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Drones in Hospitality and Tourism: A literature review and research agenda

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Abstract

Purpose

Drones have become an important element within hospitality and tourism. The main objective of this study is to identify the corpus of knowledge and create a research agenda that establishes appropriate guidelines for future study of drone application in hospitality and tourism.

Design/methodology/approach

This work has undertaken utilising a mixed methods approach that combines quantitative and qualitative research and includes a review of the literature related to the study of drone use in hospitality and tourism.

Findings

The mixed methods review identified gaps in the research, potential areas of study to enhance the scientific literature, and potential uses of drones in tourism and hospitality for researchers, consumers, and industry professionals.

Originality/value

This study makes an original contribution by establishing an integrated framework, which lead to a synthesis of the research corpus and provided a holistic conceptualisation of the relationship between tourism and drones. In addition, the research agenda proposed will help boost and consolidate this emerging field of research.

Keywords: drones; UAV; tourism; hospitality; environment; management.

1. INTRODUCTION

The use of drones[1] (also known as unmanned aerial vehicles, UAVs, unmanned aerial systems, UASs, or remotely piloted aircraft systems, RPAS) is increasing with multiple applications in different economic environments and commercial activities (Mogili and Deepak, 2018; Raj and Sah, 2019; Kellermann, Biehle and Fischer, 2020). In the field of tourism and hospitality, research is emerging, and studies have increased significantly in recent years (Stankov *et al.,* 2019; Chen *et al.,* 2018; Hwang and Kim, 2021; Vujičić *et al.,* 2022; Stankov and Vujičić, 2022).

Drones have become a disruptive technology for the tourism sector, co-creating value for companies and consumers (Buhalis, 2019; Koo *et al*., 2019; Zeng *et al*., 2020). They can increase innovation, efficiency, competitive advantage, and cost-effectiveness. Although this technology started as a tool to enhance innovation in the marketing of tourism companies, currently, drones can also be used for virtual tourism, responding to mobility restrictions and enhancing customer experience. Drones may improve tourism operation management and promote sustainability through environmental or infrastructure monitoring, while respecting the ethical, legal, and social issues that come with their use. As technology advances, the new possibilities for drone use in tourism will continue to emerge, including the capacity to obtain spatial data in real-time. Spatial data is increasingly relevant for the more efficient management of the volatile and dynamic tourism and hospitality sectors (Stylos, Zwiegelaar and Buhalis, 2021).

Despite the growing relevance of drones in tourism, research remains fragmented, and

[1] Drone is a term that broadly includes those types of unmanned aerial vehicle that can fly autonomously or can be controlled remotely. They generally resemble small multi-rotor helicopters in design. (Stankov *et al*., 2019; Vergouw *et al*., 2016).

there is a lack in the collation of findings which limits avenues for further research. This work was motivated by the need to establish a review of the emerging research areas that serve as a catalyst to integrate and stimulate interest in the topic among academics and practitioners (Torraco, 2005). In line with this motivation, this study will address the following research questions. First, what is the state-of-the-art in research analysing the use of drones in tourism and hospitality. Second, what are the main avenues of research that may lead to new knowledge in the field under study.

Therefore, this study contributes by establishing an integrated framework, which synthesises the research corpus, providing a holistic conceptualisation of the topic under study. The work also proposes a research agenda that will boost and consolidate research on the relationship between UAVs and tourism.

The remainder of this paper is structured as follows. After the introduction, section 2 details the methodology and data. Section 3 presents the empirical analysis. Section 4 proposes a research agenda about the topic under study. Finally, Section 5 establishes the conclusions, which presents the implications, limitations of the study, and future avenues for research.

2. METHODOLOGY

There is much interest in drone use within tourism and hospitality applications, as evidenced by over 77 million results found on international search engines, such as Google. This study aims to analyse the literature and to assess the convergence between drone use and tourism and hospitality.

An exploration of the research generated in tourism can aid in an understanding of its function, content, and direction (Rivera and Pizam, 2015; Ávila-Robinson and Wakabayashi, 2018). Identifying research gaps and proposing new areas of study can

provide deeper insights into various aspects of drone application including the use of drones in the management and marketing of tourist destinations, recreational use by tourists, legal issues, and potential future applications within the industry.

This work utilised a mixed methods review (Kim *et al.,* 2018; La, Xu and Buhalis, 2021; Navío-Marco, Ruiz-Gómez and Sevilla-Sevilla, 2019) that combines quantitative and qualitative research approaches. The process undertaken to promote transparency, decision making, and assisted in the formation of opinions during the study is summarised in Figure 1.

[INSERT FIGURE 1]

The Web of Science (WoS) Core Collection was the information source. WoS is considered a reliable source of scientific literature, as it includes peer-reviewed studies published in reputable journals. This research utilised a building block approach proposed by Rowley and Slack (2004) that uses a combination of synonyms and terms, which in this study relate drone technology to tourism and hospitality. This approach makes it possible to collate research within this topic area. The following inclusion criteria were applied:

- Publications were taken from the WoS historical series (1900-2022) up to 2022-06-09,
- All research areas, countries, and regions were included,
- Search by topic to identify literature related to drones, tourism and hospitality.
- The study was conducted applying the following terms:
    - “drones” (drone*) and “tourism” (touris*),
    - “drones” (drone*) and hospitality (hospitality*),

- "unmanned aerial vehicle" (unma*) and "tourism" (touris*),
- "unmanned aerial vehicle" (unma*) and "hospitality" (hospitality*),
- "UAV" (UAV*) and "tourism" (touris*),
- "UAV" (UAV*) and "hospitality" (hospitality*),

- Only full-length papers in English were retrieved.

Once duplications were eliminated, the search yielded a total of 176 studies. The Keyword, Keyword plus, and Abstract sections were reviewed to ensure relevance. Once confirmed the full article was reviewed to identify papers relating to the research objectives. The sample obtained was divided into three categories: "related" to the area being studied, "unrelated" and "possibly". Studies where the content was directly related to drones in tourism and hospitality were classified as "related". Studies classified as "unrelated" and "possibly" were fully reviewed again to ensure that relevant information had not been excluded. After reviewing all the studies, 73 were excluded as unrelated to the studied area (topics like: unmanaged tourism, unmanaged business travel, or unmanaged assets, as examples). The resulting database included 103 papers from 78 journals.

3. EMPIRICAL ANALYSIS

3.1. Descriptive analysis

The use of drones in tourism is considered an emerging field of research (Buhalis *et al.* 2019; Stankov *et al.*, 2019; Vujičić *et al.,* 2022). Figure 2 confirms the literature is very recent, with the first studies dating from 2014 (except for one in 2005). Early reviews in new research fields linking tourism and technologies usually include very limited number of studies (see Huang and Zheng, 2022; Leung et al., 2013; Yung and Khoo-Lattimore,

2019). The use of UAV technology in tourism is relatively recent, which justifies that the number of publications is still limited. However, research has increased in recent years, indicating the interest and relevance of this field from an academic perspective.

[INSERT FIGURE 2]

Figure 3 suggests that the bulk of the literature originated from Europe (51%), specifically, Italy, Spain, and Greece. These countries have a high economic dependence on tourism which would likely influence interest in the use of new technology.

Interest was also evident in Asia (28%), North America (10%), and Oceania (8%), especially in countries with greater technological adoption (China, USA, South Korea, and Australia). Less interest was evident in regions such as South America (4%) and Africa (0%), where drone use is yet to become prominent.

[INSERT FIGURE 3]

3.2. Cluster analysis: Trends and overview of drones in tourism and hospitality

A cluster analysis allows the intertwining of fundamental concepts related to the area of interest. Being a semantic study, it is possible to identify the main ideas related to the topic studied and promote discussion about theoretical conceptualisations. The sample was analysed using data mining and cluster techniques, for which the analytical software VOSviewer_1.6.18 was used (Van Eck and Waltman, 2010). Data mining allowed the identification of patterns and relationships in data that may not be immediately obvious, making it a valuable tool for academia, business, and organisations.

For the analysis, all keywords (Author, Keywords, and Keyword Plus) were used, and in

this way, any co-occurrences could be observed. It was necessary to develop frequency and co-occurrence maps that would allow cluster analysis and identify node size according to term appearance frequency and domain relationships (Koseoglu *et al.,* 2016; Callon *et al.,* 1983). This allowed an understanding of the cognitive structure of the research papers (Börner, Chen and Boyack, 2003) through the production of semantic maps. The minimum number of keyword co-occurrences was set at three out of a total of 776. For the 44 resulting keywords, the total strength of co-occurrence links with other keywords were then calculated. In total, five clusters were identified (Figure 4, Table I). The following discussion explores the five clusters.

[INSERT FIGURE 4]

[INSERT TABLE I]

Cluster 1. Ecosystem conservation and tourism impacts

Increasing natural disasters have motivated scholars to explore disaster risk reduction, strategies, and planning (Bethune, Buhalis and Miles, 2022). The first cluster identified, focused on the use of UAVs to observe the environmental impacts of tourism for the management and conservation of ecosystems. Studies presented in this cluster advanced the use of UAVs to efficiently monitor, map, and assess the effects of tourism on natural ecosystems, such as forested areas (Runnström *et al*., 2019), dunes and coastal lagoons (Evelpidou *et al.*, 2021), and species habitat (Schofield *et al.*, 2021; Séguigne *et al*., 2022). Drones have also contributed to efficient waste management (Chen *et al*., 2022) and drone monitoring allows for the early detection of fires in tourist areas (Almeida *et al.,* 2017).

Cluster 2. Management of the coastal space

Growth of tourism activities in coastal areas has influenced the economic and social development of coastal cities. However, these activities require ongoing management to mitigate environmental, social, and urban impacts. Decision makers can use drones as an assessment tool to improve coastal management decisions (Provost *et al.*, 2019; Lu and Chyi, 2020). UAV technology can also provide access to marine and coastal ecosystems in inaccessible coastal areas (Niculescu *et al.*, 2017), provide early detection of marine ingress blooms (Mcilwaine, Casado and Waine, 2022), monitor erosion in areas of intense tourism activity (Chapapría *et al.*, 2022; García-Romero *et al.*, 2019), and observe the positive sedimentary budgets for beaches (Provost *et al.*, 2019). UAVs may also be used to prevent uncontrolled or unplanned urban development in coastal areas (Bayram *et al.*, 2017).

Cluster 3. Natural disasters and search-and-rescue operations

Tourism is highly vulnerable to natural disasters that alter consumer behaviour and negatively influence tourism flows to affected destinations (Rosselló *et al.*, 2020). This cluster highlights the potential application of drones to prevent or mitigate the effects of natural disasters, such as damage caused by faults and landslides in sensitive areas, heritage sites, and tourist areas. UAVs can be used to find fault patterns in unstable rocky cliffs (J. Wang *et al.*, 2020; Garrill *et al.*, 2021; Mineo, Pappalardo and Onorato, 2021), as well as identify hazards and the risk of rock falls on roads in tourism areas (Li *et al.,* 2019; X. Wang *et al.*, 2020). The cluster identified novel and effective uses of UAVs in tourism search and rescue (SAR) operations. For example, Du *et al.* (2019) studied how to schedule several drones to find missing tourists. The study also proposed a method for estimating tourist

location depending on the topographic features, weather conditions, and time. Sambolek and Ivasic-Kos (2021) proposed a model that automatically detected people in SAR operations. Similarly, Zheng *et al.* (2019) presented an evolutionary algorithm successfully used in SAR operations to find missing tourists in a protected nature reserve.

Cluster 4. Tourist experience

Cluster 4 identified a range of potential drone applications that can transform the tourist travel experience and improve tourism marketing strategies. Drones have improved travel experiences through the application of virtual and augmented reality tours (Giuffrida *et al.,* 2021; Hua *et al.,* 2018; Lu *et al.,* 2022). UAVs allowed online virtual tours of tourist attractions during the COVID-19 pandemic lockdowns and border closures (Ilkhanizadeh *et al.,* 2020). The recording of videos and the taking of photographs with drones by tourists during their holidays and sharing these experiences on social networks is also increasingly common (Minucciani and Garnero, 2015). This use can improve the tourist experience and can provide a source of innovative marketing for destination management organisations (Vujičić *et al.,*2022).

Cluster 5. Technology, methods, and procedures

This cluster covers different technical methods and solutions involving drones playing a particularly prominent role, such as the rehabilitation and conservation of cultural heritage. Techniques such as photogrammetry using drones has enabled researchers to assess the condition and restoration costs of global and national heritage sites to be integrated as tourist attractions (Rădulescu *et al.*, 2021; Sestras

et al., 2020). Photogrammetry is also ideal for mapping hazards related to geomorphological processes in tourist destinations (Ferrer *et al.,* 2017; Fugazza *et al.,* 2018). Medium-sized drones can also be equipped with compact thermal vision cameras, hyperspectral sensors, and laser scanning such as LiDAR[2], with improved prospects for wildlife ecology, vegetation studies and forestry applications in tourism areas, respectively (Jiménez López and Mulero-Pázmány, 2019).

[INSERT FIGURE 5]

The five clusters allow the identification of the main theoretical concepts and their interrelationships. The most illuminating aspect was the use of drones in environmental conservation and sustainability (Conservation, Coastal Degradation and Natural Damage), as well drone use for tourist protection and safety (Search and Rescue and Social Interactions). It is observed that in the interaction between tourism and drones the importance of sustainability and the environmental management emerges. These theoretical connections also suggest that drones may play a role to minimise external tourism shocks, such as the COVID-19 pandemic, climate change, or political conflicts. Therefore, it is necessary to guarantee the sustainability and resilience of tourist destinations, especially those related to nature tourism, as well as to ensure the protection of tourists. For this sustainable and safe tourism, drones can play a fundamental role.

4. RESEARCH AGENDA SETTING

A research agenda comprises of a framework that allows academics to approach a topic

[2] LiDAR: Airborne or terrestrial laser system used to obtain information on the position and height of elements.

from multiple vantage points (Ertmer and Glazewski, 2014). It provides a map that guides future research (e.g.: Buhalis, 2019; Garcia-Romero *et al.,* 2019; Goel *et al.* 2022) and can identify new trends, topics, and phenomena related to a research field. A research agenda can also identify gaps in the research where critical issues may be overlooked and identify threats and opportunities for future research. This can also help career planning and goals, which tend to be linked through common concerns, methodologies, or themes. The timing of the study is appropriate given that: 1) research on the subject is in its infancy; 2) the use of UAVs in tourism and hospitality is limited but growing; and 3) there is a perceived delay in the publication of research on the subject in tourism journals compared to other disciplinary journals. This is common when it comes to addressing the use of technology in tourism, as has already been detected by Navío-Marco, Ruiz-Gómez, and Sevilla-Sevilla (2018).

Data obtained from the literature review and analysis provides an empirical basis for the theoretical conceptualisation of UAV applications in tourism to establish a research agenda. Discussion will now detail the research gaps and areas worthy of further investigation:

I) Advances and new capabilities of UAV technology

The tourism ecosystem is constantly evolving due to the development of new technology and innovative applications. This study highlights the need for the continual review of drone technology evolution, its advances and new capabilities in relation to tourism. This is especially the case as the precision and autonomy of UAV devices is growing. New technological capabilities are emerging, such as new connectivity and big data (Xiang, 2018), control algorithms (Kim, Gadsden and Willkerson, 2020), and mobile edge computing (MEC) (J. Wang *et al.,* 2020).

These capabilities allow drones to compete (by efficiency, resolution, or proximity) with alternative devices (satellites or manned aerial vehicles) in the development of virtual tours, augmented reality, remote sensing tasks, monitoring, and search-and-rescue operations. Comparative studies on the application of these devices in the tourism context may help to identify the advantages and disadvantages for given scenarios and provide a strong research foundation.

Drones can collect real-time data on tourist behaviour patterns and preferences, which can be analysed using big data. AI and machine learning enable the analysis and prediction of consumer behaviour, provide an understanding of travel trends tourist needs, allow the targeted personalisation of offerings, and improve staff planning (Stylos, Zwiegelaar and Buhalis, 2021).

II) Direct interaction with tourists

Tourists, especially digital natives, are increasingly interested in transformative travel experiences (Buhalis and Karatay, 2022). This study revealed a scarcity of drone studies that focus directly on tourists and their experiences. This presents a productive research gap. Work is evolving relating to tourist photography and videography via drones (Chen *et al.,* 2020; Dinhopl and Gretzel, 2016; Vujičić *et al.,* 2022), use in destination marketing promotion (Stankov *et al.,* 2019), and for virtual tours. The study also noted a significant deficiency in research related to the study of UAVs application in hospitality for food delivery services.

III) New applications for sustainable and safe tourism

UAVs will allow new activities in the field of tourism and will optimise existing experiences by combining data processing, autonomy, and boundless mobility. Therefore, it is useful to set new drone applications on this research agenda. Drones

have been utilised for the monitoring and protection of natural resources and the management of the environmental impacts of tourism (Donaire, Galí and Gulisova, 2020). Future studies should continue to advance the new functionalities of these devices to reduce the impacts of tourism in protected areas and the conservation of the diversity of flora and fauna within natural tourist sites. The role of drones in heritage site conservation and the monitoring cultural tourism also deserves greater investigation. For example, use for the prevention of the looting within archaeological sites and theft from cultural institutions. Novel applications of drones as an alternative to traditional fireworks displays at special events provides another avenue for investigation. This could be a safer alternative for the environment and consumers. Drone applications for the safety of tourists are also a potential research avenue. Previous studies have focused on monitoring or used in the search for missing tourists in SAR operations. However, the development of drone technology may facilitate the implementation of measures to enhance the security and protection of tourists, such as improved crowd control, delivery of first aid materials to injured tourists in hard-to-reach areas, and more effective disaster responses. Other benefits such as the security of tourism infrastructure, enhanced border patrol, improved building inspections, and the supervision of adventure tourism activities which may put tourists or wildlife at risk are also beneficial tourism outcomes.

IV) Use of drones in the post-COVID-19 era

The social interactions and consumption habits of tourists have been affected since the onset of the COVID-19 pandemic. Drones have gained an increased presence during the post-pandemic tourism recovery stage as they have enabled new forms

of virtual tourism that reduce human contact and minimise the potential spread of COVID-19 in tourist destinations. In addition, drones have helped with logistics, supply management, or with the disinfection of public areas (Zeng, Chen and Lew, 2020). These new applications present new lines of research that may be of academic interest to establish the benefits of drone use in the pandemic recovery phase. Future studies that focus on the capability of unmanned aerial devices in hospitality and tourism may improve the resilience of tourism destinations in crisis situations.

Our study has highlighted that the direct interaction between UAVs and tourists, the observation of the tourist space, and tourists' interaction with that space, together with the impact and consequences of these interactions have been identified as broad areas for future studies.

5. CONCLUSIONS

5.1. Theoretical and practical implications

Although the study of drones is gaining prominence within tourism research, the area has not yet been studied comprehensively. The literature on UAVs is inspiring, but it only offers a preliminary and incomplete perspective on the aforementioned problems. The proposed research agenda within this study provides an overview of the issues that would benefit from further research.

The work contributes to the body of knowledge in a number of ways. First, this study employs several techniques of analysis with an integrative approach that sheds light on the evolution and state-of-the-art nature of this topic. Second, it provides a holistic view of the potential applications of drones in the field of tourism and hospitality, establishing

an agenda for future research. Third, it establishes a conceptual link between drones, tourism, sustainability, and risk reduction for destinations and tourists.

Current concerns relating to environmental conservation, biodiversity management, and the protection of tourists and natural spaces are issues that can be well served through the application of drone technology to promote sustainable and safe tourism. This study of drone applications has revealed specific areas where tourism has an effect or is affected by the environment and opens new ways to ensure the sustainability of tourist destinations and tourism flows. The balance between both is required to ensure the future prosperity of tourism destinations. It is a bi-directional interaction. Likewise, we hope that the proposed research agenda provides a catalyst to integrate, guide, and stimulate interest in the subject between academics and professionals.

The academic literature demonstrates that this topic is still emerging. Much of the analyses refer to specific cases and concrete experiences. Theory building requires that a research strategy is defined and focuses on understanding the dynamics present within single settings (Eisenhardt, 1989). This allows research to move towards the conceptualisation and formulation of a theoretical framework for this topic. This path will allow drone research the capacity to have a greater global impact on society and tourism. We consider that the research agenda presented may help to stimulate the transition from an emerging research topic, towards greater topic maturity.

5.2. Limitations and Future Research

The study has several limitations. First, the sample available for analysis remains limited as the topic is emerging, but this is precisely why it is worth structuring it, analysing the current situation, and proposing future paths. Second, this article examines articles published in English from the Web of Sciences database, excluding other publications,

such as conferences and book chapters, as well as publications in other languages. Despite the wide coverage and high impact of the journals in this database, future studies could be extended to other sources to achieve a wider reach. Finally, by focusing specifically on tourism issues, we have overlooked other relevant aspects of the study of drones, such as political and social applications (i.e. Luppicini and So, 2016; Klauser and Pedrozo, 2015).

The new trends and applications open new avenues for research and have been identified in the research agenda. To compliment these new lines of research, and examination of the link between drones and the United Nation's Sustainable Development Goals (SDG) has been unexplored in the field of tourism. Such research may help to gain an understanding of how SDG goals may be achieved in areas such as life on the land and below water, climate action, or sustainable cities and communities.

Nevertheless, this work provides a timely reflection that consolidates and may serve to stimulate further investigation in this emerging research area that relates to the use of disruptive drone technology and its application in the tourism and hospitality sectors.

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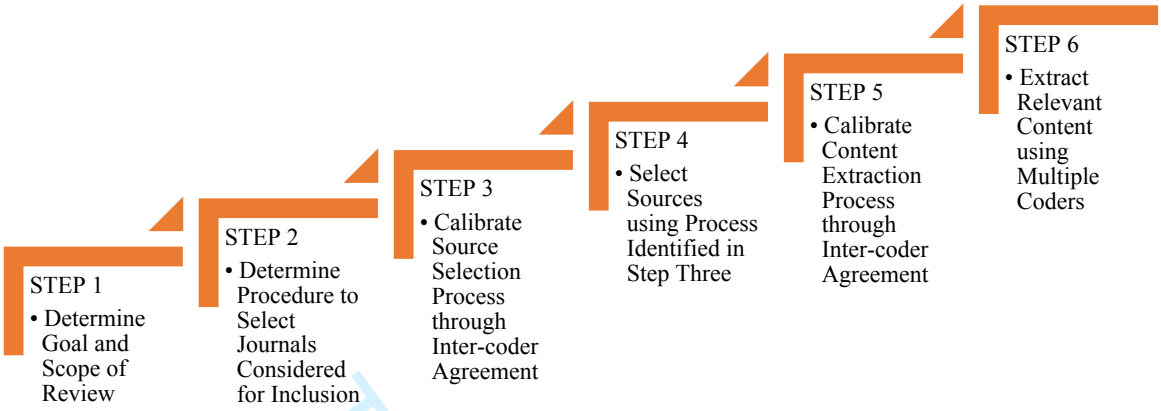
Figure 1. Process for identifying journals, articles, and content to be included in a literature review study.



Source: adapted from Aguinis, Ramani and Alabduljader (2018)

Figure 2. Evolution of publications by number of articles per year (2014-2022)

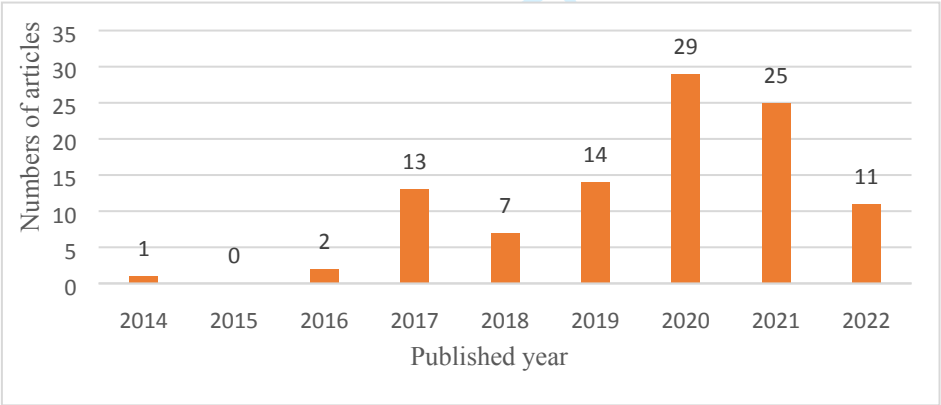


Figure 3. Geographical distribution of publications

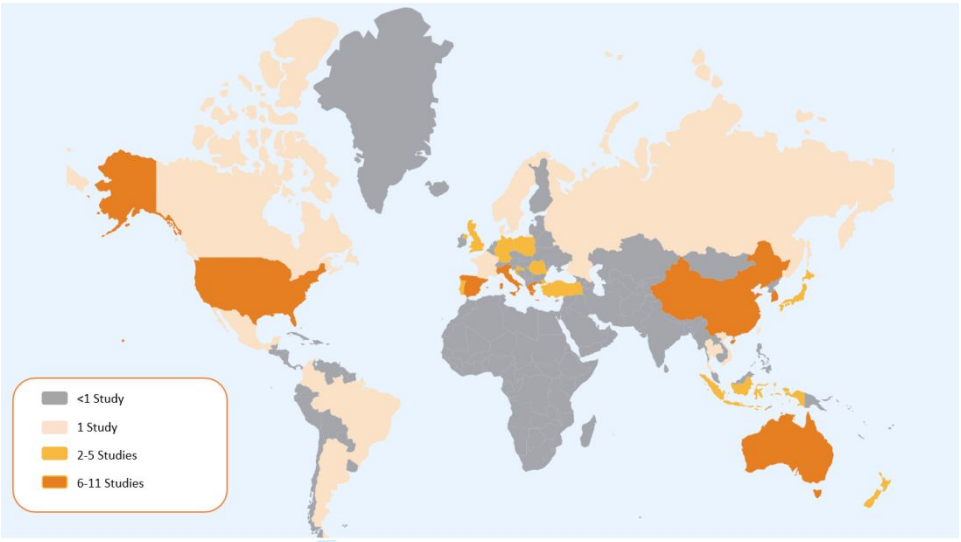


Figure 4. Clusters

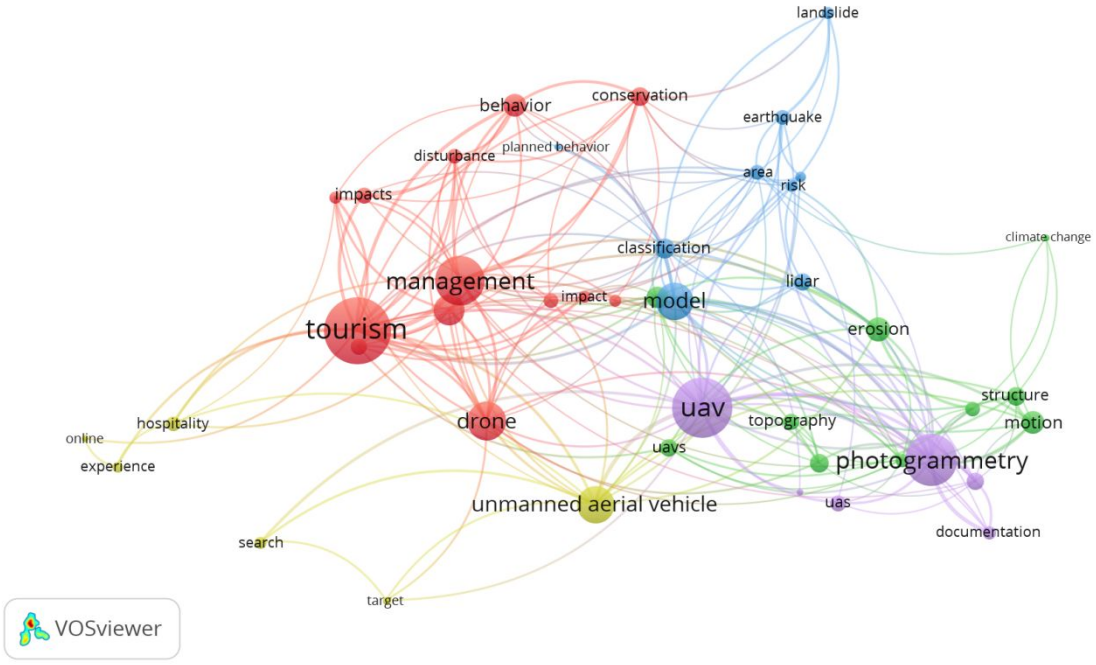


Figure 5. Findings and main uses of drones in hospitality and tourism

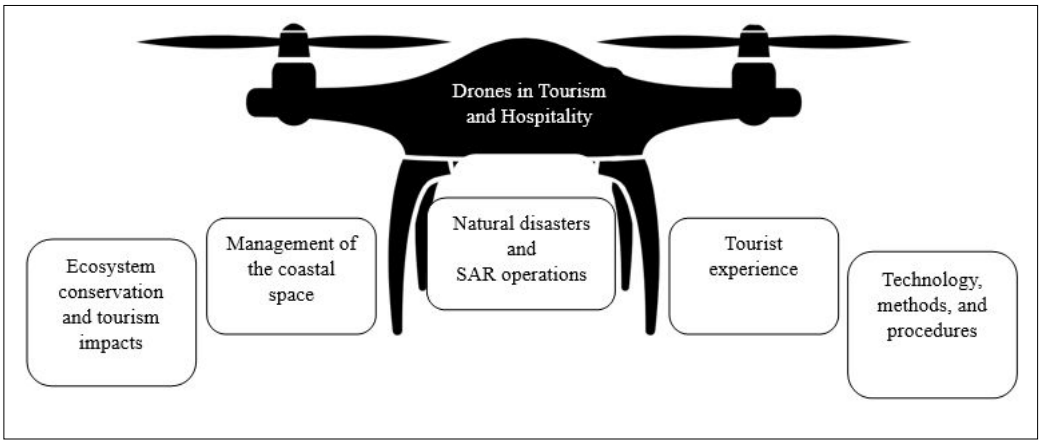


Table I. Identified clusters

No.	Cluster name	Representative keywords
1	Ecosystem conservation and tourism impacts	Behaviour; conservation; COVID-19; disturbance; drone; ecology; forest; impact; impacts; management; river; technology; tourism
2	Management of the coastal space	Climate change; coastal; coastal management; erosion; evolution; motion; remote sensing; structure; topography; UAVs
3	Natural disasters and search-and-rescue operations.	Area; classification; earthquake; landslide; LiDAR; model; planned behaviour; risk; rockfall hazard
4	Tourist experience	Experience; hospitality; online; search; target; unmanned aerial vehicle
5	Technology, methods, and procedures	Cultural heritage; documentation; photogrammetry; systems; UAS; UAV