JAR - 6 / 2 E-ISSN: 2687-3338 AUGUST 2024

JOURNAL OF AVIATION RESEARCH

HAVACILIK ARAŞTIRMALARI DERGİSİ

JOURNAL OF AVIATION RESEARCH

HAVACILIK ARAŞTIRMALARI DERGİSİ

6 / 2

JOURNAL OF
AVIATION
RESEARCH
HAVACILIK ARAŞTIRMALARI DERGİSİ

Yılda iki sayı olarak yayımlanan uluslararası hakemli, açık erişimli ve bilimsel bir dergidir.

This is a scholarly, international, peer-reviewed, open-access journal published international journal published twice a year.

Cilt: 6
Sayı: 2
Yıl: 2024

Volume: 6
Issue: 2
Year: 2024

2019 yılından itibaren yayımlanmaktadır.

Published since 2019.

Elektronik ortamda yayınlanmaktadır.
https://dergipark.org.tr/jar
Ulaşmak için tarayınız:

This journal is published digitally.
https://dergipark.org.tr/jar
Scan for access:

Yazışma Adresi:
Süleyman Demirel Üniversitesi
Sivil Havacılık Yüksekokulu Müdürlüğü
Keçiborlu / Isparta - Türkiye

E-Posta:
journalofaviationresearch@gmail.com

Telefon:
+90 246 211 85 00

Dahili:
8505

Correspondence Address:
Süleyman Demirel University
Directorate of Civil Aviation School
Keçiborlu / Isparta - Türkiye

E-Mail:
journalofaviationresearch@gmail.com

Telephone:
+90 246 211 85 00

Ext:
8505

JOURNAL OF
AVIATION
RESEARCH
HAVACILIK ARAŞTIRMALARI DERGİSİ

JOURNAL OF
AVIATION
RESEARCH
HAVACILIK ARAŞTIRMALARI DERGİSİ

İÇİNDEKİLER / CONTENTS

Derleme Makaleler / Review Articles

Araştırma Makaleleri / Research Articles

JOURNAL OF AVIATION RESEARCH
HAVACILIK ARAŞTIRMALARI DERGİSİ

Journal of Aviation Research
Cilt/Vol: 6, Sayı/Issue 2,
Ağustos/August 2024
E-ISSN: 2687-3338
URL: www.dergipark.gov.tr/jar

Evaluation of the Studies on Unmanned Aircraft System Safety Management Systems with Bibliometric Analysis

Osman Atilla ALTINTAŞ[1] **Birsen AÇIKEL**[2] **Uğur TURHAN**[3]

Araştırma Makalesi	DOI: 10.51785/jar.1453011	
Gönderi Tarihi: 15.03.2024	Kabul Tarihi: 14.07.2024	Online Yayın Tarihi: 29.08.2024

Abstract

UAV operations and their literature are developing rapidly. Along with the increasing number of risky situations, new technologies and measures are being developed to eliminate the unsafe situations created by them. Increasing UAVs have the potential to lead to unsafe situations in airspace with incident and accident backgrounds. In addition to all other studies related to UAVs, studies on safety management systems, as well as other topics related to the safety management system, need to increase. In this study, a bibliometric analysis of the studies on UAVs between the years 2003-2022 was conducted from the perspective of safety management. For this purpose, the publications found in the Dimensions database were examined. Those publications related to UAVs were filtered according to certain criteria such as year, author, country, and institution, and a sample was formed with 741 publications by using the bibliometric analysis method. VOSviewer application was used for bibliometric analysis and the achieved data were visualized in the form of tables, graphics, and visual maps. The findings show that the vast majority of publications on keywords were published in 2021. The most cited publication was written by Colomina and Molina in 2014. Most of the publications came up from the United States of America in total where 86 studies were conducted. The most cited organization is the University of Florida. In the cluster work, the words remote sensing, sensor, and drones appear frequently.

Key Words: Bibliometric Analysis, VOSviewer, UAV, Safety

İnsansız Hava Aracı Sistemlerinin Emniyet Yönetim Sistemlerine İlişkin Çalışmaların Bibliyometrik Analiz ile Değerlendirilmesi

Öz

İHA operasyonları ve literatürü hızla gelişiyor. Riskli durumların artmasıyla birlikte, bunların yarattığı emniyetsiz durumları ortadan kaldırmak için yeni teknolojiler ve önlemler geliştirilmektedir. Artan UAV'ler hava sahasında emniyetsiz durumlara yol açmaktadır. UAV'lerle ilgili diğer tüm çalışmaların yanı sıra emniyet yönetim sistemi ile ilgili diğer konu başlıklarının yanı sıra emniyet yönetim sistemlerine ilişkin çalışmalarında artması gerekmektedir. Bu çalışmada 2003-2022 yılları arasında İHA'lar üzerinde yapılan çalışmaların emniyet yönetimi perspektifinden bibliyometrik analizi yapılmıştır. Bu amaçla Dimensions veri tabanında bulunan yayınlar incelenmiştir. İHA'larla ilgili yayınlar yıl, yazar, ülke, kurum gibi belirli kriterlere göre filtrelenmiş ve bibliyometrik analiz yöntemi kullanılarak 741 yayından oluşan bir örneklem oluşturulmuştur. Bibliyometrik analiz için VOSviewer programı kullanılmış ve elde edilen veriler tablo, grafik ve görsel haritalar halinde görselleştirilmiştir. Bulgular, anahtar kelimelerle ilgili yayınların büyük çoğunluğunun 2021 yılında yayınlandığını göstermektedir. En çok alıntı yapılan yayın ise 2014 yılında Colomina ve Molina tarafından yazılmıştır. Toplamda 86 çalışmanın yapıldığı yayınların çoğu Amerika Birleşik Devletleri'ndedir. En çok alıntı yapılan kuruluş Florida Üniversitesi'dir. Kümeleme çalışmalarında uzaktan algılama, sensör, drone kelimeleri sıklıkla karşılan çalışma alt başlıklarıdır.

Anahtar Kelimeler: Bibliyometrik Analiz, VOSViewer, İHA, Emniyet.

[1] Eskişehir Teknik Üniversitesi. Lisansüstü Eğitim Enstitüsü, Hava Trafik Kontrol Anabilim Dalı, Doktora Programı, osmanatillaaltintas@outlook.com (Yüksek lisans tezinden üretilmiştir.)
[2] Eskişehir Teknik Üniversitesi, Porsuk Meslek Yüksekokulu, İnsansız Havaaracı Teknolojileri ve Operatörlüğü Programı, birsena@eskisehir.edu.tr
[3] UNSW, School of Science, u.turhan@adfa.edu.au

INTRODUCTION

Unmanned aerial vehicle systems and technologies are becoming increasingly important. Both the need for unmanned technologies and the large economic market created by these technologies reaching great value. Although unmanned aerial vehicles and system's tactical use for defense and military purposes seems to be more common, they are becoming more widespread in many different industrial areas (Nisser and Westin, 2006). Their usage is increasing in many fields such as agriculture, energy, mining, construction, real estate, media, film, and advertising makes the concept of safety even more important (Piloutsias et al., 2018). In recent years, incidents of UAVs flying near airports, airplanes, and helicopters without authorization have been increasing. Along with the increasing number of risky situations, new technologies and measures are being developed to eliminate the unsafe situations created by them. Academic studies on these developed technologies and measures will gain importance in the coming years. For this reason, knowing and analyzing the works done in the past years will create significant added value.

Bibliometric analysis is a quantitative research and statistical method and allows to see the development of academic studies in a field in terms of quality and quantity (Dixit and Jakhar, 2021). Bibliographic analysis, as opposed to systematic literature review, is an analytical technique that produces formal, quantitative data about the current state of a field and facilitates tracking academic trends using visualization software (Dirik et. al, 2021). Thus, with the data obtained, information about the publication year, keywords, number of citations, and authors of academic studies are revealed. Bibliometrics provides quantitative information about the productivity of countries, authors, universities and documents, weak and strong research areas, literature gaps, collaborative networks, potential opportunities and the far-reaching impact of results produced in a field (Dirik et. al, 2021). It has provided a lot of data to other researchers who want to work on the subject.

In this study, the most productive researchers in the field of UAV were determined by bibliometric analysis. By accessing information such as the number of studies and researchers by country, new study subjects may arise between these researchers and the institutions they work with. The topics studied in those publications will be discussed and potential opportunities for interdisciplinary studies will be created. In this study, 741 studies were analyzed in the Dimensions database between 2003 and 2022. Firstly, the methodology of the study will be explained, then the findings will be given and finally the results and recommendations will be discussed.

1. SAFETY MANAGEMENT SYTEM

Disasters such as Chernobyl, Challenger, Tenerife airport disaster, Herald of Free Enterprise, King's Cross, Piper Alpha, and Clapham Junction increased interest in the concept of safety. Therefore, the focus has shifted from accident prevention based on technical and human errors to "safety management" based on dynamic processes. This situation has led to focusing not only on the visible causes of accidents, but also on their invisible indirect causes. The concept of safety has provided a better approach to changing perspectives on the predictability and prevention of such disasters (Altıntaş, 2023).

Safety Management System (SMS) is a systematic approach to managing safety in aviation and other safety-critical industries such as aviation. In aviation activities where SMS is

applied, by identifying the safety risks they are exposed to during operations, these can be reduced and, as a result, increased safety performance (IATA, 2024).

Aviation authorities facilitate air transport and establish operating rules for all aircraft and other vehicles involved in aviation activities. These rules cover all the procedures, regulations, infrastructure, aircraft, and personnel that make up the air transportation system (Weibel and Hansman, 2006). SMS for aviation authorities becoming a standard across the global aviation industry and will integrate modern safety risk management and safety assurance concepts into repeatable, proactive systems (FAA, 2022). The integration of UAVs into the aviation system and manned, flight-based systems raises various safety issues, including the possibility of collision in the air, collision on the ground and system reliability (Carr, 2013).

The purpose of SMS is to facilitate safe, efficient and effective Unmanned Aircraft System (UAS) operations. The Safety Management System (SMS) is designed to identify safety risks and hazards and implement corrective processes and procedures. An organizational management structure is created that includes key security personnel responsible for planning, implementation, and execution. Arrangements are made to implement emergency measures. Change control procedures, continuous improvement processes, improvement of safety performance, establishment of measurement and monitoring procedures, and safety education, communication and training are provided to create a safety culture throughout the organization (Yang et al., 2022).

The usage areas of UAVs have gradually expanded and as they become more widespread, there is an increase in cases. This situation should not be ignored in the development of UAVs. Establishing the SMS reporting culture and system on solid foundations and identifying hazards and risks are important for the development and future of UAVs.

2. DESIGN/METHODOLOGY/APPROACH

This study was carried out to understand how much the issue of unmanned aerial vehicles and their systems, which has been mentioned frequently in the field of aviation in recent years, takes place in academic literature with the overview of the safety perspective and SMS. It is large enough to warrant bibliometric analysis within the scope of the study. Preliminary research was conducted on the number of publications to be analyzed. Dimensions, an academic search database, was used in this study to select the study sample for analysis and collect data. Dimensions was chosen because it covers a wide range of publications in academic fields and provides a greater number of publications. During this selection, a comparison of the publication numbers of Dimensions and Web of Science was also made. The collected data was made by choosing VOSViewer, a broadcast visualization tool that provides visual analysis of broadcasts. In this way, the relationships between publications are visualized with scientific mapping. This will allow researchers to make general judgments about the past research sequences and future research. The collected data were analyzed with the selected software. In this analysis, citations provide information about authors, institutions, countries, and collaborations.

2.1. Purpose and Importance of the Research

The increase in the use and production of UAVs in the aviation industry increases the number of studies on these aircraft in the academic field. For this reason, in this study, it is aimed to examine the academic studies on unmanned aerial vehicles and the safety management system and the relationships between these studies. The research has the unique feature as the first and original study in the literature that deals with the concepts of UAV and Safety together. It will also contribute to literature and future studies in terms of showing the trend of the articles in the field of UAV from past to present.

2.2.Scope of the Research

Within the scope of this study, answers to the following research questions will be sought with the keywords "Unmanned Aircraft System Traffic Management (UTM)", "Unmanned Aviation", "Unmanned Aircraft", "Drone", "Remotely Piloted Aircraft" and "Safety":

- What is the number and origin of articles in the international index between 2003-2022?
- Which articles were published in the international index and been cited in the international directory between 2003-2022?
- By whom the articles in the international directory between 2003-2022 were made?
- The organizations that wrote the articles in the international directory between 2003-2022.
- The top most cited authors and citation numbers in the international index between 2003-2022.

2.3.Research Data Collection Process

During literature analysis, data mining, software selection, data analysis, findings and discussions were conducted. The data for the analysis is collected from the Dimension.ai website. WOS has 23 million and Scopus 27 million documents, while Dimensions have 36 million documents and 21 million documents overlapping with Scopus (Visser et al., 2021). The selected keywords for the study: ("UTM" or "unmanned aviation" or "unmanned aircraft" or "drone" or "remote controlled aircraft" and "safety". According to the initial results, the number of 2716 publications on these keywords were released. When the results of the analysis were re-examined with open publications and articles, the number of publications was 741 in the last case. This process is shown in Figure 1 with PRISMA tool.

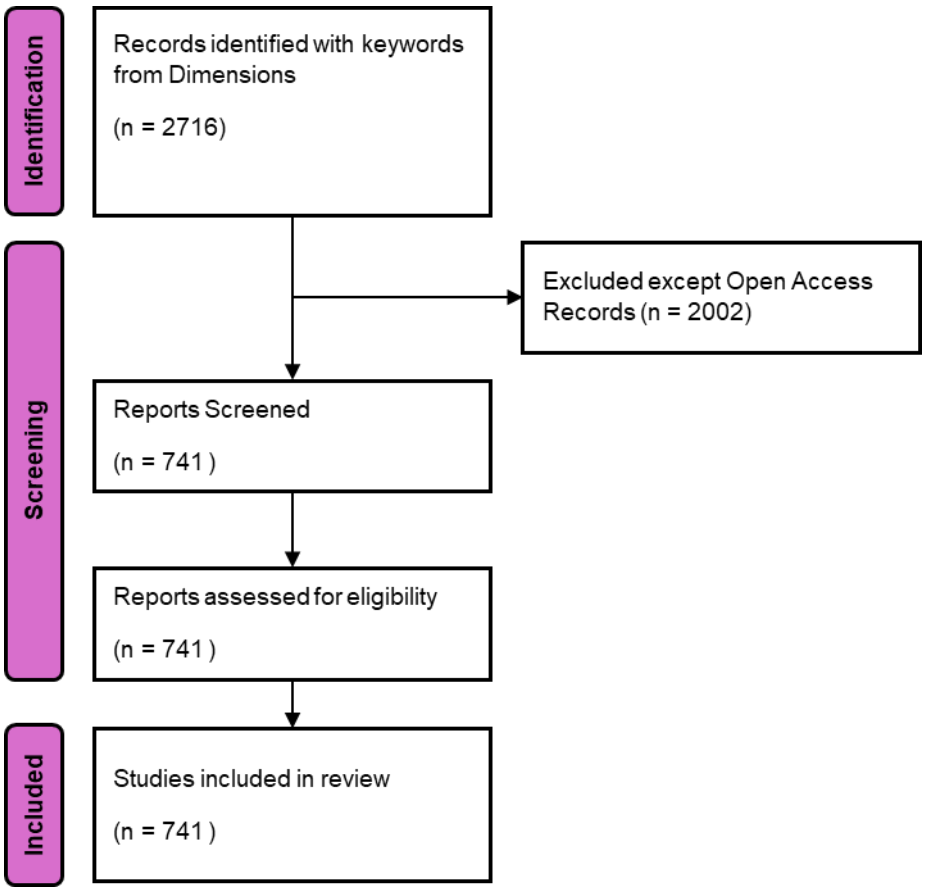


Figure 1. PRISMA Flow Chart for UAS Safety Article Collection

2.4. Analysis of Research Data

The analysis of data collected in the study and the data visualization were analyzed using version 1.6.18 of the "VOSviewer" package program. VOSviewer helps to produce findings that are visually easy to understand and aid in results analysis. It is preferred because it gives information with network relationships. In this study, information about articles, information about documents, information about authors, document co-citation network, author co-citation network, information about countries, information about keywords were analyzed and graphs were created. The maximum number of authors in the analyzes was limited to 15. The minimum number of citations per author was selected as 2 citations and the analyzes were performed according to these criteria.

2.5.Limitations of the Study

The data used in the study were obtained from the Dimensions database that was used between the years 2003-2022, there is a time limit. Accepting that the data shaped by processing in the VOSViewer program used is correct can be seen as another limitation. Another limitation is the development of literature at an accelerating pace. As seen in Figure 2, the number of publications has increased especially in the last 3 years. A new publication takes time to gather a certain impact and citation. Therefore, the predominance of older publications affects the analysis.

3. FINDINGS

In the study, information about articles, information about documents, information about authors, document co-citation network, author co-citation network, information about countries, and information about clusters were analyzed and graphics were created.

3.1.Distribution by Years

In the study, in which publications on UAV and safety issues were considered, a total of 741 articles were examined between 2003 and 2022. The distribution of publications by years is given in Figure 2. According to Figure 2, the most publications were made in 2021. In 2021, 220 studies were conducted. This number constitutes 29% of the total number of publications. There are no publications on keywords between 2003 and 2008. After one publication was made in 2003, it started to be published again in 2008, but no study was conducted in 2010 that included these keywords. After 2012, the number of publications started to increase. Considering the number of articles by year, it is seen that there has been an increase in recent years.

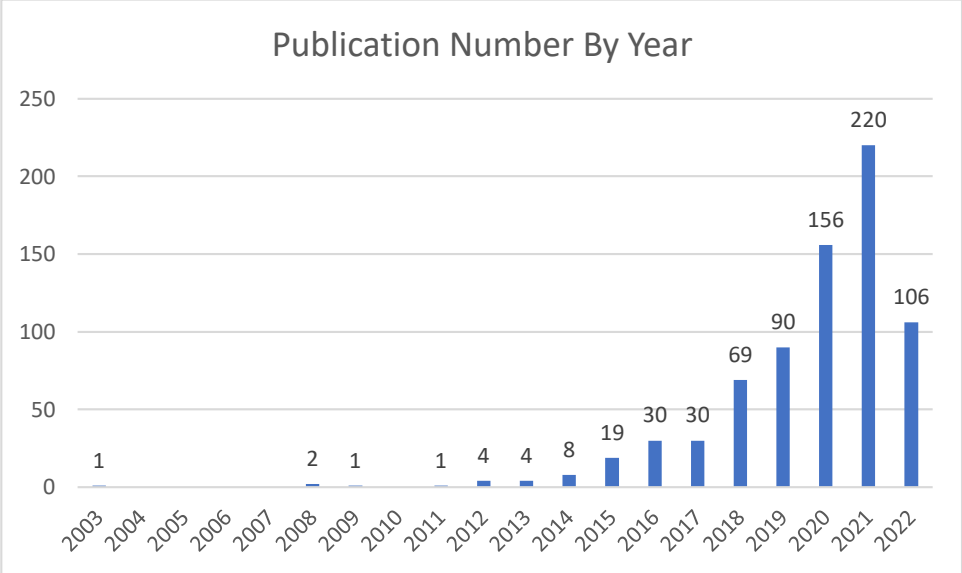


Figure 2. Publication Quantity Between 2003 and 2022

3.2.Co-Authorship Analysis

Co-authorship of a work is a formal expression of the involvement of two or more authors or institutions (Newman, 2004). Co-authorship analysis is widely used to understand and evaluate models of scientific collaboration. Co-authorship is examined by authors, then by organizations, and finally by country. As a result of the analysis, 132 authors who met the criteria were analyzed. For each of the authors, their co-authorship connections with other authors were analyzed and the authors with the highest connection strength were selected. According to this analysis, the top five most cited authors are given in Table 1.

Table 1. Top Five Most Cited Authors in Co-Authorship Analysis

Ranking	Authors	Citations
1	Ma, Ou	218
2	Alsami, Saeed H.	218
3	Shoufan, Abdulhai	90
4	Baxter, Glenn	89
5	Murray, John	89

The most cited in the co-author and author analysis are Ma and Alsami. The number of citations in both is 218. There is a serious decrease in the number of citations of the authors who come after Ma and Alsami in the ranking. In this analysis of co-authorship, some of the 132 items in the network are unconnected. The largest linked item set consists of 6 items.

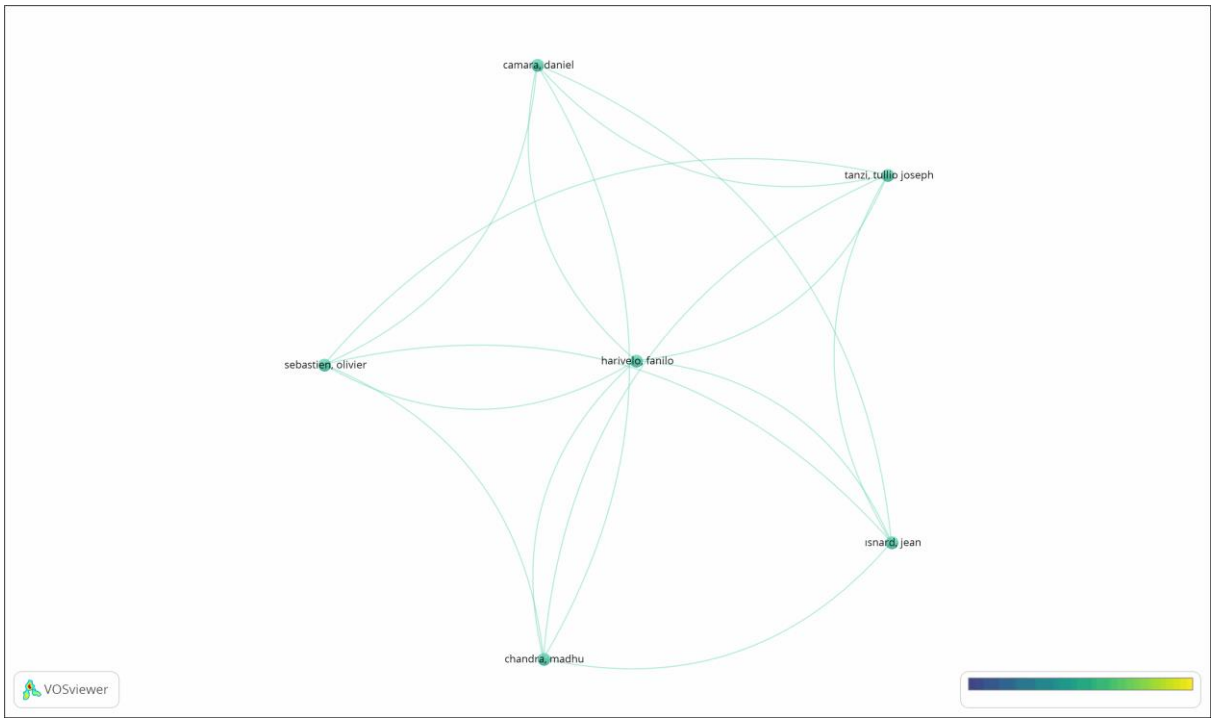


Figure 3. Overlay Visualization of the 6 Most Connected Items in The Co-Authorship Network.

As a result of the analysis conducted by the criteria, 141 out of 602 organizations passed the threshold. The first five of these organizations are given in Table 2.

Table 2. Top 5 Most Cited Organizations with Co-Authorship Networks.

Ranking	Organization	Citations
1	University of Florida	632
2	Northern Arizona University	305
3	IBB University	264
4	Nanjing University of Aeronautics an..	244
5	Nazarbayev University	232

In the co-authorship and organization analysis, it is seen that the University of Florida is the organization with the highest number of citations. Figure 4 shows the overlay visualization of the organizations' connections to each other regarding co-authorship.

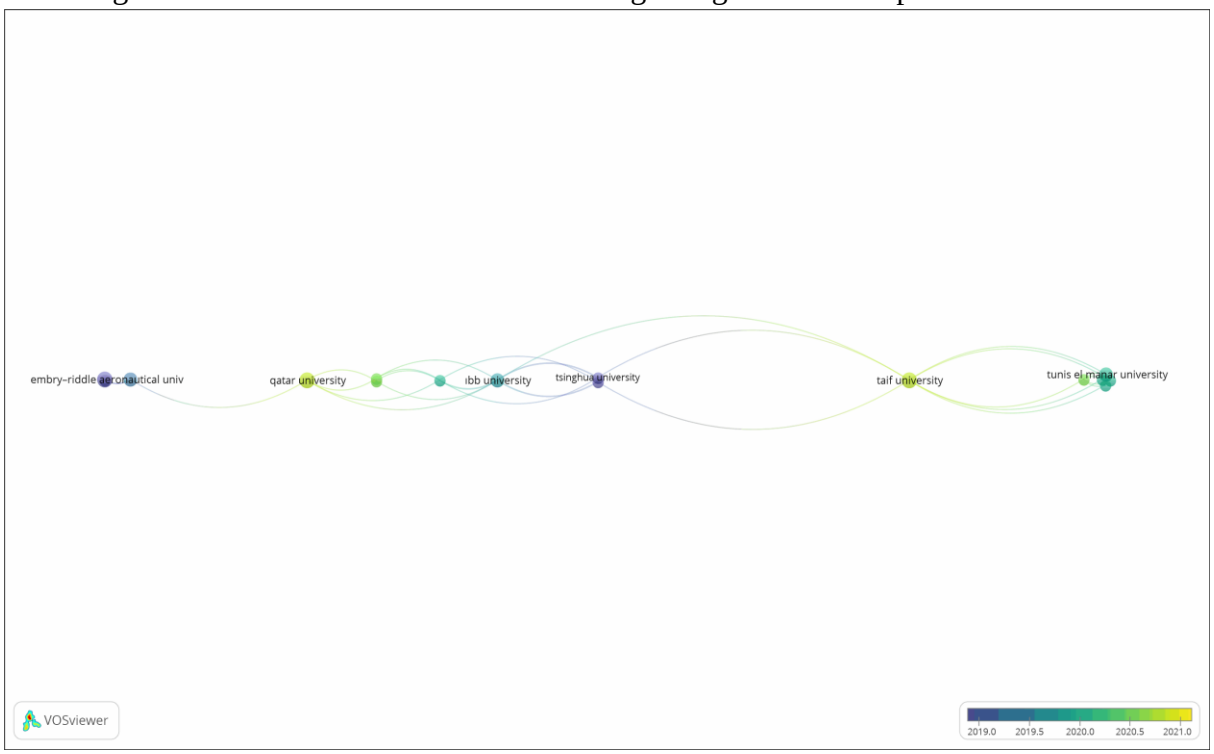


Figure 4. Overlay Visualization of Analysis of Co-Authorship and Organizations.

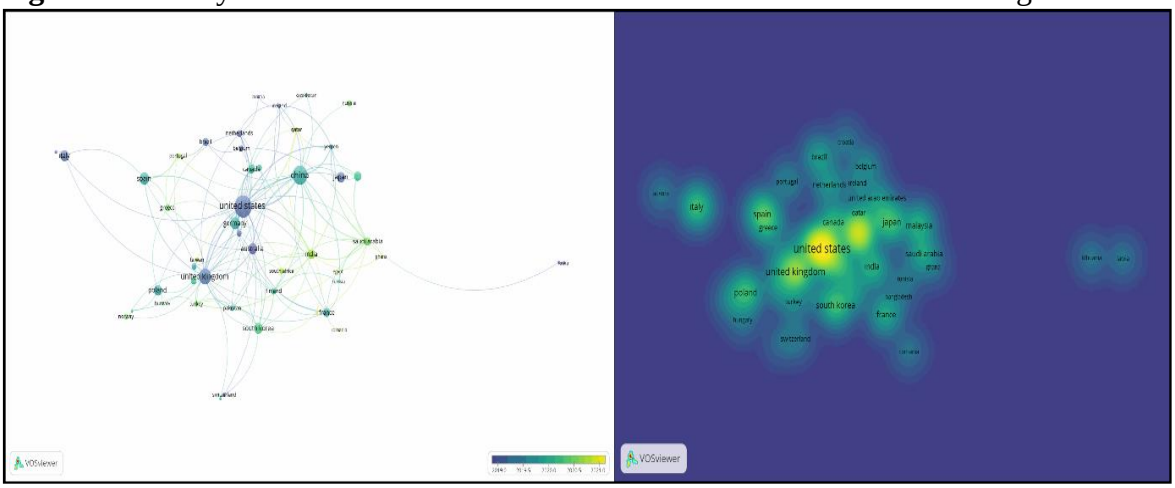
Finally, when co-authorship and countries were analyzed, 52 out of 72 countries passed the threshold. The first five of these are given in Table 3.

Table 3. Top 5 Most Cited Countries with Co-Authorship Networks.

Ranking	Country	Citations
1	United States	2217
2	Spain	1820
3	China	1052
4	United Kingdom	1012
5	Australia	429

In the co-authorship and country analysis, the top five countries among the number of countries reduced to 52 are from different parts of the world. The United States is in first place. Spain is followed by the number of citations, followed by China. Australia, which is a different part of the world, is in fifth place after the United Kingdom in fourth place.

Figure 5. Overlay Visualization of The Most Cited Countries with Co-Authoring Networks.



In Figure 5, overlay visions related to countries are seen. As can be seen from the image, the center of the works is the United States.

3.3.Citation Analysis

Citation analysis reveals various insights related to a particular field of research. It helps identify the most influential authors and publications that have contributed to and made a significant impact on a particular field of research. In short, citation analysis helps identify studies and track their popularity and progress over time (Rejeb et al., 2022).

In this section, influential studies in the field are given using citation analysis, and the 5 most cited studies are listed in Table 4. Out of 739 documents, 2 of them not being listed due to limitations, 395 documents meeting this criterion passed the threshold. The article written by Colomina and Molina (2014) is the most cited in its field with 1653 citations followed by Watts et al. (2012) as second with 564 citations. In the study, photogrammetry and remote sensing disciplines are focused together on nano-micro-mini UAS segments. It reviews the sensing, navigation, routing, and data processing developments for UAS photogrammetry and remote sensing, with a brief analysis of the historical background and regulatory framework.

Table 4. List of Most Cited 5 Articles.

Ranking	Document	Publication Year	Citations
1	Colomina and Molina	2014	1653
2	Watts et al.	2012	564
3	Zeng et al.	2020	259
4	Ding et al.	2017	227
5	Naqvi et al.	2018	158

Naqvi et al. (2018), Alsahmi et al. (2019), Forlani et al. (2018), Sandbrook (2015), Abdel-Basset et al. (2020), Taha and Shoufan (2019), Rosser et al. (2018), Perez et al. (2019), Cruz et al. (2016), Pierdicca et al. (2018) and Balasingam (2017) are on the list of the 15 most cited articles. Unlike others, Zeng et al. (2020), Abdel-Basset et al. (2020), Rosset et al. (2018), Perez et al. (2019) and Sandbrook (2015) are not primarily linked to safety issues of UAS operations or aspects aimed at improving safety. The remaining articles cover a wide

range of issues such as remote sensing and sensors, georeferenced systems, 5G, the Internet of things, and drone detection and classification.

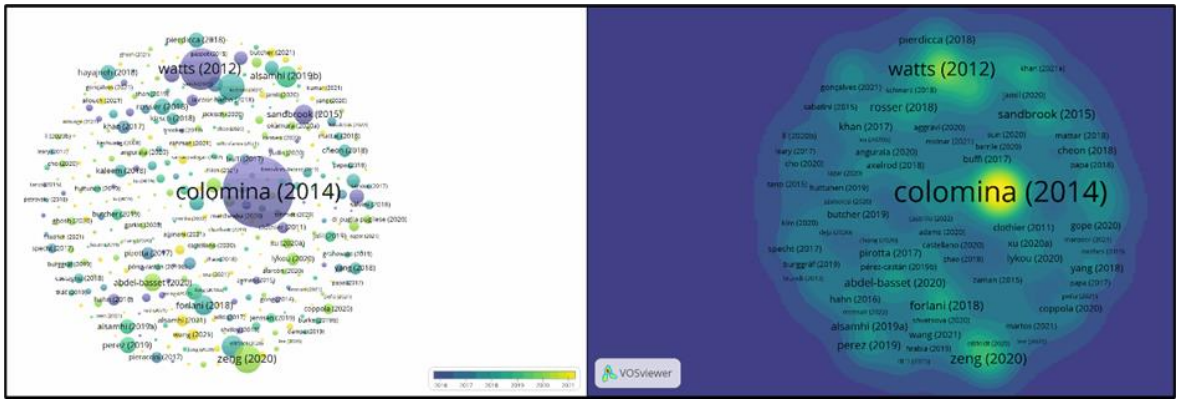


Figure 6. Overlay Visualization of The Most Cited Authors.

When analyzed according to the criteria in citation and source analysis, only 65 of 382 sources exceeded the threshold. The first 5 of these sources are given in Table 5.

Table 5. Top 5 Sources with The Highest Number of Documents and The Highest Number of Citations.

Ranking	Source	Documents	Source	Citations
1	IEEE Access	43	Remote Sensing	775
2	Sensors	33	IEEE Access	702
3	Drones	29	Sensors	531
4	Journal of Physic Conference series	23	IEEE Communications Magazine	446
5	Applied Sciences	22	Drones	253

IEEE Access ranks first in Table 5 with 43 documents, while Remote Sensing ranks first in Table 6 with 775 citations. While Remote Sensing is in the first position in reference, it is not in the top five when analyzed according to the number of documents. Still, the sources of IEEE Access, Sensors, Drones, Applied Science, Aerospace, The International Archives of the Pho., and Electronics are on both lists in terms of the highest number of citations and the highest number of documents. This shows the parallelism between the number of documents and the number of citations. Overlay and density visualization for attribution and source analysis are given in Figure 7.

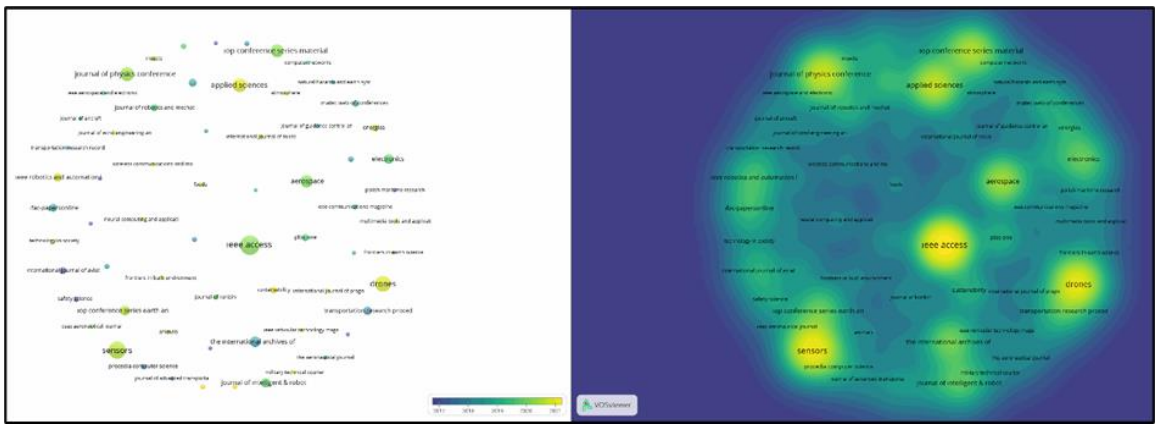


Figure 7. Overlay Visualization of The Citation and Sources Analysis.

When analyzed according to 15 documents and 2 citation criteria, 132 out of 2566 authors passed the threshold. The first five authors with the most documents and most citations among 132 authors are given in Table 6.

Table 6. The Top Five Authors with The Most Documents and The Most Citations

Ranking	Author	Documents	Author	Citations
1	Ellerbroek, Joost	6	Ma, Ou	218
2	Sabatini, Roberto	5	Alsamhi, Saeed H.	218
3	Gardi, Alessandro	4	Shoufan, Abdulhadi	90
4	Konnert, Anna	4	Baxter, Glenn	89
5	La Cour-Harbo, Anders	4	Murray, John	89

The first author with the most documents and the first author with the most citations are different people. Although Ellerbroek has 6 documents, it is not in the top five in terms of the number of citations. Ma's citation count is 218 and he is the most cited author. Ma's number of documents is 3.

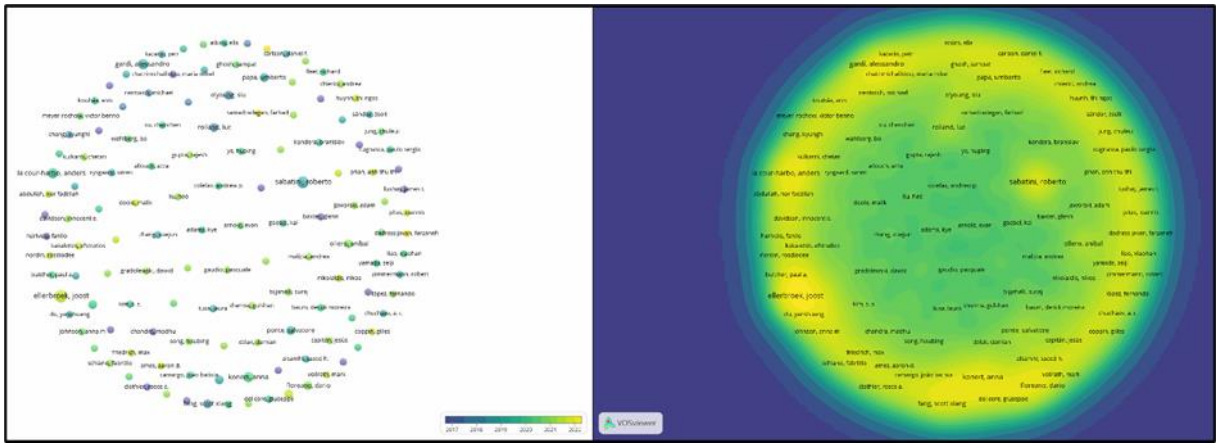


Figure 8. Overlay and Density Visualization of The Authors.

Figure 8 shows the number of authors and distribution is distributed according to the number of citations and documents. For this reason, the number of authors from 2566 was reduced to 132 for analysis. In the citation and organization analysis, 141 out of 602 organizations exceeded the threshold with the limitations made for documents and citations. Among these

141 organizations, the first five organizations with the most documents and citations are given in Table 7.

Table 7. Top Five Organizations with The Highest Number of Documents and The Most Citations

Ranking	Organizations	Documents	Organizations	Citations
1	RMIT University	8	University of Florida	632
2	University of Technology Malaysia	7	Northern Arizona University	305
3	Beihang University	6	IBB University	264
4	German Aerospace Center	6	Nanjing University of Aeronautics An...	244
5	National University of Sciences and Te…	5	Nazarbayev University	232

RMIT University ranks first among the top five organizations with the most documents. This university has 8 documents and 186 citations. RMIT University ranks tenth in the citation count with this number of citations. This again reveals the difference and importance between the number of documents and the number of citations, as in the previous analysis. For this reason, there are many items in Figure 9 like Figure 8.

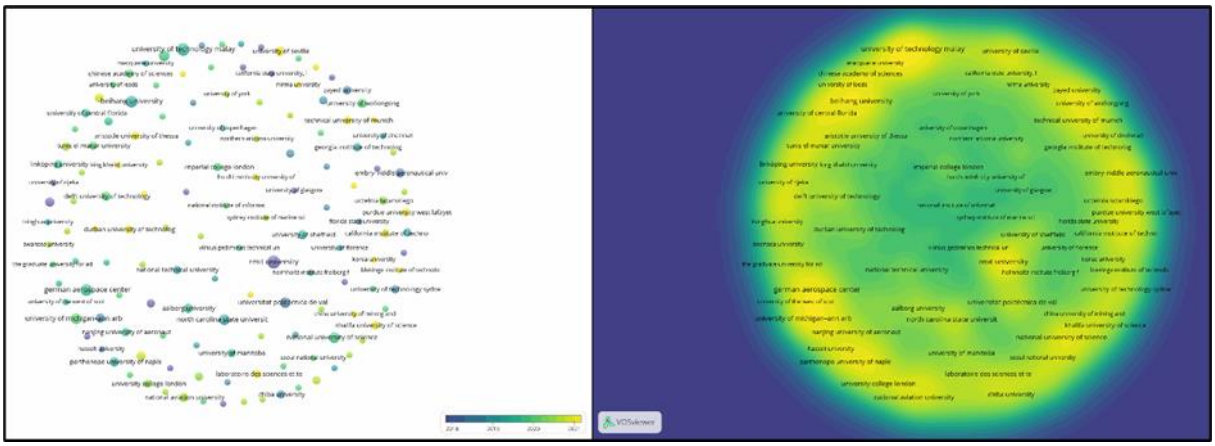


Figure 9. Overlay Visualization of The Analysis of Citations and Organizations.

When the citation and countries are evaluated together, 52 countries out of 72 countries passed the threshold. For this merger, the maximum number of countries per document is 15. The minimum number of documents and citations per country is 2 for both. The top five countries with the most documents among 52 countries are given in Table 8. The United States gave the most contribution to the field related to the keywords we selected.

Table 8. Top Five of The Countries with The Most Documents and Most Citations.

Ranking	Country	Documents	Country	Citation
1	United States	86	United States	2217
2	China	63	Spain	1820
3	United Kingdom	44	China	1052
4	Spain	27	United Kingdom	1012
5	Germany	26	Australia	429

Regarding the countries, Table 8 shows the top five countries contributing to the literature, while Spain and China are at the top of the list after the United States. The United States has the most documents and citations. In addition, the United States is the country where most UAS models are produced or developed in the world. 403 models of UAS were produced or developed in the country. After that, Spain produced or developed 36 units, and China, as the second manufacturer or developer in the world, produced or developed 227 UAS models (Blyenburgh, 2021). Figure 10 shows the overlay visualizations of the countries with documents and citations. The United States and China have higher densities than other countries.

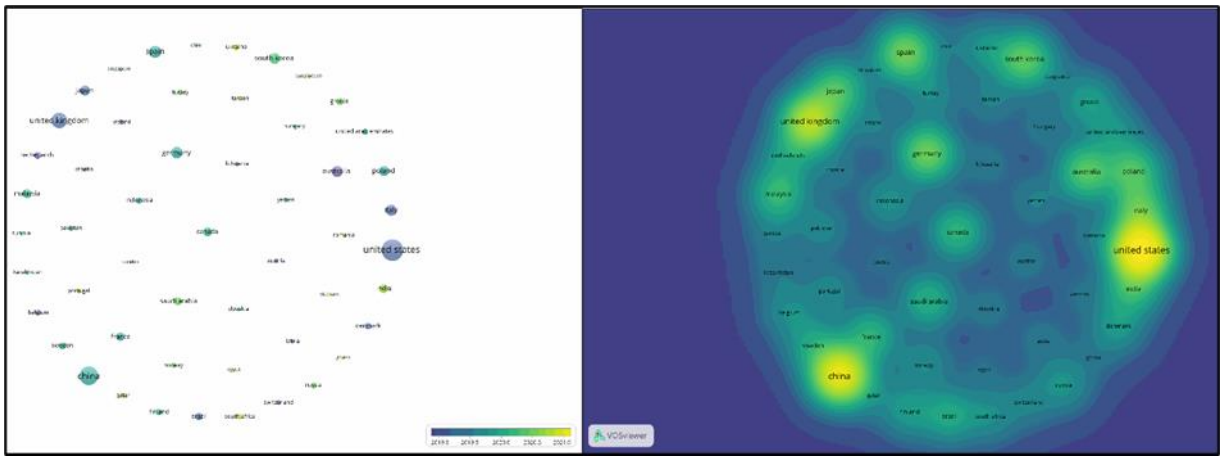


Figure 10. Overlay Visualization of The Analysis of The Citation and Countries.

3.4.Citation ranking of the sources and their clusters

As a result of the analysis, 4 clusters and the highest citation ranking of the documents were defined (Table 9). The first cluster consists of "Remote Sensing", "International Archive of Photogrammetry Remote Sensing and Spatial Information Sciences", "Electronics" and "Applied Sciences". These journals are mostly about general engineering, electronics, and engineering and its applications. The second cluster consists of "Sensors" and "Drones", which are the focus sensor technologies and UAS design and implementation. Cluster 3 consists of "Aviation" and "Transport Research Procedure". Cluster 4 consists of "IEEE Access" and "Plos one", which are more multi-domain and multi-disciplinary.

Table 9. Citation Ranking of The Sources and Their Clusters

Rank	Source	Clusters
1	Remote Sensing	Cluster 1: Remote Sensing, The International Archives of The Photogrammetry Remote Sensing and Spatial Information Sciences, Electronics, Applied Sciences
2	IEEE Access	
3	Sensors	
4	Drones	
5	Aerospace	
6	The International Archives of The Photogrammetry Remote Sensing and Spatial Information Sciences	
7	Applied Sciences	Cluster 2: Sensors, Drones
8	Plos One	Cluster 3: Aerospace, Transportation Research Procedia
9	Electronics	

10	Transportation Research Procedia	Cluster 4: IEEE Access, Plos one

With common citation analysis, it is possible to identify scientific societies and their publications, and the results provide information about the internal structure of the relevant field (Gmur, 2003). After this analysis, five clusters were identified based on the similarity of the content areas. Table 10 shows the matching of the clusters and their common content. Each of the content is linked to safety improvements and implementations.

Table 10. Clusters and Their Common Contents

Clusters	Common Contents
Cluster 1	UAS Commercials and Businesses Areas, Regulations
Cluster 2	IoT, Autonomous Systems, Multi-UAV Networks, Intelligent Transportation Systems
Cluster 3	UTM Concept, Airspace Design, Regulations, Separation and Conflict Detection
Cluster 4	Artificial Intelligence, Object Detection, Image Classification, Neural Nets
Cluster 5	Autonomous And Remotely Operated Aerial Vehicles, Artificial Intelligence and Learning, Wireless and RF Technologies

Cluster 1 mainly focuses on the UAS usage areas as commercial and business as building inspection, transportation of goods or medicals or agriculture, etc., and regulations of UAS. The second cluster is more concerned with self-flying systems using IoT and autonomy. Along with these technologies, studies focus the multi-UAV networks and intelligent transportation systems. Unmanned traffic management and airspace design gather under cluster 3. Besides that, conflict detection and avoidance systems, traffic separation methods, and regulations are in that coverage area. Cluster 4, slightly different from the others, does not directly include UAS. The cluster deals with UAS as the user of the subjects it focuses on. Cluster 5 focuses on wireless and radio frequency technologies, autonomous and remotely operated systems, artificial intelligence, and its learning methods.

4. CONCLUSION AND DISCUSSION

Unmanned aerial vehicles and/or systems are one of the indispensable aviation developments of our age. For this reason, it is important to examine the unsafe conditions of unmanned aircraft and/or systems in all these operations and air traffic so that all aircraft in aviation activities can operate safely. Examination of academic studies and bibliometric analysis will be beneficial for academic studies to be carried out in the coming years.

In this study, publications after 2003 were examined. The reason for this is that publications on UASs began to be carried out in the 2000s, and after 2020, there have been great increases in the number of publications. It is seen that the work has increased after 2020. According to the co-authorship analysis, Ma and Alsami are the most cited authors with 218 citations. Ma is an academician in the USA, the country with the highest number of unmanned aerial vehicles and systems, and Alsami is an academician in China, another country with the highest number and development. A lot of work is being done on the subject in these countries, therefore the quality of publications and the number of citations is increasing. The organization with the most citations to the co-authorship network is the University of Florida, with 632 citations, nearly double that of runner-up Northern Arizona University, with 305 citations. Additionally, when countries are examined for the same network, the

United States ranks first with 2217 citations. Spain follows with 1820 citations. The reason why Spain is included in this ranking is that the UAV industry in the country is service-oriented and has entered all kinds of sectors. These range from lifesaving UAVs in Valencia to inventory UAV implementation at Ikea, as well as security, police use, and delivery services, among dozens of other applications. The UAV industry average in Spain is above the global average (Alvarado, 2023). Therefore, the number of studies and citations were also positively affected.

The most cited article was written by Colomina and Molina (2014) and received 1653 citations. It is thought that the reason why Colombina and Molina's publications have received so many citations is that they include basic topics about UAVs and explain the concepts at an understandable level in their article "Unmanned Aerial Systems for photogrammetry and Remote Sensing: A Review". Additionally, the publication was conducted at the Technology and Telecommunications Center in Spain. In second place is the work by Watss et al. (2012), which received 564 citations. In third place, the work written by Zeng et al. received 259 citations. This article and the other 4 articles in the top 15 most-cited articles list are not primarily linked to the safety issues of UAS operations or improving safety. The top three countries with the most broadcasts are America, Spain, and China. Turkey is not in the top 10. The most cited organization is the University of Florida. It is followed by Northern Arizona University and IBB University. It is seen that the most published and cited publications are research centers and technical universities. The most preferred source for publication of the articles is Remote Sensing following the IEEE Access and then Sensors. There are five common content clusters observed by using citation analyses. Each of the contents is linked with the safety applications and may improve the safety of the UAS. More studies can be done on unmanned aerial vehicles and systems. Although there is both production and use in the field of defense in Turkey, a sufficient number of academic studies have not been performed.
As a result of the findings obtained, with the increase in safety studies on UAV systems year by year, it is important to continue the studies carried out with the safety management system in a multidisciplinary manner. It is recommended that sciences such as engineering, computer science, and aviation management work together to address complex challenges. By understanding regional differences by conducting comparative studies with countries with high levels of UAV activity, such as the USA, China, and Spain, specific safety measures can be determined, and policies can be developed.

REFERENCES

Abdel-Basset, M., Chang, V., & Nabeeh, N. A. (2020). An intelligent framework using disruptive technologies for COVID-19 analysis. *Technological Forecasting & Social Change, 163*, 120431.

Alshamhi, S. H., Ma, O., Ansari, M. S., & Almalki, F. A. (2019). Survey on collaborative smart drones and internet of things for improving smartness of smart cities. *IEEE Access*, 7, 128125-128152.

Alvarado, E. (2023, November 5). Survey Snapshot: Spain's Drone Market. Retrieved from Drone Industry Insights: https://droneii.com/drone-companies-in-spain-drone-market

Altıntaş, O.A. (2023). *Analysis of unmanned aerial vehicle systems occurrence reports from the safety management system perspective and scope of ICAO standards*. Eskişehir Teknik Üniversitesi, Lisansüstü Eğitim Enstitüsü, Eskişehir. https://tez.yok.gov.tr/UlusalTezMerkezi/TezGoster?key=a0OMTmEd_3mfOBxT8SiBTIzaePYMbQEyFvTJuotgqKLBLfuI6rsN9LAdO9xMElRw.

Balasingam, M. (2017). Drones in medicine - the rise of machines. *International Journal of Clinical Practice*, 71(9), e12989.

Blyenburgh, P. v. (2021). *RPAS The Global Perspective Volume 1*. Retrieved from Remotely Piloted Systems The International Information & Reference Source: https://rps-info.com/publications/rpas-the-global-perspective_volume-1_2021_flipbook/

Carr, E. B. (2013). Unmanned aerial vehicles: Examining the safety, security, privacy and regulatory issues of integration into US airspace. *National Centre for Policy Analysis (NCPA)*. Retrieved on September, 23(2013), 2014.

Colomina, I., & Molina, P. (2014). Unmanned aerial systems for photogrammetry and remote sensing: A review. *ISPRS Journal of Photogrammetry and Remote Sensing*, 92, 79-97.

Cruz, H., Eckert, M., Meneses, J., & Martínez, J.-F. (2016). Efficient forest fire detection index for application in unmanned aerial systems (UASs). *Sensorns, 16*(6), 893.

Ding, G., Wu, Q., Zhang, L., Lin, Y., Tsiftsis, T. A., & Yao, Y.-D. (2017). An amateur drone surveillance system based on the cognitive internet of things. *IEEE Communications Magazine, 56*(1), 29-35.

Dirik, D., Eryılmaz, İ. ve Erhan, T. (2023), Post-truth kavramı üzerine yapılan çalışmaların Vosviewer ile bibliyometrik analizi, *Sosyal Mucit Academic Review*, 4 (2), 164-188.

Dixit, A., & Jakhar, S. K. (2021). Airport capacity management: A review and bibliometric analysis. *Journal of Air Transport Management*, 91, 102010.

FAA. (2022, May 19). Safety Management System: SMS Explained. Retrieved from Federal Aviation Administration: https://www.faa.gov/about/initiatives/sms/explained

Forlani, G., Dall'Asta, E., Diotri, F., Cella, U. M., Roncella, R., & Santise, M. (2018). Quality assessment of DSMs produced from UAV flights georeferenced with on-board RTK positioning. *Remote Sensing*, *10*(2), 311.

IATA. (2023). IATA Annual safety report executive summary and safety overview – 60th Edition. https://www.iata.org/contentassets/a8e49941e8824a058fee3f5ae0c005d9/safety-report-executive-and-safety-overview-2023.pdf

Naqvi, S. A.R, Hassan, S. A., Pervaiz, H., & Ni, Q. (2018). Drone-aided communication as a key enabler for 5G and resilient public safety networks. *IEEE Communications Magazine, 56*(1), 36-42.

Newman, M. E. (2004). Coauthorship networks and patterns of scientific collaboration. *Proceedings of the national academy of sciences*, 101(suppl_1), 5200-5205.

Perez, H., Tah, J. H., & Mosavi, A. (2019). Deep learning for detecting building defects using convolutional neural networks. *Sensors, 19*(16), 3556.

Pierdicca, R., Malinverni, E. S., Piccinini, F., Paolanti, M., Felicetti, A., & Zingaretti, P. (2018). Deep convolutional neural Network for automatic detection of damaged photovoltaic cells. *Remote Sensing and Spatial Information Sciences*, 42, 893-900.

Rosser, Jr, J. C., Vignesh, V., Terwilliger, B. A., & Parker, B. C. (2018). Surgical and medical applications of drones: A comprehensive review. *Journal of The Society of Laparoscopis & Robotic Surgeons, 22*(3).

Sandbrook, C. (2015). The social implications of using drones for biodiversity. *Ambio*, 44(Suppl 4), 636-647.

Taha, B., & Shoufan, A. (2019). Machine learning-based drone detection and classification: state-of-the-art in research. *IEEE Access, 7, 138669-138682.*

Visser, M., Eck, N. J., & Waltman, L. (2021). Large-scale comparison of bibliographic data sources: Scopus, Web of Science, Dimensions, Crossref, and Microsoft Academic. *Quantitative Science Studies*, 2(1), 20-41.

Watss, A. C., Ambrosia, V. G., & Hinkley, E. A. (2012). Unmanned aircraft systems in remote sensing and scientific research: Classification and considerations of use. *Remote Sensing*, 4(6), 1671-1692.

Weibel, R. E., & Hansman, R. J. (2006). Safety considerations for operation of unmanned aerial vehicles in the national airspace system. Technical report, ICAT 2005-01

Yang, H.-H., Chang, Y.-H., & Lin, C.-H. (2022). A combined approach for selecting drone management strategies based on the ICAO Safety Management System (SMS) components. *Journal of Air Transport Management*, 104, 102257.

Zeng, Z., Chen, P.-J., & Lew, A. A. (2020). From high-touch to high-tech: COVID-19 drives. *Tourism Geographies, 22*(3), 724-734.