

Article

Recent Trends in Air Transport Research: A Bibliometric Analysis

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Abstract: The aim of this manuscript is to detect recent trends in air transport research through a bibliometric analysis. We retrieved all articles published between 2013 and 2022 in the Q1 of the Transportation ranking of the Social Sciences Citation Index published in the Journal Citations Reports (Q1-T), and in the Journal of Air Transport Management. Among these records, we retained for the analysis the articles related to air transport. Analyzing the author keywords of articles and retaining the Top 10 cited articles in each of the samples, we identified six research topics for each of the samples. Both samples share the topics of Industry Analysis, Air Traffic Management and COVID-19 and Air Transport. The specific topics of Q1-T sample are High Speed Rail and Air Transport, Environmental Impact of Air Transport and UAV and Urban Air Mobility. We also found that materials of Q1-T are mainly written from the regulator perspective, and JATM materials from the perspective of airport and airline managers. We believe that these results are useful for administrators evaluating air transport academics, and air transport academics themselves looking for new avenues of research and stakeholders of the air transport industry interested in evidence-based decision making.

Keywords: air transport management; transportation; bibliometric analysis



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1. Introduction

Although still recovering from the devastating effects of the COVID-19 pandemic in worldwide mobility, the air transport industry is a relevant actor shaping today's economy and society. During 2022, the air transport system moved 3.2 million passengers, still far from the 4.5 million passengers transported in 2019 [1]. The air cargo industry has come back to pre-pandemic values, transporting 20 billion of cargo-tonne-kilometers monthly by January 2023, far from the peak of 23 monthly cargo-tonne-kilometers transported in 2021, when the excess of capacity of passenger aircraft was divested to cargo operations [2]. The losses of the air transport industry of 137.7 billion dollars in 2020 have been reduced to 9.7 billion dollars in 2022, and industry incumbents believe that the air transport industry will reach pre-pandemic levels by the end of 2023 [3]. Another challenge for the air transport industry is the growing concern for sustainability and emissions in the air transport industry [4]. Concerns about the environmental impact of air transport has led to flight shaming activism [5]. Moreover, the volatility of fossil fuel markets has led a higher appeal for sustainable aviation fuels [3]. In spite of the drawbacks coming from environmental concerns and unstable energy markets, the spillovers of the air transport industry are still considerable. In a recent analysis [6], it has been found that air transport has relevant World Economic Benefits (WEBs) related to connectivity, tourism and savings of time.

Air transport research can contribute to foster the benefits of this means of transportation as long as it is capable of building a more resilient system for disruptive events, being more sustainable and environment-friendly at the same time [7]. Additionally, air transport research needs to be able to respond to new technological challenges. In some countries, such as China or Spain, high-speed rail has been strongly introduced. This means of transportation has a complex relationship with air transport, ranging from competition

for specific routes between cities, to collaboration in intermodal transportation networks [8]. New technologies such as unmanned air vehicles are widening the scope of air transport from the airport to other transportation environments such as urban air mobility [9]. We believe that it is a good moment to evaluate how the air transport research community is responding to the challenges that the air transport industry is facing.

An examination of recent review studies on air transport research leads to two distinct groups of reviews. The first group deals with airport management, and includes reviews about airport service quality [10], the flexible development of airport terminals [11] and airport capacity management [12]. The second group includes reviews about airline management, covering topics such as business aviation [13], the relationship between air transport and tourism [14], air travel demand analysis [15] and airline productivity [16]. While recent reviews of air transport cover specific topics, since a 2012 study [17] we have not found any review examining the research trends in air transportation. Our objective is to fill this gap in the literature identifying the recent research trends in air transport research examining the articles published in top journals on the field of transportation, paying specific attention to journals specifically dedicated to air transport research.

2. Materials and Methods

We are examining the field of air transport research through bibliometric analysis. This technique has gained growing popularity because of the availability of large volumes of research data from scientific databases such as Web of Science, Journal Citation Reports and Scopus [18]. Bibliometric analysis is preferred to other review methods such as meta-analysis and systematic literature reviews when the scope of the review is large and the resulting dataset is large. The bibliometric analysis has been successfully used in transportation research in fields such as airport service quality [10], data envelopment analysis applied to the transportation sector [19], human mobility during COVID-19 [20] or the evolution of a specific journal [21].

The workflow of the bibliometric analysis is presented in Figure 1. Once the research objectives have been defined, the analysis starts with the selection of bibliographical sources and the data retrieval process. In this study, data consists of research articles from relevant transportation journals. In a second stage, we present the air transport literature apart from the transportation articles. After obtaining the air transportation literature records, we carry out two different analysis: a keyword analysis (third stage) and the identification of top-cited articles in air transport (stage four). The fifth and last stage consists of using the findings of the two previous stages to identify the research trends in air transport research.

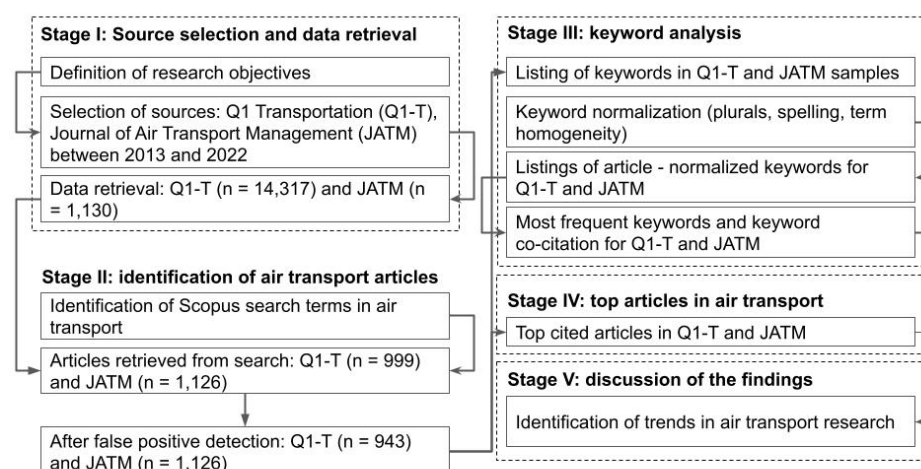


Figure 1. Flow chart of the research. The Q1-T is the set of first quartile journals of the *Transportation* ranking of the SSCI (see Table 1), and JATM is the *Journal of Air Transport Management*.

2.1. Source Selection and Data Retrieval

Our research objective consists of performing a bibliometric research to evaluate trends in air transport research; thus, our first job was to identify bibliographical sources of this research. As we are interested in the managerial and organizational aspects of air transport, we turned our attention to the *Transportation* ranking of journals in the *Social Sciences Citation Index*, published by Clarivate Analytics in the *Journal Citation Reports*. From this ranking, we selected two types of sources:

- The journals of the first quartile of the ranking, as published in 2022 with data from 2021. This was the most recent ranking published at the time of doing this research;
- The *Journal of Air Transport Management*, a journal focused on addressing “the major economic, management and policy issues facing the air transport industry today”, as presented with its aim and scope.

In Table 1 are presented the nine journals included in the mentioned ranking. JATM is in the second quartile of this ranking, with a Journal Impact Factor of 5.428. JATM's ISSN is 0969-6997.

Table 1. Listing of first quartile journals of the *Transportation* ranking of the *Social Sciences Citation Index* (SSCI).

Journal Name	ISSN	2021 JIF
Journal of Public Transportation	1077-291X	37.67
Analytic Methods in Accident Research	2213-6657	14.56
Transport Reviews	0144-1647	10.19
Transportation Research Part E-Logistics and Transportation Review	1366-5545	10.05
Transportation Research Part B-Methodological	0191-2615	7.63
Transportation Research Part D-Transport and Environment	1361-9209	7.04
Transportation Research Part A-Policy and Practice	0965-8564	6.62
Accident Analysis and Prevention	0001-4575	6.38
Transport Policy	0967-070X	6.17

To evaluate the trends in transportation research in the last ten years, we retrieved the articles of the selected journals with the date of the final publication between 2013 and 2022, both inclusive. We retrieved the articles from Web of Science and Scopus, as each bibliometric database provides complementary information. We used Scopus to identify the sources of the type *Article* and *Review*, which were the only ones that we retrieved for the analysis.

2.2. Identification of Air Transport Articles

While JATM is almost exclusively dedicated to air transport research, the rest of the journals accept research articles involving any transportation means; thus, the first job to undertake was to select the articles dealing with air transport research published between 2013 and 2022 in the journals listed in Table 1. In previous research, this task was performed by searching for the term “air” and/or “transport” in the title and abstract of keywords of articles [17]. Similarly to other bibliographic analyses [13], we refined this procedure by including additional tokens in the research with the aim of covering the facets of air transport. The retained tokens are listed in Table 2.

Relying solely on the specific search may lead to false positives, that is, articles covered by the search strategy not dealing with air transport. We carried out an exhaustive false positive detection search by examining the title and abstract of the sample of selected articles manually.

Table 2. Tokens used in the search of articles of air transport in title, abstract and keywords.

Tokens			
Air transport	Air travel	Airport	Airline
Low cost carrier	Low-cost carrier	Flight	Flying
Aviation	Air cargo	Air-cargo	Cargo-air
Air freight	Aerospace	Aircraft	Airplane
Air navigation	Air traffic	Air taxi	Drone
Air passenger	Overbooking	Cabin attendant	Air network
hsr-air	air-hsr	Air-rail	Rail-air

2.3. Keyword Analysis and Selection of Top Articles

After obtaining the samples of air transport research articles published in Q1 Transportation journals and in JATM, we analyzed them through two elements:

- Keyword analysis;
- Top-cited articles.

Most scientific journals make it compulsory for authors to add keywords, which are later retrieved in scientific databases such as Scopus and Web of Science. Keywords can be considered tags or tokens selected by authors to identify the subject of their research, the research methodologies used or the theoretical perspectives adopted [22]. We retrieved the author keywords of all articles of the final samples defined in the previous section. Usually authors are not required to standardize the way they used keywords; thus, we defined a keyword normalization procedure. Firstly, we calculated the distance between all pairs of keywords using the *Optimal String Alignment* measure. This metric counts the number of insertions, substitutions and deletions necessary to turn a string x into a string y , allowing the transposition of adjacent characters. We retained all pairs of keywords with distances smaller or equal than two, and examined each pair manually. This allowed us to collapse singulars and plurals (e.g., “accident” and “accidents”), differences of spelling (“airfare” and “air fare”) and British-American English spelling (“air travel behavior” and “air travel behaviour”). Secondly, we collapsed into a single keyword concepts worded in different ways. A special case was low cost carriers, referred to as “low cost carrier”, “low-cost carrier”, “low-cost-carrier” and “low cost airlines”, among other spellings. This normalization process allowed us to obtain a more consistent set of keywords.

Previous bibliometric research has used keywords to evaluate citation bursts of top used keywords [23], in order to explore the map of knowledge with co-citation keyword networks [12] or to examine the keyword frequency distribution through the Herfindahl–Hirschman concentration index [13].

Another valuable source of information about research trends is the top-cited articles, as used by [24] in their analysis of the first forty years of TR-B, and by [23] in a similar analysis for JATM. We ranked the articles of the sample using the number of citations in Web of Science, which is usually the most authoritative source for article relevance.

Both keyword analysis and top-cited articles ranking were carried out for the Q1-T and JATM samples separately. We conducted this to compare the research trends on air transport in transportation journals with the trends observed in JATM, which are mainly focused on air transport.

2.4. Relationships between Research Topics

As researchers tag their articles with more than one keyword, it is possible that an article belongs to more than one research topic. To account for this, we defined a research topic network for each sample. In this weighted and undirected network, nodes are research topics. Nodes of research topics with at least one common article are linked by an edge, with a weight equal to the number of articles belonging to the pair of research topics. As the objective of the research is identifying research topics in air transport, we chose to not elaborate co-citation networks of keywords or other article metadata such as authors,

affiliations or countries. We believe that these tools are more apt to describe a scientific community through bibliometric analysis, such as in [24] for *Transportation Research part B: Methodological* or in [23] for the *Journal of Air Transport Management*.

3. Results

3.1. Data Retrieval and Identification of Air Transport Articles

We retrieved from the Web of Science databases all items of published between 2013 and 2022 in the Q1 journals of the Transportation ranking presented in Table 1 (Q1-T) and in JATM. From both datasets, we retained the items with the *Document Type* field equal to the *Article* and *Review*. Both types of documents will be labelled as articles from now on. We retrieved 14,317 articles from the Q1-T dataset and 1130 documents from the JATM dataset.

The yearly number of published articles in each journal of the Q1-T dataset is presented in Figure 2. Of the nine journals, we observe that the three top journals of the *Transportation* ranking publish less than 100 articles each year: TREV, AMAR and JPT. It is noteworthy that JPT, the top journal in the ranking, published no articles in 2019 (this has been double-checked in the journal website, <https://www.sciencedirect.com/journal/journal-of-public-transportation/issues> (accessed on 4 July 2023)). The rest of the journals in Q1-T publish more than 100 articles per year. In all journals, we observe that the evolution of the number of published articles is quite stable. Other bibliometric studies of the field, such as [21] for transportation journals or [24] for TR-B, show an exponential increase in the number of articles from 2006 and a stabilization phase from 2015; thus, the result of our analysis coincides with these previous studies.

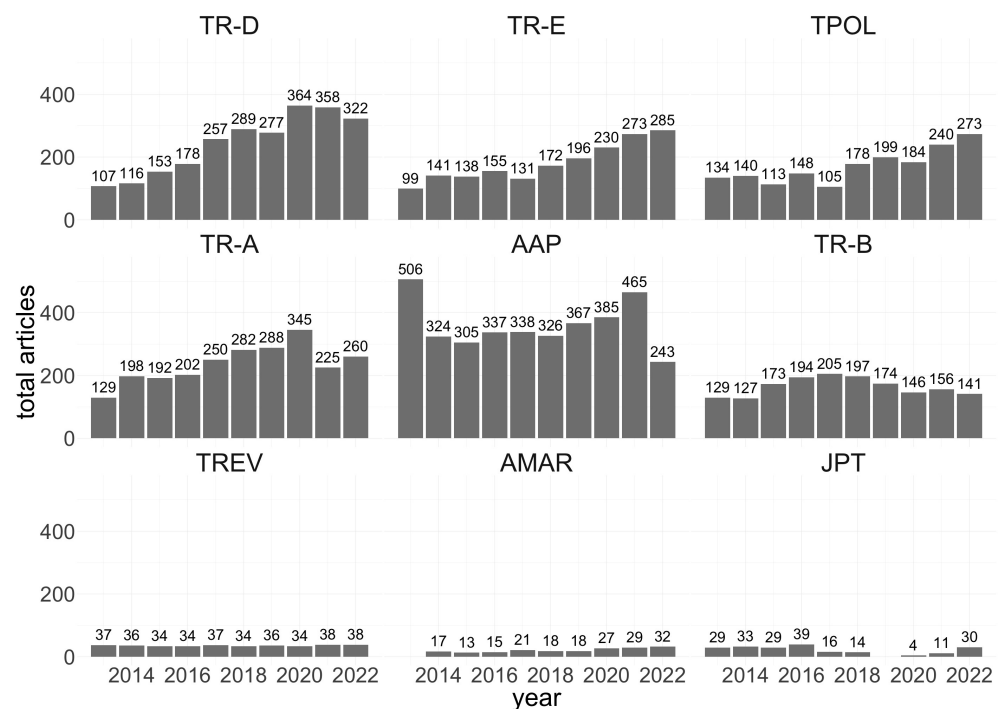


Figure 2. Number of articles published in the Q1 journals of the *Transportation* ranking of the Social Sciences Citation Index from 2013 to 2022.

The yearly number of publications in JATM is presented in Figure 3. Between 2013 and 2022, JATM has published around 70 articles (in 2013) and 142 articles (2020). Therefore, JATM is in an intermediate position between the “small” and “large” journals of Q1-T. JATM has been very active in tracking the impact of COVID-19 in the aviation industry, publishing the special issues *Air Transport COVID-19* and *COVID-19: Long Term Impact* (see <https://www.sciencedirect.com/journal/journal-of-air-transport-management/special-issues> (accessed on 4 July 2023)). The key performance indicators of JATM have been improving

in recent years [25], consolidating its role of a main forum in air transport management research.

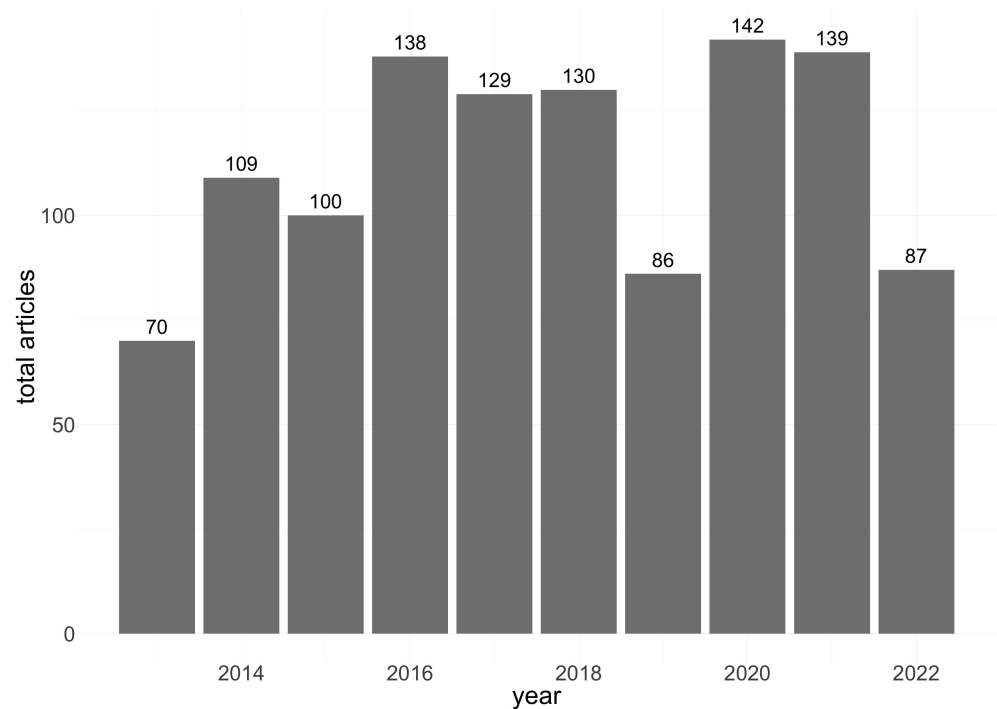


Figure 3. Number of articles published in the *Journal of Air Transport Management* from 2013 to 2022.

Once we obtained the Q1-T and JATM datasets, we proceeded to identify the articles focused on air transport research. The filtering of articles of both datasets looking for any of the tokens in Table 2 resulted in 999 articles out of 14,317 from Q1-T and 1126 out of 1130 from JATM. As described in Section 2, we examined the title and abstracts of the filtered articles to detect false positives. As an example of filtering, we excluded articles using drones to gather spatial data, but retained articles about urban air mobility. Similarly, we did not include articles translating to other transportation means techniques of air transport, such as the safety-II concept or revenue management. The final dataset retained 943 articles for the Q1-T dataset and the same 1126 articles for the JATM dataset, representing 6.59% and 99.64% of articles, respectively.

The 6.59% of air transport articles in top transportation journals is distributed unevenly across journals, as indicated in Figure 4, where the yearly proportion of air transport articles published in each journal is depicted. We observe that JPT, the top journal of the listing, has published no air transport articles in the 2013–2022 period. In AMAR and APP, the number of air transport articles is quite low, and in TREV no air transport articles were published between 2019 and 2022. This is balanced by the other six journals, which publish a quite high rate of air transport research material. Therefore, we observe that the top transportation journals whose aim is to publish research on public transportation (JPT) or accident research (AMAR and AAP) tend to not publish air transport research contributions. This means that it will be hard for researchers in air transport to publish in the first and second journal of the *Transportation* category.

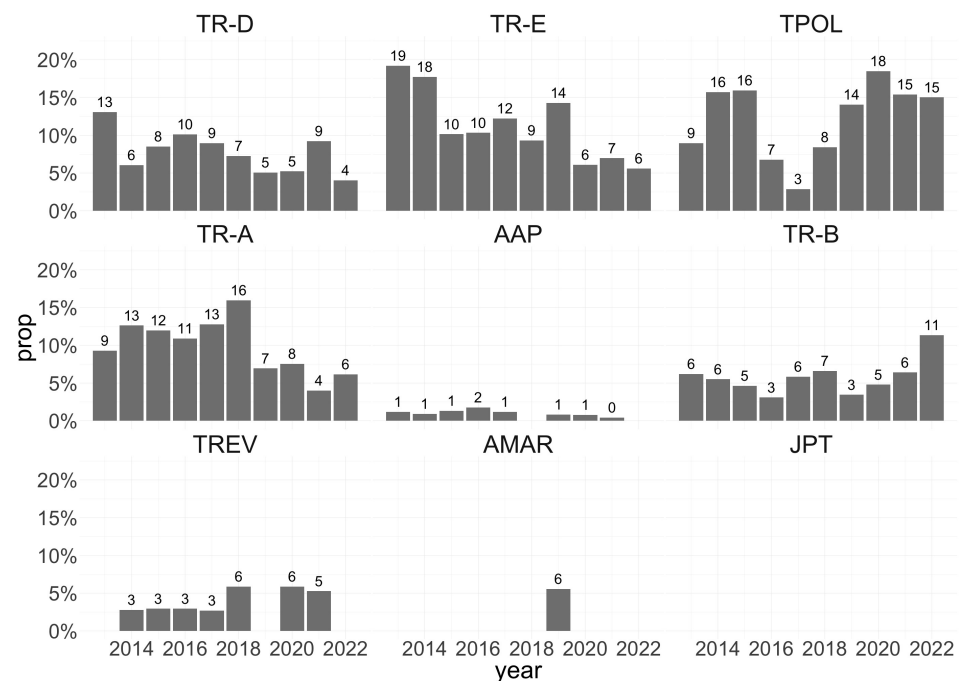


Figure 4. Proportion of air transport articles published in the Q1 journals of the *Transportation* ranking of the Social Sciences Citation Index from 2013 to 2022. Numbers above bars are percentages.

3.2. Keyword Analysis

We gathered the author keywords from each of the articles of the Q1-T and JATM samples. Then, we pooled both samples to normalize the keywords, as described in Section 2. The aim of this normalization process is to group similar keywords into a single keyword, so that we can reduce the dispersion of the set of keywords of each sample. In Table 3 are listed the number of unique keywords and the Herfindahl–Hirschman Index (HHI) for each sample before and after the normalization. We observe that the number of unique keywords and HHI are significantly reduced after the normalization of keywords.

Table 3. Number of unique keywords and HHI of the keyword distribution before and after keyword normalization.

	Q1-T Sample	JATM Sample	Joint Sample
Number of keywords	3450	2953	5763
HHI ($\times 10^4$)	9.624	11.853	8.222
Number of keywords after normalization	3278	2823	5440
HHI ($\times 10^4$) after normalization	14.317	16.165	13.119

Once we obtained the normalized keywords for each of the articles for both samples, we proceeded to list the keywords used more frequently. As we are interested in examining how the most prevalent research topics have changed over time, we split each of the samples into two sub-samples: one including articles of the 2013–2017 period, and another for articles of the 2018–2022 period. We kept all keywords of the same frequency, cutting each sub-sample of a number of keywords equal or smaller than twenty. For instance, we retained only 17 keywords for the Q1-T sample in the 2013–2017 period, with a maximum frequency of six, as the number of keywords with a frequency of five was larger than four.

The most frequent keywords for the Q1-T and JATM samples for each of the two periods are presented in Tables 4 and 5, respectively. The resulting listings of keywords were present in a significant number of articles in each sample. For the Q1-T sample, 428 out of 943 articles of the sample (45.38 %) contained at least one of the keywords. For the JATM sample, 496 out of the 1126 articles (44.05 %) contained at least one of the keywords.

Table 4. List of most frequent keywords in articles of the Q1-T sample. Left columns are for the 2013–2017 period, and right columns are for the 2018–2022 period.

Keywords (2013–2017)	Frequency	Keywords (2018–2022)	Frequency
Airline	36	Air transport	41
Airport	35	Airline	35
Air transport	28	High speed rail	31
Aviation	22	COVID-19	29
Low cost carrier	16	Aviation	26
Competition	15	Airport	23
High speed rail	15	Drone	14
Climate change	13	Low cost carrier	13
Data envelopment analysis	11	Competition	12
Airline competition	9	Willingness to pay	11
Aircraft noise	8	China	11
Policy	7	Aircraft noise	10
CO ₂ emissions	7	Data envelopment analysis	9
General aviation	6	Emission	9
Biofuel	6	Air travel	9
Air traffic management	6	Regulation	8
Delay	6	Urban air mobility	8
—	—	Climate change	8
—	—	Connectivity	8

Table 5. List of most frequent keywords in articles of the JATM sample. Left columns are for the 2013–2017 period, and right columns are for the 2018–2022 period.

Keywords (2013–2017)	Frequency	Keywords (2018–2022)	Frequency
Low cost carrier	48	COVID-19	50
Airline	35	Airline	39
Airport	35	Air transport	37
Data envelopment analysis	23	Airport	37
Air transport	17	Low cost carrier	26
Service quality	17	Aviation	22
Efficiency	11	Service quality	16
Aviation	9	Airline industry	14
Revenue management	8	Airport management	14
Air cargo	8	Air traffic management	12
Airline industry	8	Multi-criteria decision making	10
Competition	7	Tourism	9
Multi-criteria decision making	7	Air travel	9
Airport performance	6	Flight delay	9
Airport capacity	6	ahp	8
Behavioral intention	6	Data envelopment analysis	8
Customer satisfaction	6	Machine learning	8
Uncertainty	6	Pandemic	8

By assigning keywords to journal articles, authors associate tags or tokens that help to identify their research in a variety of ways. The most frequent keywords for each sample describe the *context* where the research takes place: “airline” and “airport” represent the two main playgrounds of air transport research, and other contextual keywords are “air transport” and “aviation”. The keywords “China” and “uncertainty” describe specific contexts of the research. Other sets of keywords describe the *research method* used, especially if authors judge it to be relevant or innovative. The keywords “ahp” (Analytic Hierarchy Process), “data envelopment analysis”, “multi-criteria decision making” and “machine learning” describe research methodologies adopted frequently in air transport research. The rest of keywords describe the research topic of the article, and are the most relevant for our aim. We can group these keywords into categories that describe the research trends that appear more frequently in the sample.

In Tables 6 and 7 are listed the research topics obtained from the keywords used by authors to describe the context of the research of each article. We observe that top journals in the Transportation category address air transport research differently from the JATM. Both sets of articles share three research topics: *Industry Analysis* (topics AT1 and JT1), *Air Traffic Management* (topics AT4 and JT5), and *COVID-19 and Air Transport* (topics AT5 and JT6).

Table 6. Research topics in the Q1-T sample.

Topic	Keywords (2013–2017)	Keywords (2018–2022)
AT1: Industry Analysis	Low cost carrier, competition, airline competition, policy, general aviation	Low cost carrier, competition, connectivity, willingness to pay, regulation, connectivity
AT2: High Speed Rail and Air Transport	High speed rail	High speed rail
AT3: Environmental Impact of Air Transport	Climate change, aircraft noise, CO ₂ emissions, biofuel	Aircraft noise, emission, climate change
AT4: Air Traffic Management	Air traffic management, delay	
AT5: COVID-19 and Air Transport		COVID-19
AT6: UAV and Urban Air Mobility		Drone, urban air mobility

Table 7. Research topics in the JATM sample.

Topic	Keywords (2013–2017)	Keywords (2018–2022)
JT1: Industry Analysis	Low-cost carrier, air cargo, airline industry, competition	Low cost carrier, airline industry, tourism, air travel
JT2: Service Quality	Service quality	Service quality
JT3: Marketing	Revenue management, behavioral intention, customer satisfaction	
JT4: Efficiency	Efficiency, airport performance, airport capacity	
JT5: Air traffic Management		Air traffic management, flight delay
JT6: COVID-19 and Air Transport		COVID-19, pandemic

The other three topics were different for each sample. Transportation journals focus on High-Speed Rail and Air Transport (AT2), Environmental Impact of air Transport (AT3) and UAV and Urban Air Mobility (AT6). On the other hand, JATM focuses on Service Quality (JT2), Marketing (JT3) and Efficiency (JT4). Both sets of topics are related to air transport research, although, in a first examination, Q1 transportation journals focus on challenges of the air transport system, while JATM focuses on challenges facing airline and airport managers.

To examine the temporal evolution of the research topics, we counted the articles including the keywords defining each topic in the normalized keywords, title and abstract. The results are presented in Figures 5 and 6, respectively.

For the Q1-T sample, we observe in Figure 5 three topics with a stable production in the last ten years: Industry Analysis (AT1), the evolution of Environmental Impact of Air

Transport (AT3) and Air Traffic Management (AT4). There is a less prolific, although significant, stream of research on High Speed Rail and Air Transport (AT2). Finally, we can observe two emerging topics: COVID-19 and Air Transport (AT5) and UAV and Urban Air Mobility (AT6). For obvious reasons, contributions related to COVID-10 start appearing in 2020, although the bulk in contributions is observed in 2021 and 2022. Contributions about the use of drones and urban air mobility start to appear in 2018, and they have been increasing steadily since then.

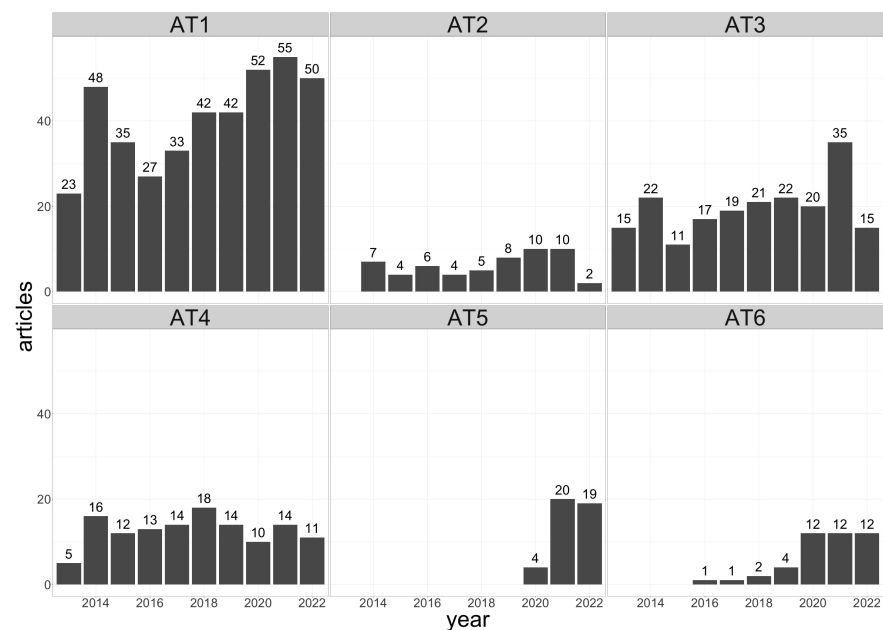


Figure 5. Articles in the Q1-T sample with research topics included in title, abstract or keywords.

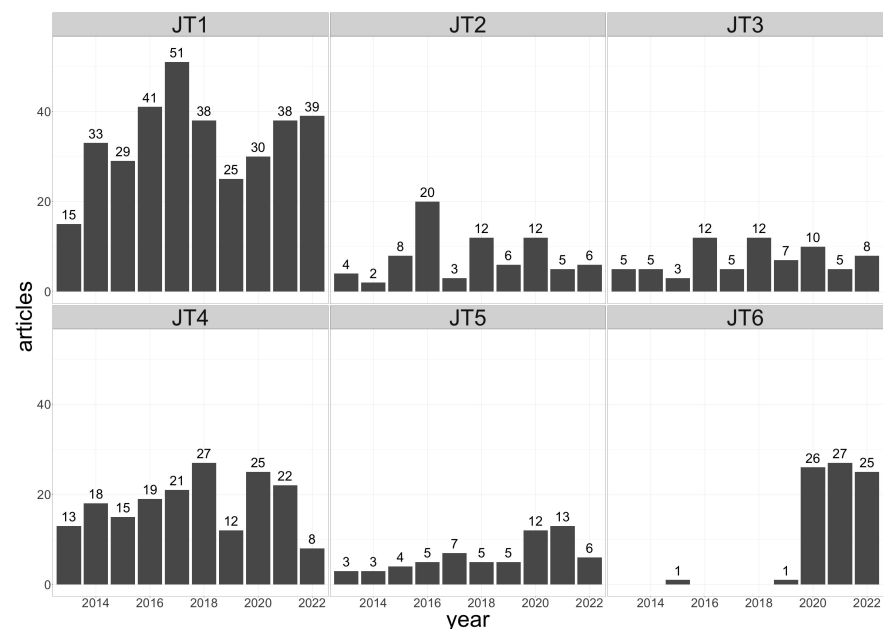


Figure 6. Articles in the JATM sample with research topics included in title, abstract or keywords.

From Figure 6, we observe two important research topics in JATM: Industry Analysis (JT1) and Air Transport Efficiency (JT4). While topic JT1 is maintaining its relevance over time, we observe a slight decrease in contribution on topic JT4. Topics JT2 (Service Quality) and JT3 (Marketing) represent a specific trait of JATM, as they are applications of business administration research topics of quality management and marketing to the air transport

sector, not only in airlines but also in airports. Air traffic management (JT5) has been gaining relevance over time, but the topic with a larger increase has been the analysis of impact of COVID-19 on air transport. Articles prior to 2020 related to this topic appear because of the inclusion of the *pandemic* keyword on this topic. Unlike Q1-T journals, JATM starts reporting contributions about COVID-19 on air transport in 2020, providing quick insight on this topic for academics and practitioners in the air transport management community.

3.3. Top-Cited Articles

The aim of the author keyword analysis was to identify the research topics that occur more frequently in air transport research. To complement this analysis, we gathered the citations received in the Web of Science by each of the articles in the sample, so that we can obtain the top 10 most cited articles in each sample. By using total citations as a metric of relevance, we proceeded towards the extant bibliometric analysis [12,19,23,24]. We also considered ranking the articles by citations per year, but we found that this metric tended to produce articles published recently. Listings of top-cited articles for the Q1-T and JATM samples are presented in Tables 8 and 9, respectively. In addition to article title and reference, we provide information about the number of citations and citations per year. In the Topic column, we present the research topics that the article belongs to. In some cases, the articles did not belong to the topics that are less frequent in the examined sample.

Table 8. Top-cited air transport articles published in Q1 journals of the *Transportation* ranking of the Social Sciences Citation Index (2013–2022). Cites gathered on 27 June 2023.

Rank	Title	Reference	Cites	Cites per Year	Topic
1	Insights into the impact of COVID-19 on household travel and activities in Australia—The early days under restrictions	[26]	219	62.57	AT5
2	Analysis of the Chinese Airline Network as multi-layer networks	[27]	205	27.33	—
3	The strategic role of logistics in the industry 4.0 era	[28]	185	41.11	AT6
4	Delivery by drone: An evaluation of unmanned aerial vehicle technology in reducing CO ₂ emissions in the delivery service industry	[29]	160	29.09	AT3, AT6
5	Vehicle routing problem with drones	[30]	153	34	AT6
6	Evaluating economic and environmental efficiency of global airlines: A SBM-DEA approach	[31]	152	16	AT3
7	Exploring the roles of high-speed train, air and coach services in the spread of COVID-19 in China	[32]	145	41.43	AT2, AT5
8	Systemic accident analysis: Examining the gap between research and practice	[33]	137	13.05	—
9	Impacts of high-speed rail on airlines, airports and regional economies: A survey of recent research	[8]	132	29.33	AT2
10	A military airport location selection by AHP integrated PROMETHEE and VIKOR methods	[34]	128	23.27	—

The top-cited articles presented in Table 8 belong to a large number of topics related to transportation research. This was to be expected, given the diversity of the research aims of the Q1-T journals. Some of these contributions do not fit into the most frequent topics identified in the previous section, although they also represented interesting topics in transportation research. The second article of the ranking [27] is an example of the analysis of air transport with complex network theory. This stream of research examines air transport activity on a global level, defining airport networks from a set of flight schedules of a specific time window. These networks can be defined on a global level, but are also for airlines or airline alliances [35]. The other two articles not assigned to prevalent research topics deal with issues relevant in air transport, but which are less explored in air transport research. The eighth-ranked article [33] examines the factors that hinder the application in the practice of systemic accident analysis in rail, aviation and maritime industries. To that respect, although safety analysis is a relevant topic in air transport management practice, top transportation journals such as *Analytic Methods in Accident Research* or *Accident Analysis and Prevention* publish few articles related to air transport, as can be observed in Figure 4. The last article of the ranking [34] uses a military airport selection problem to evaluate the effectiveness of methods to integrate multiple criteria in decision making such as the analytic hierarchy process (AHP), preference ranking organization method for enrichment evaluation (PROMETHEE) or VIKOR.

In terms of the articles related to prevalent research topics, we observe the momentum that has been gained in the research on UAV and Urban Air Mobility (AT6). The availability of drone technology and its possibilities in the urban environment has made this topic more relevant since 2020 (see Figure 5). There is an ongoing stream of research consisting of formulating classical operational research problems in the context of urban air mobility. This is the case of the reformulation of the vehicle routing problem (VRP) with drones by [30]. The classical VRP problem consists of satisfying the demand of a set of customers with vehicles departing from a depot, assuming that customers and the depot have fixed positions. As drones can depart from or arrive at movable trucks, the VRP problem is more complex, as customers and the depot can move. The use of drones in the context of urban mobility can make the delivery of goods more effective, contributing to the reduction in emissions [29]. Drones can also play a relevant role in the development of industry 4.0, the aggregation of new technologies such as additive manufacturing, and the advancement of robotics in the traditional supply chain [28].

Other relevant streams of research are High Speed Rail and Air Transport (AT2). The bet for developing large networks of a high speed rail in recent years in countries such as China or Spain has stirred interest in research on the economic and organizational implications of this new means of transportation. Within this context, a number of studies examining the interaction between high speed rail and air transport has been published in transportation journals. This complex relationship has been examined in the survey [8], ranking in the ninth position of Table 8. On the one hand, high-speed rail and air transport may compete for short-haul routes, and in some cases authorities may ban short-haul flights if they can be covered with high-speed rail with the expectation of reducing emissions [36]. On the other hand, they can be complementary, as high-speed rail may divert traffic to airports with low capacity utilization and intermodal facilities [37]. Although in recent years this stream of research has experienced some decline in the number of published articles, it is expected that this stream of research will continue in the near future.

Another emerging research topic in air transport research is the environmental Impact of Air Transport (AT3). This stream of research is embedded in the global concerns for a more sustainable economy and the evaluation of the economic, social and environmental impact of policy decisions. This concern has increased research on the environmental impact of air transport, mainly on CO₂ emissions [38] or noise reduction in near airport terminals [39]. The need to consider social, economic and environmental impacts simultaneously has increased the interest of multi criteria decision-making frameworks, such as data envelopment analysis. The top-ranked article [31] proposes a data envelopment analysis

with a slack-based measure method to evaluate the multiple dimensions of economic and environmental efficiency of airlines. Authors point out the relevance of factors such as poor fuel consumption of old aircraft fleets in reducing the economic and environmental efficiency of airlines.

The top-cited article in Table 8 belongs to the research topic of COVID-19 and Air Transport (AT5). In [26] are identified the changing patterns of travel activity during the first phase of COVID-19 restrictions in Australia, including air travel.

Table 9. Top-cited articles of the *Journal of Air Transport Management* (2013–2022). Cites gathered on 27 June 2023.

Rank	Title	Reference	Cites	Cites per Year	Topic
1	Service quality and customer satisfaction of a UAE-based airline: An empirical investigation	[40]	184	21.65	JT2, JT3
2	Evaluating service quality of airline industry using hybrid best worst method and VIKOR	[41]	168	30.55	JT2
3	Impact of service quality on customer satisfaction in Malaysia airlines: A PLS-SEM approach	[42]	147	26.73	JT2, JT3
4	A study on the effects of social media marketing activities on brand equity and customer response in the airline industry	[43]	137	24.91	JT3
5	Efficiency and effectiveness in airline performance using a SBM-NDEA model in the presence of shared input	[44]	119	12.53	JT4
6	Service quality and price perception of service: Influence on word-of-mouth and revisit intention	[45]	118	15.73	JT2, JT3
7	An investigation of service quality, customer satisfaction and loyalty in China's airline market	[46]	107	14.27	JT2, JT3
8	Online drivers of consumer purchase of website airline tickets	[47]	106	10.10	JT3
9	COVID-19 pandemic and prospects for recovery of the global aviation industry	[48]	106	42.40	JT6
10	A cross-cultural investigation of airlines service quality through integration of Servqual and the Kano model	[49]	105	12.35	JT2

In Table 9 are listed the top-cited articles of JATM, in a similar way as the Q1-T articles in Table 8. Six out of the ten listed articles contribute to the research topic, Service Quality (JT2). This result confirms the importance of service quality in the research published in JATM observed in previous bibliometric studies on JATM [23,25]. As remarked by [41], the growing competition in the airline industry makes airline customers very specific about service requirements; therefore, airlines failing to meet service quality standards risk losing their customer base. Service requirements have resulted in changing with the customer cultural background; therefore, cross cultural and non-Western studies of service quality such as [40,49] are amongst the most cited in the JATM sample.

Another relevant research topic in JATM is Marketing (JT3). Within this research topic, we include research on customer preferences and consumer behavior. Beyond the

traditional studies on revenue management and customer satisfaction, in [43] are examined the effects of social media marketing activities on brand awareness and brand image, two key airline marketing constructs that are considered to be related with the intention of traveling with an airline [50]. As service quality is expected to impact consumer behavior, it may not be surprising that four of the top JT2 articles also belong to the JT3 research topic. The relationship between service quality and customer satisfaction is the one examined more frequently and in more cultural contexts, such as UAE [40], Malaysia [42] and China [46]. This stream of research can help airline companies to understand the impact of several dimensions of service quality on customer satisfaction in markets with cultural differences. Besides customer satisfaction, these studies have also examined the relationship between several dimensions of service quality and other consumer behavior characteristics such as loyalty to an airline [46] or perception of airline price tickets [45].

Although it is relevant for airlines with certain levels of service quality able to meet customer expectations, they also need to provide these levels with an adequate use of resources. This concern has led to the Efficiency (JT4) stream of research, one of the most relevant trends of JATM, as confirmed by a previous analysis [25] and the results presented in Table 6. The originality of [44] is to propose an efficiency analysis with a slacks-based measure and network data-envelopment analysis technique, measuring both operational efficiency and service effectiveness.

The last research topic to be included in the listing of top-cited articles is COVID-19 and Air Transport (JT6), which are also present in the Q1-T sample as AT5. The comparison of the top-cited papers related to COVID-19 for the two samples illustrates the specificity of JATM with respect to the rest of the transportation journals. Reference [26], published in *Transport Policy*, evaluates the impact of restrictions to tackle the COVID-19 threat on the pattern of travel activities, including air transport. On the other hand, reference [48] evaluates the impact of COVID-19 on aviation industry and the potential recovery patterns after the pandemic. The article belonging to the Q1-T sample examines the impact of the pandemic from the perspective of policy makers and regulatory bodies in transportation, and the article belonging to the JATM sample examines the same phenomenon for the perspective of airport and airline managers.

4. Discussion

As each article has a set of keywords, it is frequent that an article may belong to more than one stream of research. An article about high speed rail and air transport (topic AT2) may deal with implications about competition in transportation markets (topic AT1) [51,52]. Other articles belong to a single category. This is the case of [53], which is about the impact of regulation on governance of UK airports. To examine the interactions between research topics, we looked for articles belonging to any pair of research topics for the two samples. In the following subsections, we will present the obtained results for the Q1-T and the JATM samples.

4.1. Research Topics on Q1-T Articles

Figure 7 presents the relationships among research topics for the Q1-T sample. We added the number of articles belonging to each pair of research topics as edge labels, and we presented relationships with a high number of articles as opaque edges and relationships with less articles with transparent edges.

We observe that Industry Analysis (AT1) is related to the rest of research topics described. Examples of those relationships are articles describing trade-offs between environmental regulation and market competition (topics AT1 and AT3) [54], or the effects of liberalization of air traffic control (AT1 and AT4) [55].

The other topic that is closely related to other research topics is the Environmental Impact of Air Transport (AT3), which is related to AT2, AT4 and AT6. Among the studies relating the environmental impact and high speed and air transport interaction (AT2, AT3), the analysis examining the potential of a high speed rail to replace air transport in

short-haul routes stands out, as the electric high speed rail is presumed to have a smaller environmental footprint than aircraft. Recently, these measures led to the ban of air travel journeys that are possible in less than two-and-a-half hours by train [56]. This ban may have been driven as a result of previous research examining the potential mitigation of CO₂ emissions via the substitution of a high speed rail by air travel [36,57]. Studies relating the environmental impact (AT3) with air traffic management (AT4) introduce environmental considerations when analysing the effectiveness and efficiency of air traffic. Examples of this kind of research are [58] introducing emission policies in air traffic management, or [39] introducing environmental considerations in the optimization of terminal air space operations. The introduction of environmental issues implies using, explicitly or implicitly, several criteria for the optimization of policies and operations, versus the extensive use of multi-criteria decision making techniques, such as data envelopment analysis or analytic hierarchy process (AHP). The studies of the use of UAV and urban air mobility (AT6) are related to the environmental impact of air transport in two ways. Firstly, environmental issues are considered in UAV production. This is illustrated with contributions such as [59] for the design of UAV or [60] for the UAV lifecycle. Another stream of research is the evaluation of the potential of electric UAV to mitigate carbon emissions in urban air mobility. This is addressed in [29] for the delivery service industry and in [61] for delivery systems using air and ground electric autonomous vehicles.

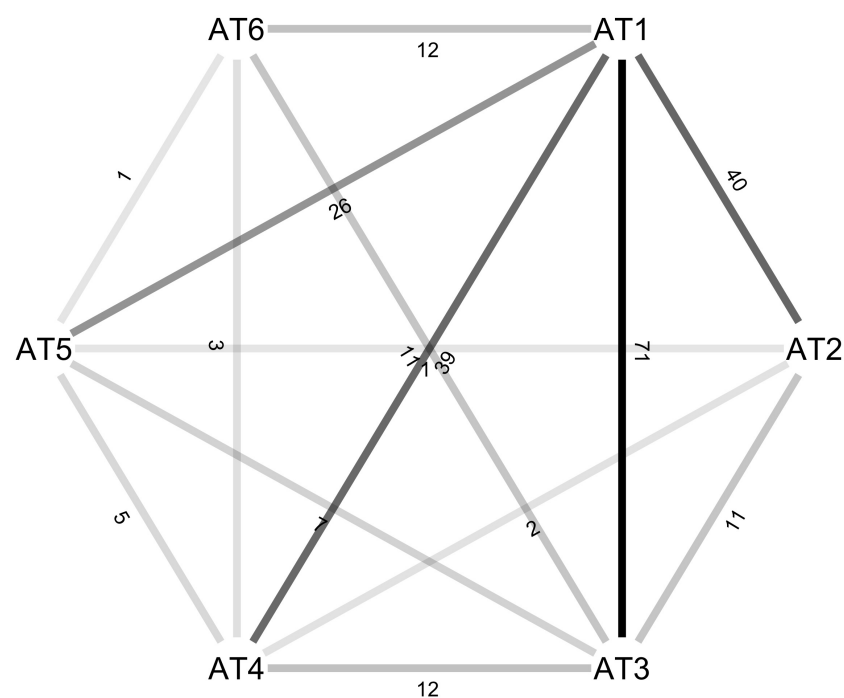


Figure 7. Relationships between topics on the Q1-T sample. The number of articles sharing topics are presented as edge labels.

4.2. Research Topics on JATM Articles

The relationships between research topics for JATM are depicted in Figure 8 in a similar fashion as the relationships between research topics of the Q1-T sample in the previous section.

The Q1-T and JATM samples share the prevalence of a research topic of industry analyses (AT1 and JT1, respectively). An interesting finding coming from the observation of the articles on the research topic for both samples is that while Q1-T tend to take the viewpoint of regulators of the air transport system, JATM articles adopt the perspective of airline and airport managers. For instance, a stream of research in JATM from this topic is the viability analysis of different elements of the business model spectrum [62], such as the

long-haul low cost carriers [63] or airlines-within-airlines. This later model, consisting of the creation of low cost subsidiaries by full-service carriers, is analyzed in JATM from a managerial perspective [64], while in an article in TR-E on this business model discussed the impact on competence in the Australian air transport sector [65]. Other examples of the industry analysis from the regulator perspective is the contribution of [66] in Transport Policy on the links between domestic market regulation, dominant airline performance and international market liberalization in Northeast Asia. An example of research from air transport regulation in the airport market is the yet mentioned contribution from [53] about regulation in airports. Such as in the Q1-T sample, the industry analysis topic tends to be related to other topics, in this case Service Quality (JT2), Marketing (JT3), Efficiency (JT4) and of COVID-19 and Air Transport (JT6).

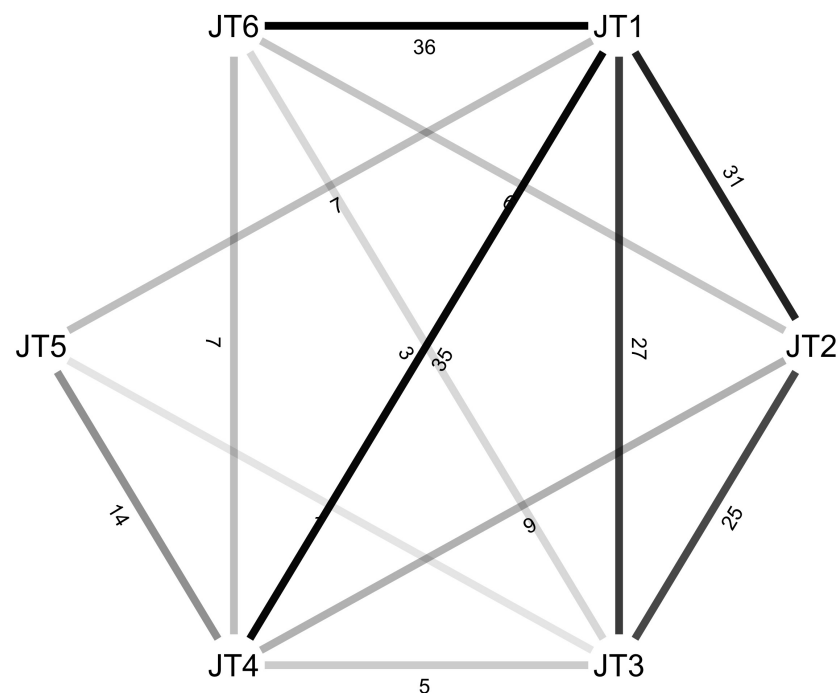


Figure 8. Relationships between topics on the JATM sample. The number of articles sharing topics are presented as edge labels.

Contrarily to the industry analysis, the contributions of the air traffic management of both samples (AT4 and JT5) share similar topics. As an illustration, we present some contributions on airport congestion, a source of disruption of air traffic management, leading to delays and cancellations. In a contribution published in TR-A, ref. [67] presents a congestion control strategy for a specific airport (Boston Logan), while a JATM contribution [68] presents a strategy of the mitigation of airport congestion combining disruption management with flight planning. If we analyze the research on delays, an important source of air traffic management vulnerability [69], we observe a similar convergence. A prediction of delays with machine learning has been presented by [70] in TR-E, and by [71] in JATM.

One distinctive pattern of the publications of JATM is the attention paid to the impact of COVID in air transport since the beginning of the pandemic. While journals included in the Q1-T listing began to publish a significative amount of research on COVID-19 and aviation in 2021, JATM started publishing in 2020 (see Figures 5 and 6 for yearly counts). Yet, in 2020, JATM published research on the effect of government support for airlines because of COVID-19 [72], the European airlines' strategic responses to COVID-19 [73] or even the attitudes of ageing passengers to air travel since the coronavirus pandemic [74].

A distinctive line of research of JATM, especially during the period 2013–2017 (see Figure 6), is the analysis of efficiency through the data envelopment analysis (JT4). Although some contributions used this technique to evaluate the efficiency of airlines [75], the bulk of contributions has been dedicated to the airport efficiency evaluation. In a review on this topic published in JATM, [76] presents the objectives of this research: find antecedents of efficiency, track the temporal evolution of efficiency, decompose the efficiency using network DEA, and evaluate tools alternative to DEA in order to evaluate efficiency.

Finally, an important stream of research in JATM consists of contributions to airline and airport management from two complementary perspectives: service quality (JT2) and marketing (JT3), this later stream focusing on consumer attitudes and behavior. A fruitful stream of research combines both topics, examining the impact of service quality on consumer behavior and satisfaction. This is the reason for the thickness of the edge between JT2 and JT3 that appears in Figure 8, suggesting a large commonality of both research topics. Contributions focus on both airlines and airports, usually adopting multi criteria approaches [77]. In the context of airlines, research models can include service quality, passenger satisfaction and passenger intentions [78]. This research profits from the well-established relationship between attitudes, intentions and actions in behavioral research. Other contributions focus on how to enhance airline passenger's satisfaction in a context of different pre-purchase expectations [79]. The examination of the relationship between service quality and passenger's attitudes is also of interest for airport managers and researchers [80]. For instance, the arrival of passengers of low cost carriers to airports has led researchers to examine their purchase intentions in duty-free shops, an important element for airports' revenues [81].

5. Conclusions

The objective of this research is to detect and summarize recent trends in air transport management research. To accomplish this objective, we examined the articles published between 2013 and 2022 in two samples of scientific literature: the first quartile (Q1) journals of the *Transportation* listing of the SSCI published in Clarivate's JCR (Q1-T sample) and the articles published in the *Journal of Air Transport Management*, the journal of the highest impact focused on air transport management research. After examining the bibliographical information of both sources, we obtained a sample of 943 articles for Q1-T and 1136 articles for JATM. One reason for the small size of the Q1-T sample is that several top transportation journals published little, if any, research on air transport in the 2013–2022 period. Therefore, air transport researchers have few slots, if any, to publish in the two top journals of the *Transportation* listing: *Journal of Public Transportation* and *Analytic Methods of Accident Research*. This leaves *Transport Reviews* as the only first decile *Transportation* journal accessible to air transport research.

Examining author keywords of articles, we identified six main research topics for each sample. Three topics are shared by both samples: Industry Analysis (AT1, JT1), Air Traffic Management (AT4, JT5) and COVID-19 and Air Transport (AT5, JT6). The three specific research topics for the Q1-T sample are High Speed Rail and Air Transport (AT2), Environmental Impact of Air Transport (AT3) and UAV and Urban Mobility (AT6). On the other hand, JATM's topics are Service Quality (JT2), Marketing (JT3) and Efficiency (JT4). A closer examination of the sets of articles in each topic revealed that an article can belong to more than one research topic. In particular, the Industry Analysis topic had strong relationships with most of the other topics in both samples (see Figures 7 and 8). In the JATM sample, we detected a strong relationship between topics JT2 and JT3, as many articles examine service quality as antecedent of consumer behavior constructs such as customer satisfaction, customer loyalty and price perception. In the industry analysis topic, we found that Q1-T articles (AT1) tended to adopt the perspective of air transport regulators, while JATM articles (JT1) adopted the perspective of airline and airport managers. The examination of top-cited articles of the research topics COVID-19 and Air Transport, published in both samples, confirmed this difference in perspective. While the Q1-T article [26] analyzed the impact of

COVID-19 containment measures on mobility, the JATM article [48] focused on the impact of COVID-19 in the air transport industry. When selecting target journals, authors must consider that Q1-T is usually focused on problems of air transport regulatory bodies, while JATM is more focused on airport and airline managers. Air transport industry stakeholders (transportation system regulators, airline managers and airport managers) must also take this fact into account when looking for quality research to ground political action.

We believe that our findings are relevant for agents evaluating air transport researchers and air transport researchers themselves. Administrators evaluating the research record of academics in air transport research should take into account that the Transportation listing is quite narrow (including 37 journals in the 2021 SSCI edition), and that top journals in this ranking are dedicated to public transportation and accident research, thus having little relationship with air transport. We believe that journals such as *Journal of Transport Geography* or the *Journal of Air Transport Management* can also be considered top targets of publication for air transport researchers. This study can be also for interests of academics of air transport. We believe that opportunities of successful research projects reside in emerging research topics such as urban air mobility, or at the crossroads between two research topics, such as service quality and marketing, or the environmental impact of high speed rail and air transport. A research topic that researchers on air transport management may pay close attention in the near future is, in our opinion, UAV and Urban Air Mobility (AT6). While this topic has been gaining momentum in the Q1-T sample since 2020, it is still not salient in the JATM sample. Nevertheless, we believe that after the paper hurricane of COVID-19 research [82] loses intensity, the progressive development of urban air mobility management can also be a fruitful avenue for research in the near future.

Finally, we must point out the limitations of our research. Unlike other reviews, we selected a relatively narrow time horizon of ten years and a relatively wide research topic such as air transport. There is also room for other review studies by considering longer time frames and reviewing some of the topics described here.

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Abbreviations

The following abbreviations are used in this manuscript:

AAP	Accident Analysis and Prevention
AMAR	Analytic Methods in Accident Research
DEA	Data Envelopment Analysis
ISSN	International Standard Serial Number
HHI	Herfindahl–Hirschman Index
JATM	Journal of Air Transport Management
JCR	Journal Citation Reports
JIF	Journal Impact Factor

Q1-T	First quartile (Q1) journals of the <i>Transportation</i> ranking of the SSCI
SSCI	Social Sciences Citation Index
TREV	Transport Reviews
TR-A	Transportation Research Part A-Policy and Practice
TR-B	Transportation Research Part B-Methodological
TR-D	Transportation Research Part D-Transport and Environment
TR-E	Transportation Research Part E-Logistics and Transportation Review
TRP	Transport Policy
UAE	United Arab Emirates
UAV	Unmanned Air Vehicle
VRP	Vehicle Routing Problem

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