RECENT DRONE APPLICATIONS IN MALAYSIA: AN OVERVIEW

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ABSTRACT:

This study aims on an exploration of recent applications of drones in the Malaysian context. More specifically, to investigate the drone's application status and application areas. To search the academic literature and identify the included documents, we have followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. We conducted an overview study of the total number of 54 documents (out of 202) published since 2018, which were extracted from the Scopus database. The results of the bibliometric analysis of the included documents showed that drones in Malaysia are applied in different disciplines, including agriculture, mapping, forestry, river monitoring, transportation, construction, coastal management, flood management, and other applications. Among these, agriculture and mapping are the main application areas. MDPI published the most journal articles, and IGRSM conferences published the highest number of conference papers. Furthermore, scholars from the Universiti Teknologi Malaysia have the highest contribution among others.

1. INTRODUCTION

The vast applications of drones, which are known as small-sized Unmanned Aerial Vehicles (UAVs), have gained huge interest nowadays and have become central to the functions of various businesses and governmental organizations in countries around the globe. It could be due to the high potential of drones to offer countless benefits to the current industries in different sectors by providing innovative products and solutions. Increasing work efficiency and productivity, decreasing workload and production costs, improving accuracy, refining service and customer relations, and resolving security issues on a vast scale are a few of the top uses drones offer industries globally. Drones can perform indoor and outdoor activities and enable us to collect data in large and difficult-to-access areas in a short time while reducing human intervention and manpower requirements (Gohari et al., 2022).

To the best of our knowledge, there is a lack of literature regarding a review study on drone applications in the Malaysian context. In this regard, Ab Rahman et al. (2019) attempted to explore drone applications in Malaysia. However, this research has not been conducted in a systematic method. A systematic review of the literature allows for a detailed analysis of recent research. The aim of this review is to investigate the application of drones in Malaysia through bibliometric analysis of academic literature and seek to answer the following research questions: What is the application status of drones in the Malaysian context? What application areas of drones have been presented in the literature in the Malaysian context?

The remainder of this study is presented as follows. In the next section, we discuss the methodology used to extract the relevant research works from the academic literature. In the finding and results section, we demonstrate the outcome of the bibliometric analysis, which includes statistics about annual published documents, the contribution of journal outlets and conferences, the author's affiliations, and the categorization of the included documents. The conclusion is given in the last section.

2. METHODOLOGY

The methodology of this systematic review is based on the PRISMA guidelines to extract the relevant documents. The flowchart process of this study is presented in Figure 1. To collect relevant academic papers in the identification stage, the Scopus database was searched on August 07, 2022. We used an advanced search tool and the search string in their title, abstract, and keywords. The complete used search string was *(''drone'' OR ''UAV'' OR "UAS" OR "unmanned aerial vehicle" OR "unmanned aerial system") AND ("Malaysia")*. The result of this query showed 202 documents since 1993. However, since this study focuses on the most recent researches, we picked the papers published in the last 5 years (2018 onwards). We also limited the search results based on the different criteria including document type (article and conference paper), source type (journal and conference proceeding), publication stage (final), keyword ("unmanned aerial vehicles (UAV)", "drones", "UAV", "unmanned aerial vehicle", and "drone"), and language (English). These limitations caused a reduction of the search results to 77 documents, which were extracted for further processing in the next stages. Checking these documents showed no duplication. In the screening stage, we checked the titles and abstracts of all the 77 documents and found that 11 documents records were irrelevant to this study. Therefore, a total of 66 documents remained. In the eligibility stage, the authors carefully screened the full text of all 66 documents. Among them, 12 documents addressed different technical and non-technical issues (drone operations, performance, optimization, and review), which are out of the scope of this review. Ultimately, a total of 54 documents were included in the current review.

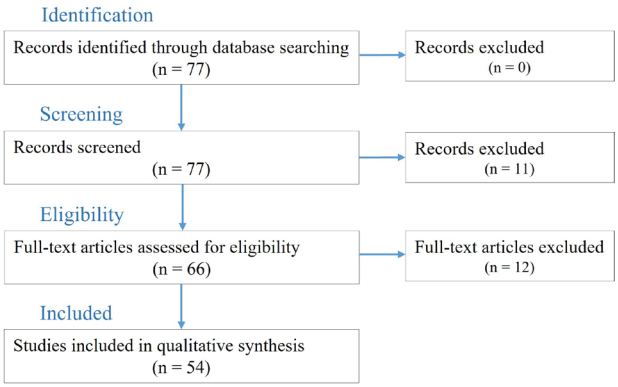

Figure 1. Flowchart process of the current review.

3. FINDINGS AND RESULTS

The bibliometric analysis of all included articles was performed to investigate the current applications of drones in Malaysia in terms of the number of documents yearly published, conference and journal papers, publishers, affiliation of authors, and categorization of the included documents. The annual number of documents was distributed between 2018 (14 documents), 2019 (11 documents), 2020 (13 documents), 2021 (10 documents), and 2022 (6 documents), which is shown in Figure 2.

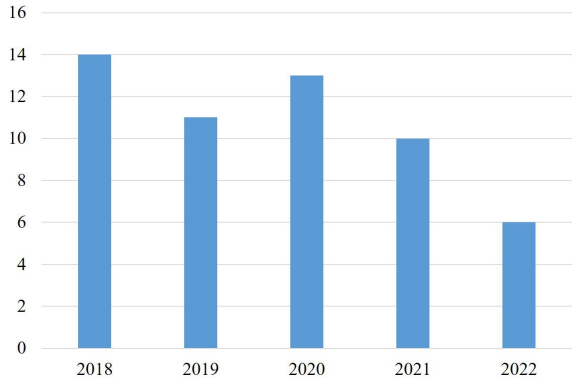

Figure 2. The annual number of published documents.

The 54 documents consist of 28 journal articles and 26 conference papers. The only journal with more than 1 published article (2 articles) is the "Remote Sensing" journal. The list of involved journals is presented in Table 1. The highest number of articles were published by MDPI (7 articles) and Elsevier (2 articles) outlets, while the remaining articles were published by 19 different publishers (1 each), which is illustrated in Figure 3.

	Journal	Number of articles
1	International Journal of Architectural Computing	1
2	International Journal of Civil Engineering	1
3	Journal of Theoretical and Applied Information Technology	1
4	Journal of Tropical Forest Science	1
5	Journal of Advanced Research in Fluid Mechanics and Thermal Sciences	1
6	Forests	1
7	BMC Health Services Research	1
8	Physics and Chemistry of the Earth	1
9	Sustainability	1
10	Journal of Mines, Metals and Fuels	1
11	Estuarine, Coastal and Shelf Science	1
12	Computers, Materials and Continua	1
13	Applied Artificial Intelligence	1
14	Journal of Oil Palm Research	1
15	Remote Sensing	2
16	Journal of Sustainability Science and Management	1
17	ISPRS International Journal of Geo-Information	1
18	International Journal of Remote Sensing	1
19	Sensors	1
20	International Journal of Innovative Technology and Exploring Engineering	1
21	Drones	1
22	Journal of Sustainability Science and Management	1
23	Journal of Advanced Manufacturing Technology	1
24	International Journal of Supply Chain Management	1
25	Forest Ecology and Management	1
26	International Journal of Supply Chain Management	1
27	International Journal of Integrated Engineering	1

Table 1. The list of journals.

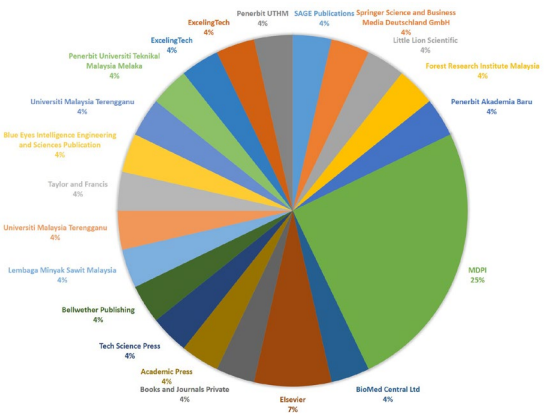

Figure 3. Contribution of the publishers.

The greatest number of conference papers (seven out of 26) were belonged to the Institution of Geospatial and Remote Sensing Malaysia (IGRSM) conferences in 2018 and 2020, followed by the Asian Conference on Remote Sensing (ACRS) conferences (total of six papers) in 2018, 2019, and 2020, and the International Conference on System Engineering and Technology (ICSET) in 2020 (2 papers). The remaining conference papers belong to 11 different conferences. The contribution of involved conferences regarding published papers is illustrated in Figure 4.

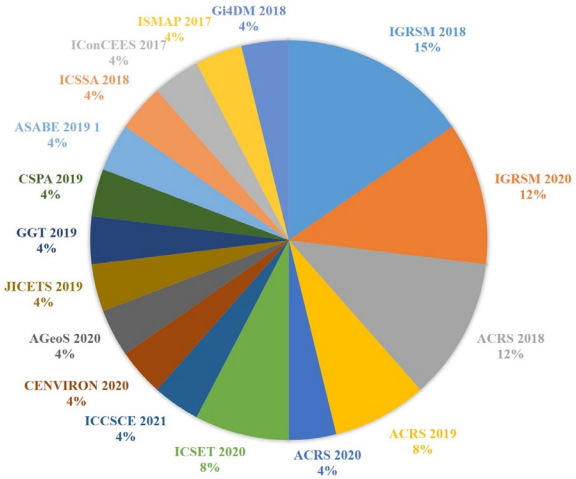

Figure 4. Contribution of conferences.

The results of the author’s affiliation indicated that a total of 51 local and international universities and organizations have been involved, which consists of local universities (16), international universities (18), local organizations (15), and international organizations (2). Local universities have shown the maximum number of affiliations (107), followed by international universities (27), local organizations (20), and international organizations (2). Consequently, a total number of 156 affiliations has resulted. Among local universities, the top two most prominent affiliations belong to Universiti Teknologi Malaysia (24) and Universiti Teknologi MARA, Malaysia (18). Among international universities, Université Libre de Bruxelles in Belgium, Kennesaw State University in the United States, and Hokkaido University in Japan have the most affiliations (3 each). In terms of local organizations, the Forest Research Institute Malaysia has highest affiliations (3), followed by the Department of Agriculture in Sarawak, Malaysia, the Ministry of Health (MOH), Malaysia, and the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) (2 each). The National Institute for Environmental Studies, Japan, and Vlaamse Instelling Voor Technologisch Onderzoek (VITO) Research Organisation, Belgium, were involved international organizations. The affiliation appearance of local and international universities is shown in Figure 5 and Figure 6, respectively.

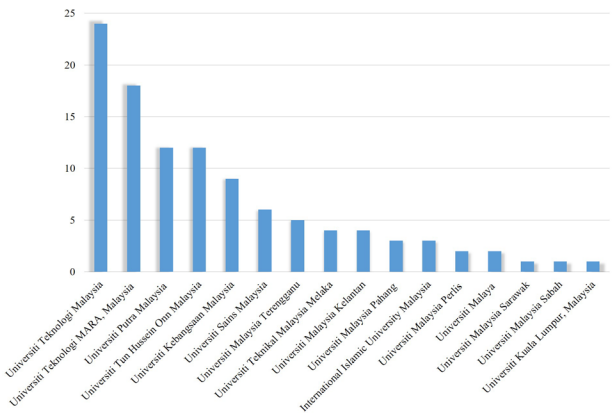

Figure 5. Affiliation appearance of local universities.

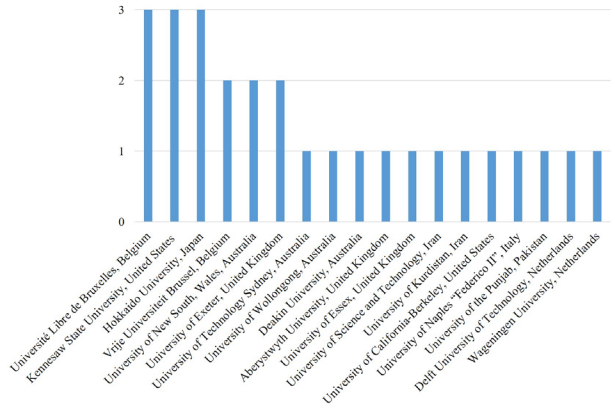

Figure 6. Affiliation appearance of international universities.

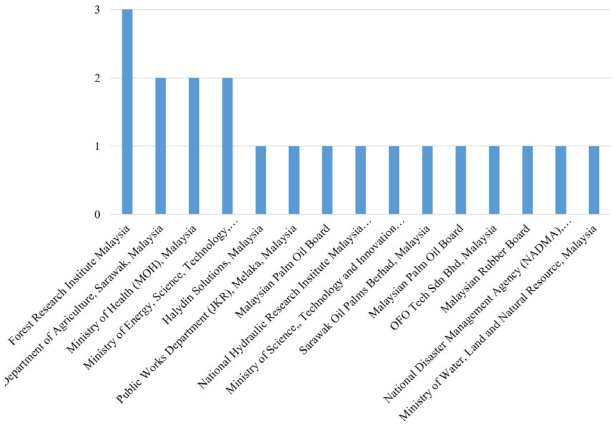

Figure 7. Affiliation appearance of local organizations.

In recent years, the application of drones in Malaysia has been addressed in different disciplines. The authors of this review categorized the 54 included documents into nine distinct groups, including construction, agriculture, transportation, forestry, mapping, coastal management, flood management, river monitoring, and others, which is shown in Figure 8. Note that applications that have been addressed by one document are placed in the "others" group. Based on the categorization results, almost one quarter of the documents have addressed the application of drones related to agriculture (13), followed by mapping (10), forestry (6), and river monitoring (5). Transportation, construction, and coastal management groups have shared an equal number of documents (4 each). A few studies addressed drone applications in flood management (2).

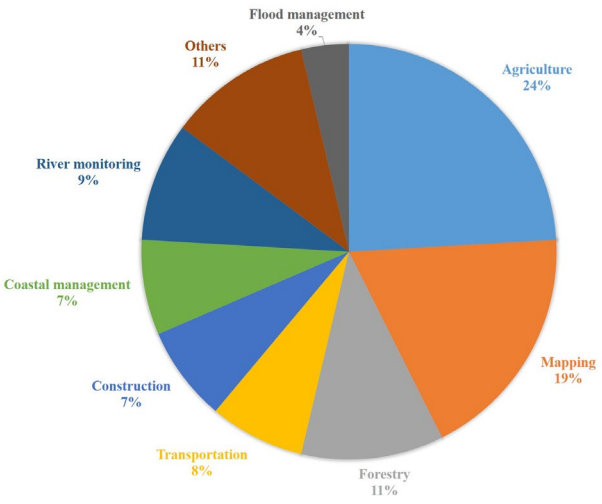

Figure 8. Application areas of drones in Malaysia.

The associated references to each group are presented in Table 2. The Agriculture group covers estimation of Nitrogen (N) status in MD2 pineapple (Ananas comosus var. MD2) crop on mineral soil, durian orchards monitoring, automatic oil palm detection, detection of palm oil health condition, detection of ganoderma disease in oil palm, extraction of biophysical parameters of young oil palm, durian plantation management, estimation of leaf area index, oil palm (Elaeis guineensis) canopy segmentation and height estimation, chemical spraying, rubber-tree clones leaf diseases determination, and rice crop monitoring. The mapping group focuses on slope, 2D, 3D, land use, landslides, terrain, and topographic (large scale) map production. The forestry group includes different topics: determination of emission factor from selective logging activities; detecting and mapping post-selective logging impacts; mangrove tree height measurement; tree stump height estimation; deforestation and forest degradation; and forest inventory. River monitoring applications include water level changes, riverine plastic debris quantification, sustainability monitoring, and quantifying variations in river surface flow areas and vegetation growth. Transport-related applications are blood products delivery, road image segmentation, effectiveness analysis of transverse rumble strips, and shipping container counting. Applications related to construction include construction site visualization and mapping; progress monitoring; information fusion for 3D modelling of cultural heritage; and housing renovation identification. Coastal management studies addressed the effects of erosion and accretion on beach profile, volume measurement, shoreline evolution, and reef-island shoreline change assessment. The flood management group represents studies on real-time and intelligent flood forecasting and flood assessment. The other groups include rockfall trajectory and back analysis, detecting Bornean orang-utans, elevation data acquisition for geophysical survey alignments, monitoring trawler activities, suspected unregulated dumping site detection and verification, and eutrophication process monitoring.

Application	References
Agriculture	(Hasni et al., 2022); (Yusof et al., 2022); (Liu et al., 2021); (Rafezall et al., 2020); (Izzuddin et al., 2020); (Avtar et al., 2020); (Syafiqah et al., 2020); (Abdullah et al., 2020); (Fawcett et al., 2019); (Suab et al., 2019); (Ismail et al., 2019); (Ali et al., 2018); (Norasma et al., 2018)
Mapping	(Zolkepli et al., 2021); (Chaudhry et al., 2020); (Noor et al., 2020); (Kaamin et al., 2020); (Udin et al., 2019); (Yazid et al., 2019); (Ahmad et al., 2018a); (Abdullah et al., 2018); (Yusoff et al., 2018); (Ahmad et al., 2018b)
Forestry	(Siti-Nor-Maizah et al., 2022); (Kamarulzaman et al., 2022); (Saliu et al., 2021); (Maizah Saad et al., 2020); (Otero et al., 2018); (Nadia Zainol et al., 2018)
River monitoring	(Ansari et al., 2021); (Mohamad et al., 2019); (Geraeds et al., 2019); (Elijah et al., 2018a); (Elijah et al., 2018b)
Transportation	(Zailani et al., 2021); (Mahmud et al., 2021); (Sanik et al., 2019); (Abdullah et al., 2019)
Construction	(Keyvanfar et al., 2022a); (Keyvanfar et al., 2022b); (Mohd Noor et al., 2020); (Mustaffa et al., 2018)
Coastal management	(Narashid et al., 2021); (Yusoff et al., 2020); (Zulfakar et al., 2020); (Lowe et al., 2019)
Others	(Sheng et al., 2021); (Nagendran and Ismail, 2021); (Azmi et al., 2020); (Mutalib et al., 2019); (Ismail et al., 2018); (Suteris et al., 2018)
Flood management	(Goudarzi et al., 2021); (Sharom et al., 2018)

Table 2. References associated with each group.

4. CONCLUSION

This study contributes to the body of literature by providing bibliometric analysis of published documents regarding drone applications in the Malaysian context. We found that this topic of research is growing since a variety of local universities and governmental organizations are involved. MDPI and IGRSM are, respectively, the main publisher and conference organizer that publish most of the journal articles and conference papers. The highest number of authors' affiliations in terms of local universities and organizations is assigned to the Universiti Teknologi Malaysia and Forest Research Institute Malaysia, respectively. The involvement of a number of international universities and a few international organizations also appeared. Drones in Malaysia are applied in different disciplines, including agriculture, mapping, forestry, river monitoring, transportation, construction, coastal management, flood management, and other applications. Among these, agriculture and mapping are the main application areas. However, it should be noted that the outcomes drawn from this study are based on some limitations which are explained in the methodology section. Thus, we suggest conducting the study by considering other scholarly databases such as the Web of Science. Also, by investigating the integration of different technologies with drones to perform flight operations and data collection, further studies can be conducted.

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