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Discovering the Global Landscape of Internet of Things (IoT) Studies for Blind Wearable Devices; A Bibliometric Analysis

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ABSTRACT

This study explores the research trends and characteristics of the Internet of Things (IoT) in blind people's wearable devices using bibliometrics analysis. The study aims to identify the publication types, countries, research subjects, and social impact of journal articles related to this topic. The researchers used Microsoft Excel for frequency analysis, VOSviewer for data visualization, and Harzing's Publish or Perish for citation metrics and analysis. A total of 7870 articles from 2006 to March 2023 were retrieved and analysed from Scopus indexed database publications. The study found that India was the most active country in IoT research and China was the most active institution that published significant publications related to this research. The study has limitations due to the exclusivity of Scopus indexed publications, but the findings could assist researchers in the disabled or health area, especially in IoT, to identify future research directions.

1. Introduction

The Internet of Things (IoT) is a term that describes the digitization of physical objects such as machines and vehicles and has received a lot of attention from academics and industries in recent years. It is growing rapidly and bringing significant changes to the economic, healthcare, social and political spheres. The term was coined in 1999 by Ashton who envisioned a world where everyday objects could communicate with each other and be managed by computers without human intervention [1]. The goal of IoT is to enable anything to be connected anytime, anyplace, and to make human life simpler and smarter. The economic value generated by IoT technologies is estimated to reach up to $11.1tn a year by 2025.

Research on IoT has been increasing rapidly in recent years, with several survey papers focusing on its vision, applications, architectures, protocols, fundamental technologies, tools, opportunities, and security requirements. Bibliometrics is a systematic analysis of research trends and publication output, which is the best instrument for social sciences research. [2] were the first to review IoT

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literature using bibliometrics and network analysis techniques. However, they only focused on the vision and applications of IoT and recommended exploring other aspects of this topic [2,3].

This paper reviews IoT literature in the past eighteen years using rigorous bibliometrics and network analysis tools, offering future directions for the IoT research community, and implications for researchers, practitioners, managers, and decision-makers [4]. The study pays special attention to collaboration, productivity, and impact in IoT literature [5].

IoT is playing an essential role in the technology industry, where wearable devices are being used to sense and analyse physiological and psychological data movements, heart rate, and blood pressure [6]. Wearable technology provides opportunities to monitor human activity continuously through miniature wearable sensors embedded in garments. The potential benefits of wearable technology include improving productivity, efficiency, connectivity, health, and wellness.

The research is based on global publication data on IoT retrieved from Elsevier's SciVerse Scopus database. The search strategy used the terms "Internet of Thing*" or "IoT" or "Internet of Everything*" or "Web of Thing*" to search titles and keywords, and all the relevant literature on IoT from 2006 to March 2023 were retrieved. The study excluded documents classified as errata, books or book chapters, and undefined types of documents. Based on the search strategy implemented, a total of 43,272 articles and related documents were found. However, due to identifying specific documents related to IoT in blind wearable devices, the list was then cleaned and analysed [5,7].

This research conducted a bibliometric analysis of published IoT research by involving the following research questions:

RQ 1. What is the current trend and impact of publications relating IoT in blind wearable device?
RQ 2. Which are the most productive and influential countries, institutions, and authors on IoT in blind wearable devices?

The paper is divided into six sections, starting with an introduction, and followed by a brief overview of the methodological elements and procedures of text mining, bibliometric analysis used in the study. The paper also includes a network analysis, including the text mining approach, results and discoveries, limitations, and conclusions.

2. Methodology

Bibliometric analysis is a technique used to examine how literature and information related to a specific subject have developed over time [8-10]. This involves studying data from a database, which may include information such as quotes, authors, keywords, or the number of articles read. Scopus is an extensive and diverse database that contains citations and abstracts from various sources such as peer-reviewed papers, industry journals, books, patent records, and conference publications. It provides tools to track, analyze, and visualize search data, and it has a vast collection of over 39,743 titles, including over 25,000 active and 14,558 inactive titles. With more than 210,000 books, Scopus can provide a comprehensive overview of the world's scientific research output and is a primary source of related information for the international scientific community.

For this bibliometric research, the Scopus science database was used to analyze documents related to "IoT in wearable devices for the blind." This study analyzed all types of publications released from 2006 to March 2023 in the Scopus database. The bibliometric analysis was conducted using the Scopus database as of March 2023, with the search term "IoT in wearable devices for the blind" used to find relevant articles published in any language related. To avoid double or false counting of documents, duplicated document types were excluded.

The search strategy employed in this study for analysis is depicted in Figure 1. Bibliometric analysis was performed on all the documents. The following tools were used for this research:

1. VOSviewer (version 1.6.15) to create and display the bibliometric networks.
2. Harzing's Publish and Perish tool was utilized to calculate the citation metrics.

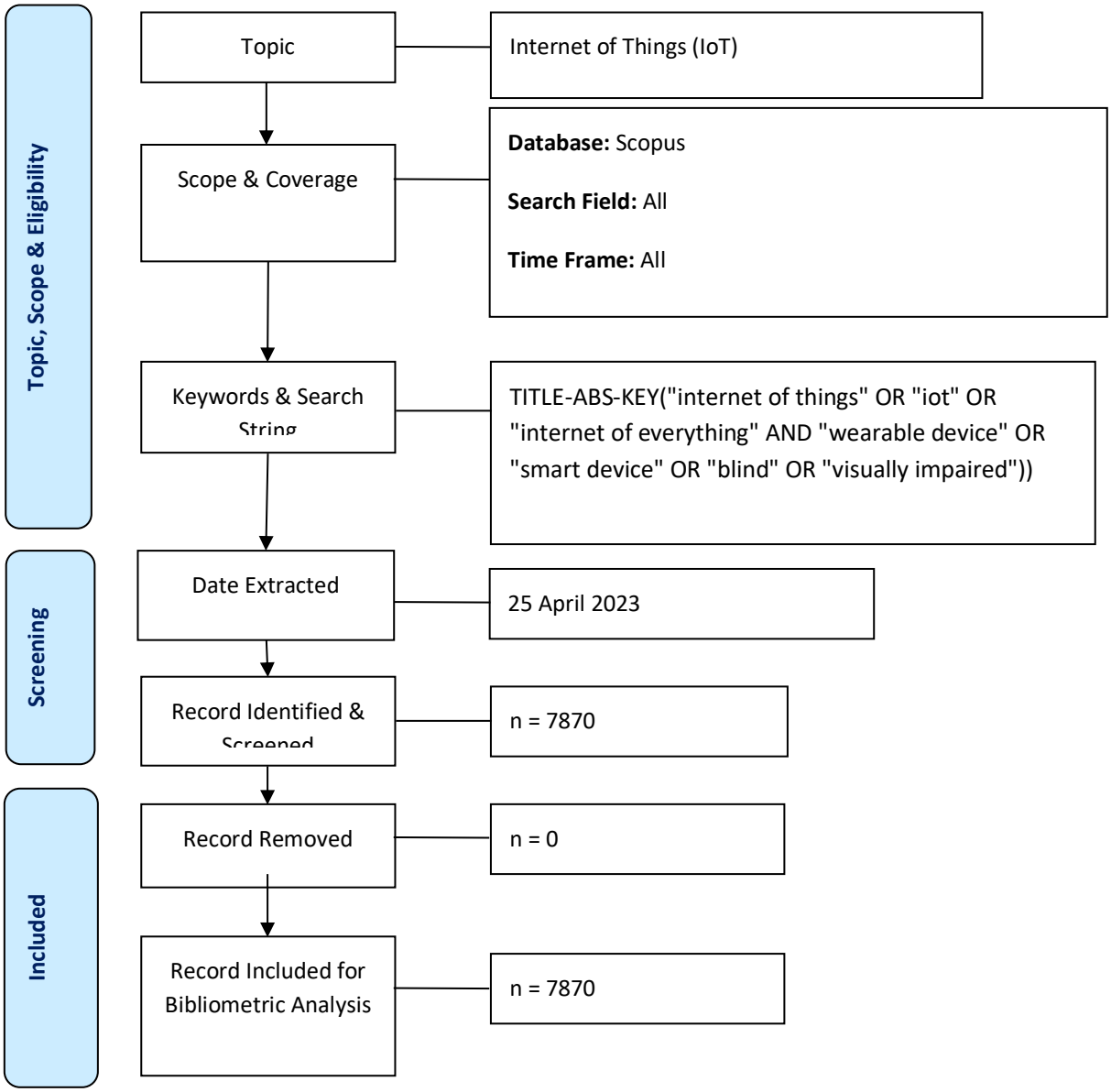

Fig. 1. Flow diagram of the search strategy

From Scopus, a total of 7870 peer-reviewed publications on internet of things especially in wearable devices were obtained through this search strategy. The data were then entered into a Microsoft Excel spreadsheet and subsequently analyzed using SciVal, a research performance assessment tool available through Elsevier's subscription service, which draws on data from Scopus. The retrieved articles were evaluated based on several attributes, including:

- publication trend;
- authorship patterns;

- contributing countries;
- subject area of publications; and
- highly cited publications

The data underwent careful verification and editing before analysis. Authorship patterns were determined based on the affiliations of the authors. Co-authorship was used as an indicator of scientific collaboration, with single authorship assigned to papers without any collaboration. International collaboration was assigned if authors from multiple countries were involved, while national collaboration was assigned if two or more institutions from the same country contributed to a paper. Additionally, papers authored by more than two researchers affiliated with a single institution were classified as institutional collaboration. The study utilized the following productivity and impact indicators for publications:

- Total publications (TP): Total number of publications on the IoT during 2011-2016 as reflected in Scopus database.
- Total citations (TC): Total number of citations received by the IoT-related publications during 2011-2016 as reflected in the Scopus database.
- Citations per publication (CPP): The number of total citations divided by the number of total publications.
- h-index (H): The number of papers that have at least h citations each [11]

3. Results and Findings

In this section, the outcomes of the bibliometric analysis are presented, which were conducted to address the research questions. The objectives of the study were to determine the current trends in internet of things, especially in wearable devices for blind, identify the most productive and influential countries, institutions, and authors in this area, and recognize the most influential articles on this topic [12-14]. The analysis was conducted based on various attributes of the extracted academic work, such as annual growth, document and source type, language, subject area, keywords, distribution of publication by countries, authorship, title and abstract, and citation analysis [15,16].

The findings include annual growth data until March 2023, presented in terms of frequency and percentage. To understand the current trends and impact of publications in IoT research, the total number of publications was analysed by year, country, journal, author, and organization [17-20]. The bibliographic data obtained from the Scopus database was used for this analysis. The discussion of the annual growth data reveals the current trends and impact of publications in IoT, which is the primary focus of this study.

3.1 Leading County and Top Institution

The Network bibliometric map in Figure 2 shows 86 productive countries in contributing to the growth of IoT reach activity worldwide especially in the disabled field under wearable devices. The larger the frame, the greater the country's contribution in publication [15] and the closer countries have the stronger connection between them. India ranked first with China on 2nd and United States ranked third in total. Yet, India contributed 1850 articles (23.51%), China with 1177 articles (14.96%) and United States with 989 articles (12.57%). It should be noted that India led the contribution in publication as the top institutions.

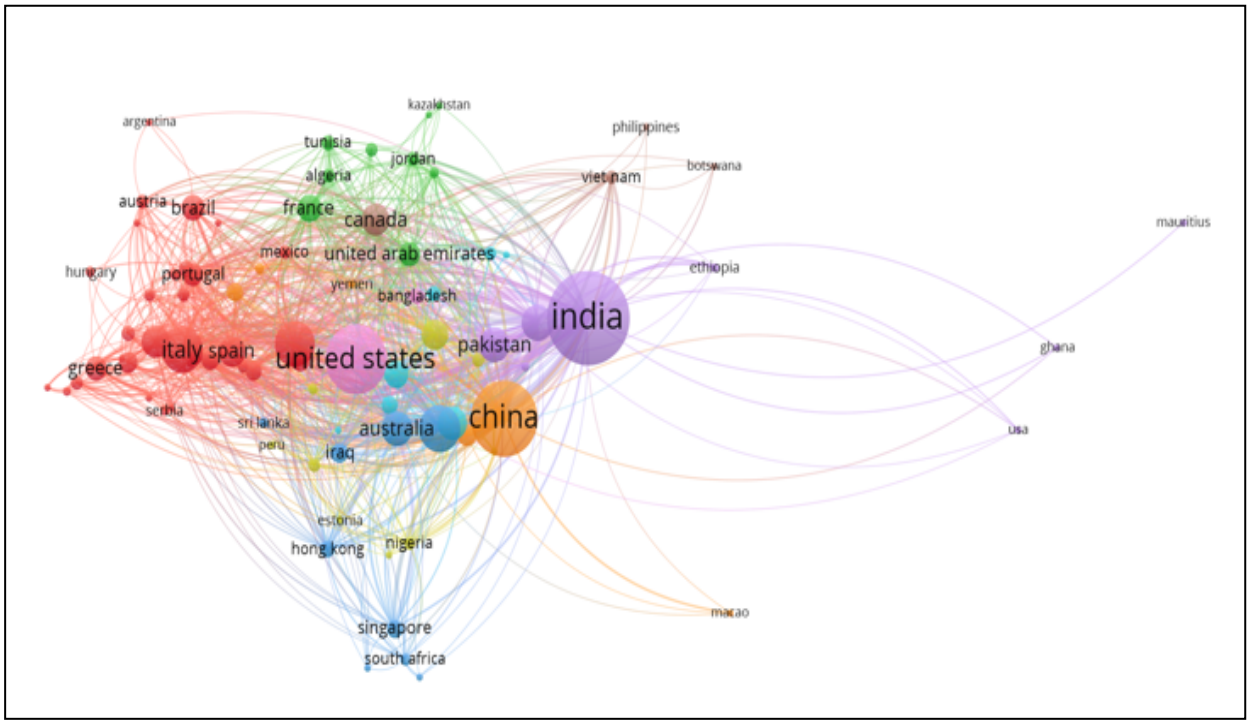

Fig. 2. Bibliometric map based on co-authorship and country

3.2 Author Keyword

From 2006 until March 2023 in IoT application research, a total of 92 keywords have been detected (Figure 3). The most used keywords are internet of things' (69.99%), 'smart home' (19.78%) and 'machine learning (6.63%). There are also other attributes such as 'deep learning', 'authentication, 'social computing' and 'web of things' and many.

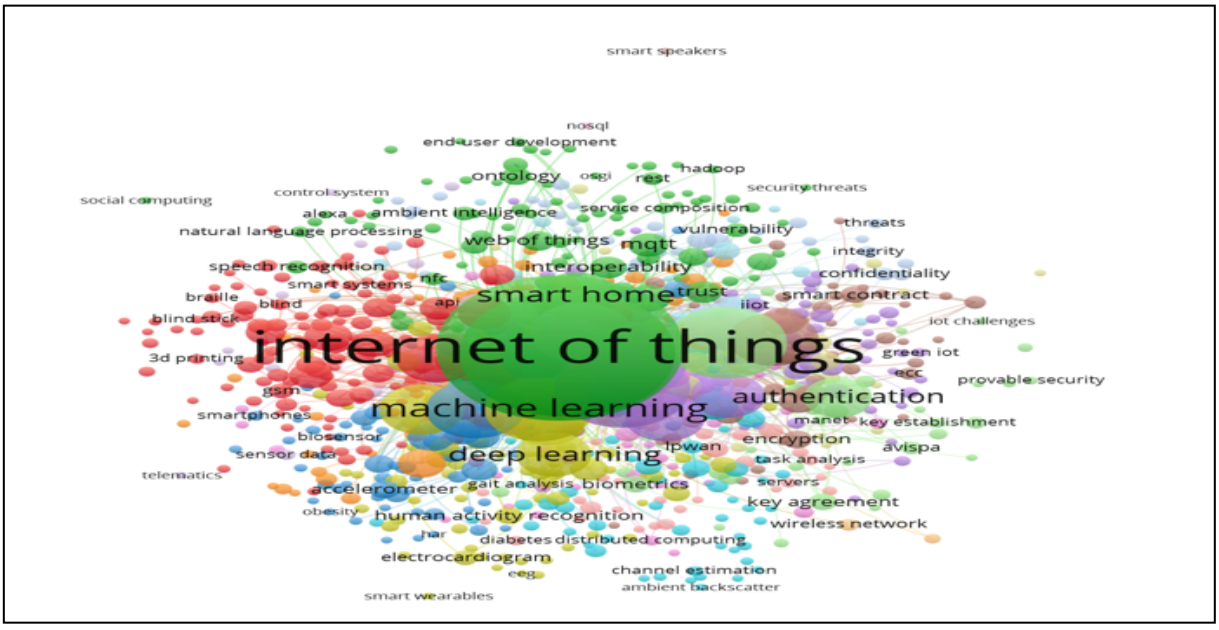

Fig. 3. Overlay visualization of bibliometric map based on author keywords

3.3 Subject Area

Tabulated in Figure 4 is the highest contributed subject area as follows; Computer Sciences with total of 78.46%, followed by Engineering (49.96%) and Mathematics (14.73%) respectively. The total publications ranged between 1159 to 6175 in the top three subject areas were also identified.

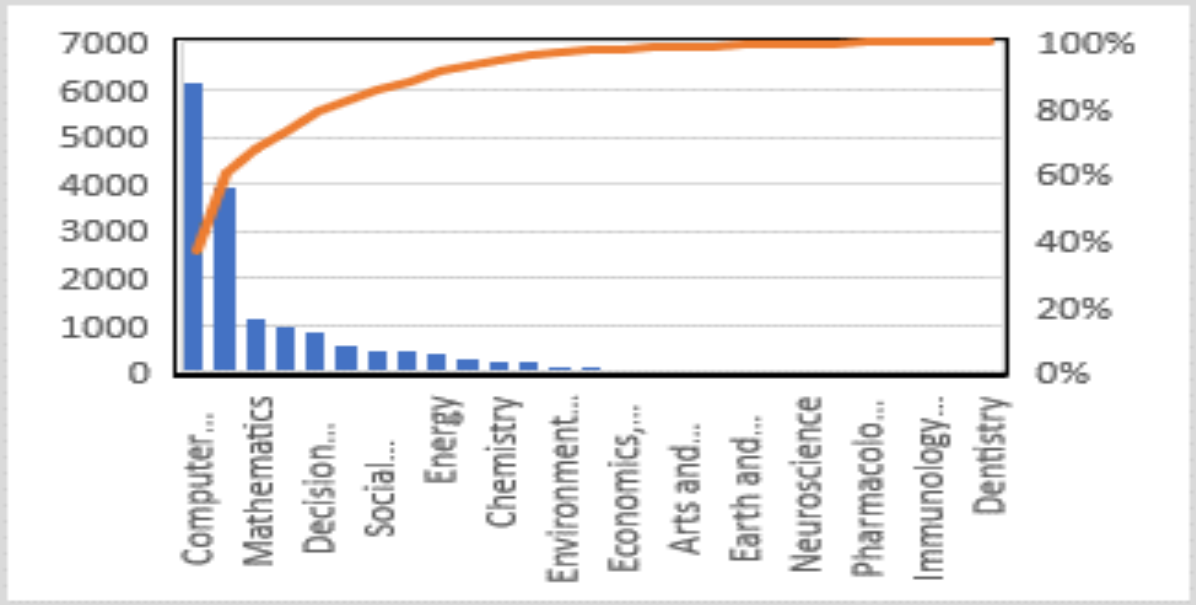

Fig. 4. Tabulation of subject area

3.4 Year of Publication

Table 1 summarises the details statistic of annual publications on IoT in wearable devices for blind people in specific. Based on the Scopus database, there were tremendous growth in IoT since 2012 where total of 28 publication were recorded. Hence, by and large, these pioneer articles set a history for IoT when it was cited 17504 times in 2018. As per records, between 2006 to 2011, the growth of the publication was somewhat slow with only less than 0.10% of publication in 2012 since it is the beginning of the computer era and smart technologies being introduced in many wearable devices [6] and helps the disabled people worldwide. Beginning the year of 2012, a sharp growth was witnessed with 0.36% of articles being published.

The trend started to pick up since then, with an average of 650 publications a year. The highest number of publications is observed in 2022 with a total of 1522 documents (19.34%). This observation signifies the peak period of the trending practice via the IoT, and smart technologies [6-7]are widely used in many applications on wearable for the blind people globally. This situation is understandable when the succeeding analysis was executed, particularly with respect to the trend of countries participating in research.

Table 1
Year of Publication

Year	TP	NCP	TC	C/P	C/CP	h	g
2006	1	0.01%	1	10	10.00	10.00	1
2007	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0
2009	3	0.04%	3	104	34.67	34.67	3
2010	3	0.04%	3	68	22.67	22.67	3
2011	8	0.10%	8	55	6.88	6.88	5
2012	28	0.36%	20	646	23.07	32.30	10
2013	58	0.74%	49	196	3.38	4.00	17
2014	104	1.32%	88	2176	20.92	24.73	22
2015	213	2.71%	182	3318	15.58	18.23	33
2016	397	5.04%	320	8894	22.40	27.79	36
2017	610	7.75%	514	14324	23.48	27.87	59
2018	855	10.86%	733	17504	20.47	23.88	65
2019	1183	15.03%	984	15576	13.17	15.83	58
2020	1189	15.11%	975	14455	12.16	14.83	52
2021	1363	17.32%	991	8572	6.29	8.65	38
2022	1522	19.34%	692	3285	2.16	4.75	24
2023	333	4.23%	47	154	0.46	3.28	6

Notes: TP=total number of publications; NCP=number of cited publications; TC=total citations; C/P=average citations per publication; C/CP=average citations per cited publication; h=h-index; and g=g-index

By analysing the data in the Table 1, the number of publications in the field has steadily increased over the years, and that the percentage of NCP has generally remained low. This suggests that there is a high level of interest and activity in the field, and that scholars are generally making valuable contributions to the existing body of knowledge. Additionally, the C/P and C/CP values can be used to assess the impact of individual papers and authors and can help to identify the most influential works and authors in the field. The h-index and g-index can also be used to evaluate the impact of individual scholars and can help to identify the most productive and influential scholars in the field.

Overall, the data findings presented in the table provide valuable information that can help to guide future research in the field, identify areas where more research is needed, and highlight the most productive and influential scholars and works in the field of disability for wearable smart technologies.

4. Discussions

The first question of the study was regarding the identification of current trends impact of publications relating IoT in blind wearable device. Therefore, to fulfil the primary goal, which was to explore the trend of research on IoT, bibliometric analysis has been made. Using a bibliometric analysis can assess the productivity of research and publications in a particular research field [21]. According to the research of [22], the information obtained from bibliometric data can evaluate the performance of the study field, and help research- related institutions to regulate some policies linked to the allocation of funds, and to compare scientific inputs and outputs. In addition, the bibliometric research findings can further explain the factors that support the research contribution of the study field and guide researchers to conduct influential research [23].

Therefore, the concentration of this research is on IoT publications collected from the Scopus database. This study used a defined search query to find 7870 documents from the declared database. IoT research on blind wearables (as per documents collected from the Scopus database) was started in year 2006. From then on until 2022, the number of publications increased slightly and 2023 is yet to be fully accountable for as the year of this article is in current 2023 year. As then, to date, the number of publications on IoT has been increasing.

Regarding the second research question, which was to find the most productive and influential countries, institutions, and authors on IoT in blind wearable devices. India, China and USA have been ranked the top countries with the largest contribution in the publications of IoT. Research on IoT for blind wearables is usually published in publications in the subject areas of computer science, engineering, mathematics, decision science, and business. Research on IoT for blind wearables is not concentrated in the field of social sciences, but in the field of technology.

The significance of the IoT in blind wearable devices publications can be explained from the citation metrics that are discussed in this research. As a consequence of the 17 years of publications in IoT for blinds wearable devices area (2006– 2023), 7,870 articles have been published. In general, the IoT in blind wearable devices documents collected from the Scopus database are cited grows from 0.04% total citation in 2009 to 19.34% in 2022 which is a whooping 19.3% percentage of citations seen in 13 years (2009-2022).

Finally, regarding the most prevalent themes of IoT wearables for the blind among scholars. The key points of this field can be seen from the results of keyword analysis and subject area analysis generated by VOSviewer. For instance, when we looked through Figure[3, the keywords “Internet of things”, “machine learning”, “smart home”, and “authentication” were among the top 10 most popular keywords we identified in the collected documents while the subject area tabulated towards highest in computer science area as shown in Figure 4. Nevertheless, Scopus is one of the most comprehensive databases that archive all academics research, it does not easily cover all published sources [24]. Further databases, for example, Web of Science, Google Scholar, Dimensions and other databases, could be used in future research. Integrating all these databases can help add exciting and valued results. In spite of these limitations, the current research adds to knowledge by providing current research trends on IoT for blind wearable devices. This research also contributes by applying the bibliometric method to expand the knowledge of IoT for blind wearable devices literature.

Although the bibliometric analysis has specific properties, the research also has some limitations, which should be restricted to allow readers to clearly understand this article and strength future research. Primary, the outcomes are only from particular keywords, namely, IoT for blind wearable devices on the basis of document titles. So, search query results for other fields (for example, abstract and keywords) are not involved in this analysis. The key goal is that most academic studies used the title as a catchword. Some researchers might also focus on search words in the abstract or the keyword field; Consequently, their research might not be directly related to their purpose. Therefore, data screening (filtering and cleaning) is required before data analysis. Future research may extend to it.

5. Conclusions

This study aims to examine the trend of research on IoT especially wearable devices by looking into the current state of publication, the pattern of citations, presenting the theme involved and propose the areas for future research in the IoT. This paper adopts the bibliometric approach by presenting the quantity (i.e. the number of publications by year, document types, number of publications by source title, source type, number of publications by country, number of publications

by institution, languages, and subject area), quality (such as the number of citations and citation metrics) and structural map for the data gathered from the Scopus database. The findings presented here cover the data obtained from the Scopus database only. The data were pooled from searches using keywords “Internet of things”, “wearable devices”, “blind” and “iot”, extracting data only under the ‘title of the article’. Further research can be expanded into other fields, such as abstract and keywords. However, this requires more detailed screening and filtering. The results presented in this article may not include all IoT studies in Scopus database due to the restriction search only to “application” in the titles and abstracts. With 7870 articles retrieved from Scopus, the trends of IoT application studies are presented together with its major study area. It has been discovered that India contributes most of the article paper as it has many branches of institutions and connections. For future studies, it is recommended to include several databases such as Web of Science along with Scopus. The advantage of Web of Science database is it shows automatically the most cited paper in which lacking with Scopus database. Thus, this paper will be useful not only for academicians, and policymakers but also assist researchers in the disabled or health area, especially in IoT, to identify future research direction in the future.

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