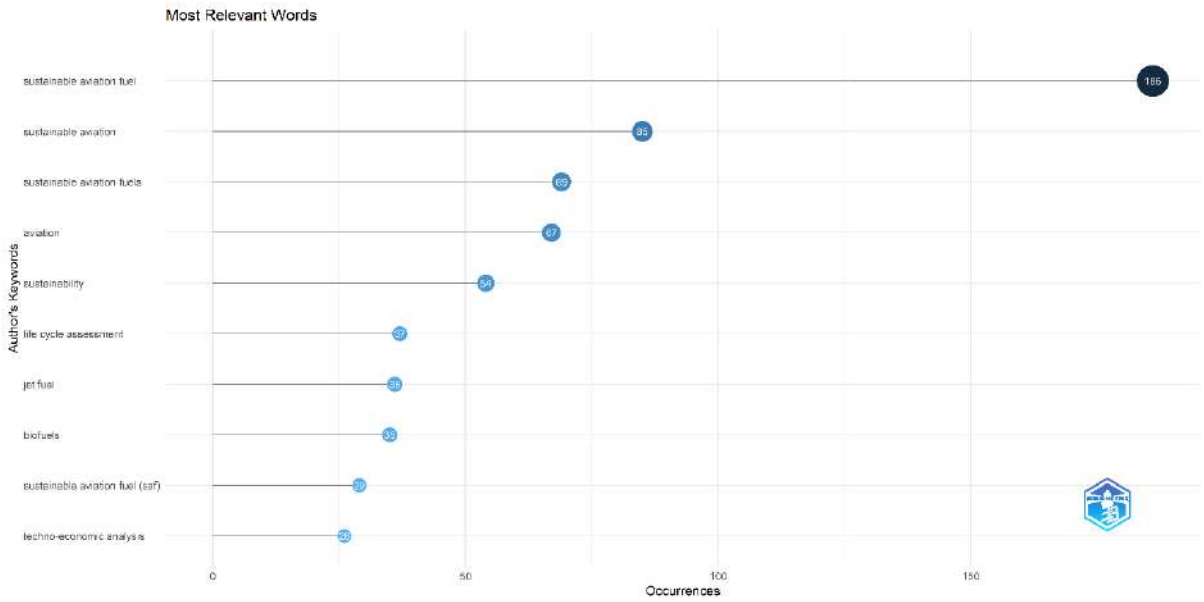

Figure – 16 The Most Repeated Author Keywords.

Figures 15 and 16 depict the word cloud, showcasing the most prevalent writer keywords in the field of "sustainable aviation". The word cloud analysis reveals that the predominant keywords are "sustainable aviation fuel", "sustainable aviation", "sustainable aviation fuels", "aviation", "sustainability", "life cycle assessment", "jet fuel", "biofuels", "sustainable aviation fuel (SAF)", and "techno-economic analysis". In relation to the author's keywords, the percentage shares are as follows: 3%, 2%, 1%, 1%, 1%, 1%, 1%, 1%, 1%, and 1%.

4.2.2 Trending Topics

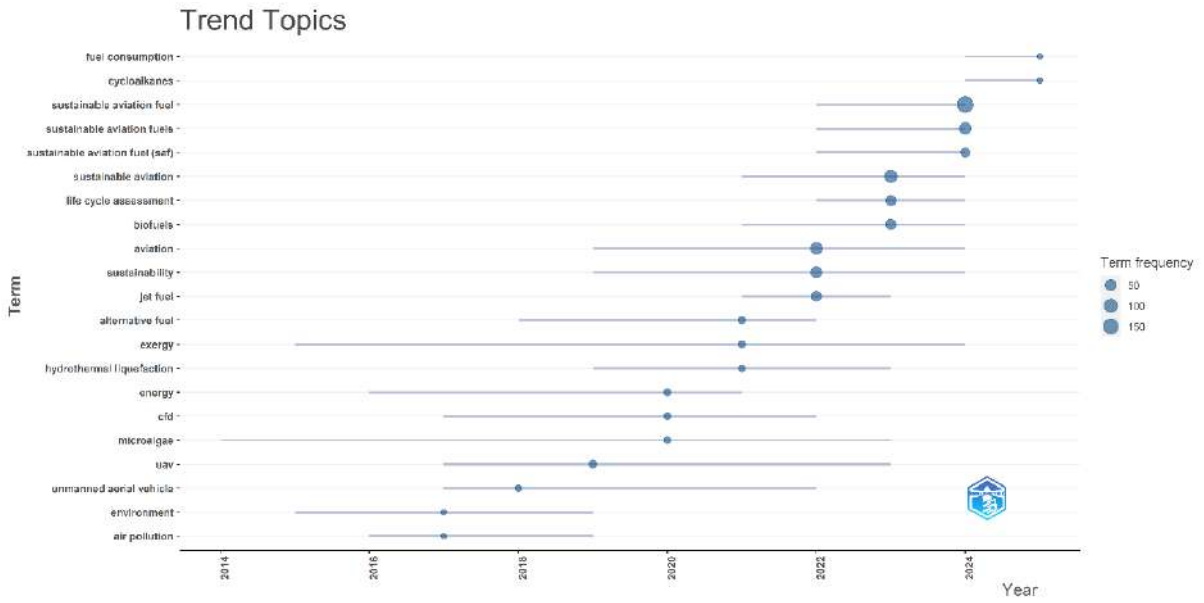

Figure – 17 Trending Topics.

Figure 17 illustrates that, particularly from 2021 onwards, researchers have increasingly focused on "sustainable aviation" topics, including "sustainable aviation fuel," "cycloalkanes," "fuel consumption," "biofuel," "jet fuel," "alternative fuel," and "exergy." Beginning in 2024, there has been a significant shift towards areas such as "sustainable aviation fuel". Researchers have commenced exploration of "sustainable aviation" domains since “the post-Covid era,” starting in 2020.

4.3 Conceptual-Structure

Co-word analysis is predicated on the premise that the simultaneous occurrence of two terms elucidates the principal concepts and themes within a “scientific discipline” (Noyer, 1983). This methodology quantitatively delineates “co-occurrences by examining occurrence frequencies, which reflect associations or shared data.” Co-word analysis elucidates the interrelationships among various themes in a research domain by assessing the frequency of “word or phrase pairs,” thereby enabling researchers to monitor advancements in science (He, 1999). This approach facilitates “the identification and documentation of all connections” between terms in the scientific realm, “along with their mapping and visualisation” (Del Barrio-García et al., 2020).

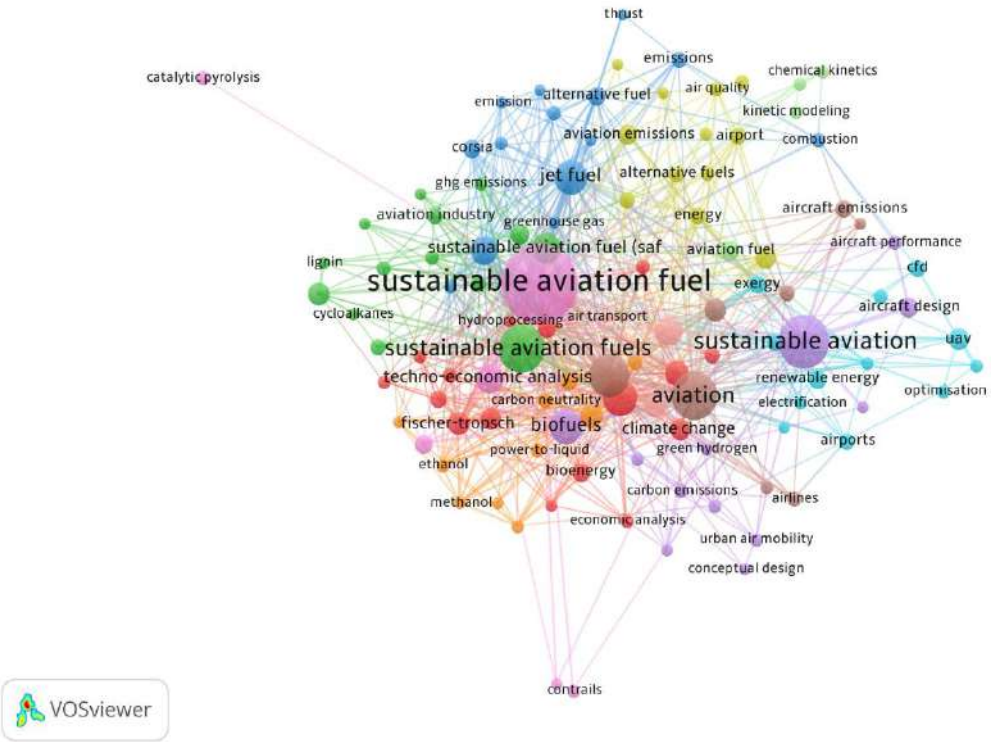

Figure – 18 Author keywords Analysis with Reference to “Sustainable Aviation”

Figure 18 depicts the interconnections among co-occurring phrases within the network. The researchers set a minimum requirement of five times for phrases to appear together and looked at 3,297 terms, which resulted in 11 groups that represent the main topics in “sustainable aviation research.” The diameter of each circle is

directly proportional to the "frequency of the keyword's occurrence." Each cluster is defined by a unique colour, and all words within it display the same shade.

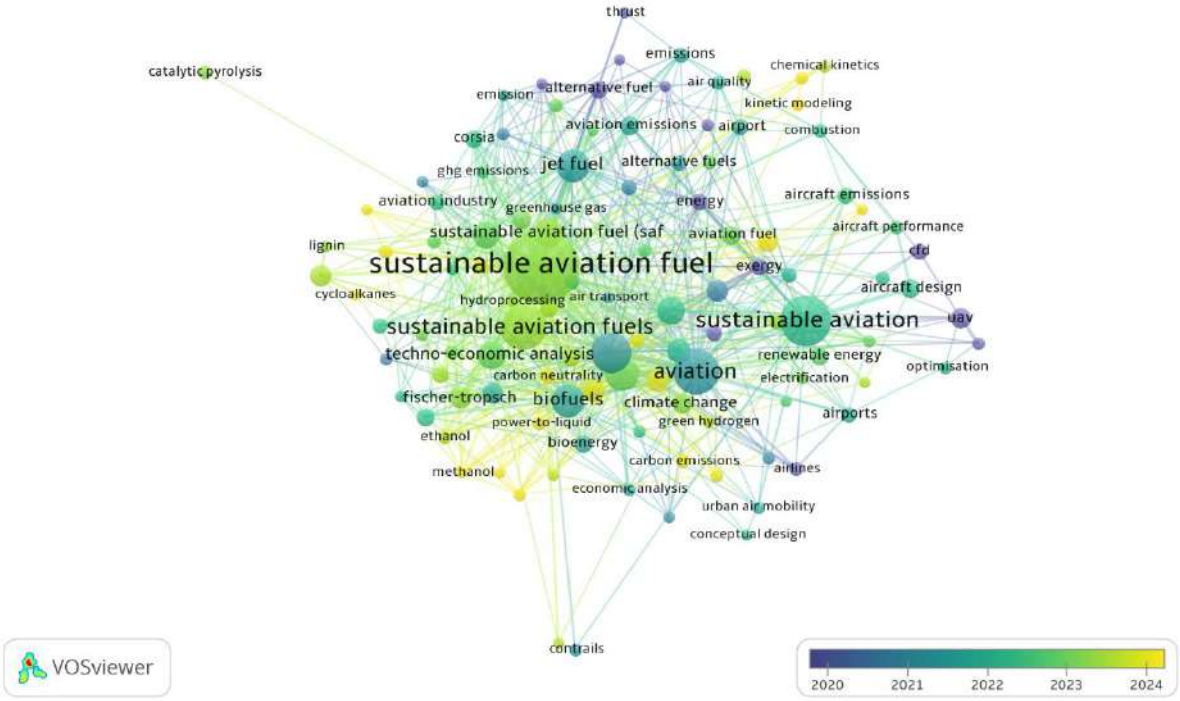

Figure – 19 Sequential Outline of Writer Keywords.

Figure - 19 illustrates the convergence of research periods pertaining to "sustainable aviation," accompanied by the co-word map of pertinent works. The temporal chart enables researchers to accurately categorise historical and modern patterns among various disciplines. The study reveals that just 112 of the 3,297 author keywords were repeated five times. Keywords have been categorised into five clusters, resulting in a total link strength of 1183. The researchers conducted this investigation to determine the primary themes in historical and contemporary contexts. Prior research has investigated issues like "biofuels, alternative fuels, jet fuel, exergy, unmanned aerial vehicles, microalgae, sustainability, and bioenergy." The current focus encompasses various domains, including "renewable fuels, carbon emissions, power-to-liquid technology, green hydrogen, bio-jet fuel, biomass, fuel consumption, shock tubes, kinetic modelling of cycloalkanes, decarbonisation, carbon neutrality, methanol, and machine learning."

5. Findings of The Study.

- The current investigation has been conducted utilising "the Web of Science database."
- Furthermore, the data has been sourced from the years 2013 to 2025.
- The current study is entirely a "bibliometric study" of all nature.

- With reference to the number of publications in the area of "sustainable aviation," there is an upward trend from "2021 to June 2025"; the size of periodicals in this sector has greatly expanded, resulting in an 81 per cent contribution.
- The most influential journals that have significantly contributed to the advancement of "sustainable aviation" The data reveals that "International Journal of Sustainable Aviation" provides the most with 208 articles, followed by "Fuel" with 61 articles. "Energies" with 38 articles.
- The key authors, contributing to the literature on "sustainable aviation." The author, "Heyne J", has made a major contribution, having written 14 documents in the areas of "sustainable aviation." Authors Heyne JS, Lei TZ, and Yang have each contributed 13 documents in the field of "sustainable aviation."
- The list of countries that produce the biggest number of articles: the "USA" has the highest number of articles at 656, followed by "China" with 406, "Germany" with 208, the "UK" with 139, "Turkey" with 120, "Italy" with 76, "Canada" with 70, "Australia" with 67, "Brazil" with 66 and "France" with 63.
- The authors and nations furthermost commonly referenced in the "literature concerning sustainable aviation." The subsequent authors are the furthermost recurrently quoted. "Le Clercq P" is the leading author in citations, with a total of 343 citations. Followed by writers; Heyne J with 331 citations and Lu XF with 315 citations. The foremost nations in the domain of "sustainable aviation," as indicated by total citations (TC), are the "USA" with 2375 citations, followed by "China" with 1663 and "Germany" with 1062.
- The top cited journals in which the top cited journal in the area of "sustainable aviation" is "Fuel" with 882 citations, followed by "the International Journal of Sustainable Aviation" with 551 citations and "the Energy journal" with 541 citations.
- The engrossment of writers from diverse nations enriches "MCP," a notion recognised as universal teamwork. Among the 20 countries, "USA" demonstrates the highest "MCP ratio," recorded at 16%.
- The "word cloud analysis" indicates that the most frequently used keywords include "sustainable aviation fuel," "sustainable aviation," "sustainable aviation fuels," "aviation," "sustainability," "life cycle assessment," "jet fuel," "biofuels," "sustainable aviation fuel (saf)," and "techno-economic analysis."

6. Contributions of The Research.

- This research has made considerable "contributions to the literature" on "sustainable aviation."
- The "VOSviewer software version 1.6.18" and the "Biblioshiny R program version 4.2.2" were employed in the analysis.

- The “Web of Science database” is utilised in this study, which is recognised as one of the most reputable and expansive databases, containing a substantial number of articles from a variety of sources.
- The research exclusively examined fully published “journal articles in English,” totalling 1040 for data analysis.
- This research is unique in that it exclusively encompasses papers related to "sustainable aviation" in the fields of “business, management, and accounting; social sciences; economics; econometrics; and finance,” while excluding publications from other subject areas. This investigation is exhaustive and thorough, as evidenced by the “literature review” conducted by Dinçer et al. (2024).
- This research has conducted three primary types of analysis: “performance analysis related to prominent writers, documents, nations, and sources.” “Scientific mapping” and conceptual organisation have been the primary focus of this investigation.
- The primary sources were identified in accordance with "Bradford's Law", and the prominent authors were identified using "Lotka's Law".
- The study conducted a thorough analysis of writer keywords using a “word cloud” and investigated the conceptual framework using the “VOSViewer software version 1.6.18” and the “Biblioshiny R program version 4.2.2.”
- The current study suggests that there has been a significant increase in the volume of documents and researchers who are currently studying topics such as “sustainable aviation fuel", "cycloalkanes", "fuel consumption", "biofuel", "jet fuel", "alternative fuel", and "exergy" since 2020, particularly in the post-COVID era.
- This study employed "VOS viewer software" to conduct a temporal analysis of author keywords, which revealed that researchers are currently concentrating on the following topics: "renewable fuels", "carbon emissions", "power to liquid", "green hydrogen", "bio-jet fuel", "biomass", "fuel consumption", "shock tube", "kinetic modelling", "cycloalkanes", "decarbonisation", "carbon neutrality", "methanol", and "machine learning".
- The current analysis identifies the primary affiliations related to total article production in the "sustainable aviation" sector, highlighting "Washington State University," "Beihang University," and "University Illinois" as the top three leading institutions, contributing 46, 43, and 27 documents, respectively.

7. Conclusion

The quantity of studies published on “sustainable aviation” has markedly risen since 2020. This surge is linked to the growing significance of “sustainability” across several sectors globally and the impact of

"dynamic technological advancements on the scientific domain." The challenges of "sustainable aviation" primarily involve the analysis of "sustainable aviation fuel, its manufacture, and its application in the aviation sector." This study employed a "quantitative bibliometric analysis method" to investigate the historical aspects of research on "sustainable aviation." This work is likely among the first analyses to contextualise a "bibliometric examination of sustainable aviation literature." Consequently, pinpointing critical topics and discoveries in "sustainable aviation using bibliometric analysis" can provide researchers with a more lucid understanding of the issue and may direct them in acquiring insights for future investigations. This study offers both practical and intellectual consequences. "Airlines, governments, regulatory bodies, and corporations" can utilise its findings to inform their decision-making processes. The study's findings may enhance awareness of "sustainable aviation" and facilitate informed decision-making and future projections regarding "sustainable aviation" matters.

8. Limitations and Future Directions of The Study.

This study, like others, has certain limitations. Initially, the study excluded publications not in "English" and research areas outside of "business, management, and accounting; social sciences; economics; econometrics; and finance." Secondly, we used "the Web of Science database for literature search" and analysis, and "VOSviewer as the software tool." Publications from databases such as "Scopus, Google Scholar, Microsoft Academic, and Dimensions" were excluded. The sample-size is restricted to one search key. Future studies should explore this subject utilising diverse databases, indexes, software, and analyses while incorporating a larger sample size and additional keywords to enhance the literature.

Furthermore, advancements in digital technology have facilitated the integration of statistics and machine learning methods into workflows. "Airlines utilise advanced technology" and are increasingly adopting a technology-centric approach, integrating a diverse array of interconnected industry ecosystems (Deloitte, 2023). Conversely, "digital technology" continues to evolve, and "research efforts are needed to both overcome fundamental "machine learning problems" and apply novel methods in the "aviation field" (Gao & Mavris, 2022; Dinçer et al., 2024). As "digital technology becomes more important in aviation," future research on "aviation and sustainable practices" should focus on more detailed and complicated subjects and methods, especially on how "sustainability, aviation, and digital technology" work together. In light of current information and technological advancements, establishing additional co-authorship relationships may enhance the development of "sustainable aviation literature" through more comprehensive analyses and diverse perspectives.

AUTHOR CONTRIBUTIONS

All writers have equally contributed towards the article.

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COMPETING INTEREST

The writers state no opposing interests.

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