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Internet of Things Scholarship (2010–2026): A Scopus-Based Bibliometric Review of Thematic Clusters and Research Fronts

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ABSTRACT

With the fast development of the digital world, the Internet of Things (IoT) has become an important element in the research domain nowadays. This research seeks to explore how the IoT literature developed from 2010 to 2026 via the bibliometric analysis of publications in Scopus databases. Using VOSviewer software to analyze co-authorship network, citation network, and keywords co-occurrence network, this study is intended to illustrate the structural features of the IoT literature in terms of its intellectual, social, and conceptual aspects. The findings indicate that IoT studies are characterized by close relations between researchers around the world, resulting in several major knowledge diffusion centers. In the context of citations analysis, the major sources not only contribute to technological development but also address issues like the sustainable environment, digital governance, and socio-economic transformations. As regards keywords co-occurrence analysis, the main groups of IoT research are smart environments, technology, engineering, and socio-technical studies. Overlay and density maps point out that there is a change in time concerning the focus of research towards more advanced concepts in the field, such as artificial intelligence in IoT, big data analysis, industry 4.0, and sustainable development. It can be concluded that IoT research is becoming more mature and multidisciplinary in nature, focusing more on addressing issues on a global scale. This paper will contribute to the existing literature on IoT research through a thorough systematic and long-term analysis of IoT studies.

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1. INTRODUCTION

The Internet of Things (IoT) is perhaps one of the most disruptive technology concepts of the 21st century owing to the convergence of communication networks, embedded systems, and data analysis [1], [2]. IoT conceptually entails the use of connected physical objects, such as embedded sensors, software programs, and connectivity to enable data collection and sharing. The emergence of IoT technology is an evolutionary process beginning in the early decades of the 21st century [3]. Since then, the concept has become a reality and has been

implemented across various sectors like smart cities, healthcare, manufacturing, and environmental monitoring [4]. The explosive increase in connected objects and advancements in technology such as wireless sensor networks and cloud computing make IoT an essential part of digital transformation [5].

In terms of the development trend of the research on IoT, the results were no less impressive. In particular, the rapid increase in scholarly papers can be attributed to the widespread availability of mobile technologies and the availability of high-speed Internet, which occurred from 2010 onwards. According to bibliometrics, the IoT is gaining more attention in academia and the corporate world because it offers innovative solutions for multiple industries [6]. Its research is multidisciplinary, involving computer science, engineering, management, and social sciences.

Not only has there been an expansion in terms of numbers of published works, but the scope of thematic coverage has also been broadened significantly. The first generation of IoT papers was mostly concerned with enabling technologies like RFID, sensors, and communication protocols. Nevertheless, the current trend in IoT research is to deal with much more complicated issues, including artificial intelligence, big data, cybersecurity, and edge computing [7]. As a result, new directions of research have been identified, highlighting intelligent solutions, real-time processing, and autonomous decision-making abilities. In this context, it is possible to state that IoT is a multidimensional technology ecosystem now.

While the rate of academic work concerning IoT keeps growing, it still suffers from fragmentation caused by its interdisciplinarity. Different scientific groups pay attention to different areas of IoT research – ranging from infrastructure to applications or sociological effects. Such bibliometric research as an analysis of IoT intellectual structure, the identification of major participants, or collaborative network mapping can help solve this problem. For instance, bibliometrics shows that the number of papers produced in this area is unevenly distributed, with most papers coming from technologically advanced countries and published in IT and engineering journals. However, it is still necessary to conduct an integrated analysis of thematic clustering and new research fronts.

In addition, the growing complexity of the IoT architecture raises many difficulties regarding issues of security, privacy, interoperability, and scalability. With billions of connected devices, the issue of data security has gained more attention in the last few years. This highlights the need for ongoing studies that will ensure the sustainable growth of the IoT industry. Moreover, other new developments like Industry 4.0, smart environments, and digitalization continue to influence future research areas in the IoT industry. This makes it important to conduct a systematic study of the historical growth of research in the IoT field. This review study will be conducted between 2010 and 2026.

Despite many research papers addressing different aspects of IoT, there is still a gap in conducting a thorough analysis of the literature on IoT research development during a lengthy period of time, especially between 2010 and 2026. The research conducted by others is limited in scope since the studies tend to address a particular topic or cover a relatively short period of time, making the picture of development fragmental. In addition, no attention has been paid to the analysis involving thematic clustering and research fronts, which is important for revealing the intellectual structure of IoT research and its future developments.

This research is meant to carry out an exhaustive analysis of the scientific literature on Internet of Things between the years 2010 and 2026 via the Scopus database. The purpose will be focused on conducting an examination of publication trends, as well as identifying significant authors and collaborations, and the thematic clusters of the subject matter. In addition, the study will focus on exploring novel fronts of research and the emerging topics in relation to the future development of IoT studies.

2. METHODS

In this case, bibliometric research will be adopted as an approach to conduct an investigation of the development of IoT literature from 2010 to 2026. Bibliometric research is a statistical tool used to examine patterns in the field of scientific publishing, such as the authorship patterns, structure of citations, and themes in evolution [8], [9]. The sources of information were collected from Scopus because of its large amount of databases covering many disciplines, especially peer-reviewed journals and conference papers. Specific terms such as "Internet of Things," "IoT," and other relevant terms were used in the search queries, in addition to applying a set of filters. Only articles, reviews, and conference papers written in English were considered for this research. Duplicate entries and non-relevant information were removed.

After the data gathering process, the research made use of both bibliometric and descriptive approaches in analyzing the dataset. The use of the descriptive approach was used for the analysis of publication trends over time, top nations publishing on the topic, authors' contributions, and leading journals that have contributed to the IoT literature. The citation approach was used to determine the highly cited works and measure their impact on academia. Further, the co-authorship network analysis technique was applied to understand collaboration patterns within the IoT research community.

The structure of the literature, as well as any trends that exist in IoT research, was identified by applying the use of science mapping techniques, which include co-word analysis and co-citation analysis. The use of co-word analysis was used to determine thematic clusters based on the identification of keywords and their frequencies and co-occurrences, thus classifying different research themes. In addition, co-citation analysis was conducted to establish connections among cited documents and determine the knowledge base that existed in IoT literature. VOSviewer was used to create visualizations for network maps and thematic clusters.

3. RESULTS AND DISCUSSION

3.1 Co-Authorship Visualization

Co-authorship analysis offers a complete picture of the collaborative practices associated with IoT-related scholarly works between 2010 and 2026. By analyzing the connections between different researchers, institutions, and countries in the study field, co-authorship analysis shows how scientific collaboration and knowledge creation occur within a particular area. Bibliometric visualization based on such an analysis allows observing the emergence of research clusters, the extent of cooperation between scholars, as well as prominent actors serving as hubs for the global IoT research network. It is important to recognize the collaborative links between researchers in order to evaluate the level of integration of particular communities.

The co-authorship network map for the IoT research literature is shown in Figure 1, which was produced by analyzing data collected from the Scopus database using the VOSviewer software program. This co-authorship network map shows how researchers collaborate through co-authorship. Each node here is a researcher, and lines joining the nodes are indicative of co-authorships. The density of connections between the nodes indicates collaboration intensity. Overall, the network map shows how IoT research knowledge is created within different research groups.

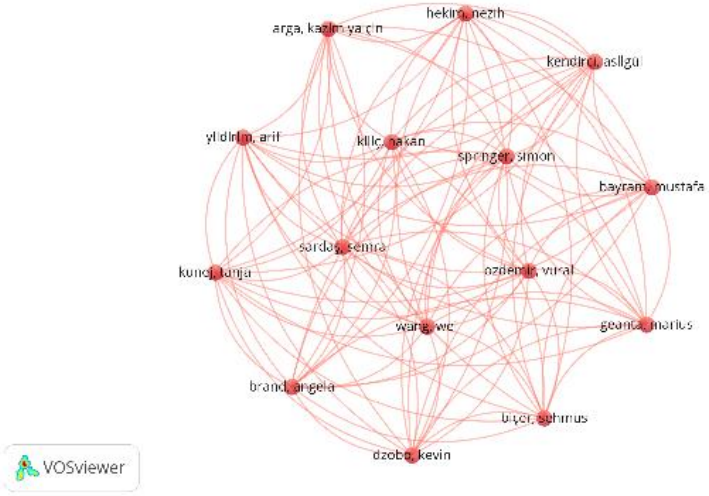

Figure 1. Author-Level Visualization

Source: Data Analysis

As seen from the visualization, there exists a very complex co-authorship network, which shows that IoT-based research is one which features high collaboration among researchers. Authors are connected to each other through multiple connections to form a tightly-knit community, which means that knowledge creation in this sphere does not occur on an individual level, but as a result of joint contribution and interaction. There are some central figures in this network who seem to have more connections than others, which points out that there must be influential people among them as well.

In addition, since there is no clear demarcation of distinct clusters, this suggests that collaboration within the field of IoT research is characterized by global unity and not regional disunity. Collaboration appears extensive among authors of diverse backgrounds, and perhaps even across institutions or nations, as is characteristic of IoT research. This observation is consistent with the complex nature of IoT research as a field, necessitating the involvement of knowledge from fields including computer science, engineering, data analysis, and telecommunications.

Figure 2 displays the network of institutional collaborations within Internet of Things (IoT) literature obtained from Scopus database and mapped using VOSviewer software. Here, nodes refer to institutions whereas edges represent connections between the nodes in terms of collaborative publications. This network shows the dynamics of institutional collaboration that helps in understanding the contribution of universities, research institutes, and organizations in developing IoT literature around the world.

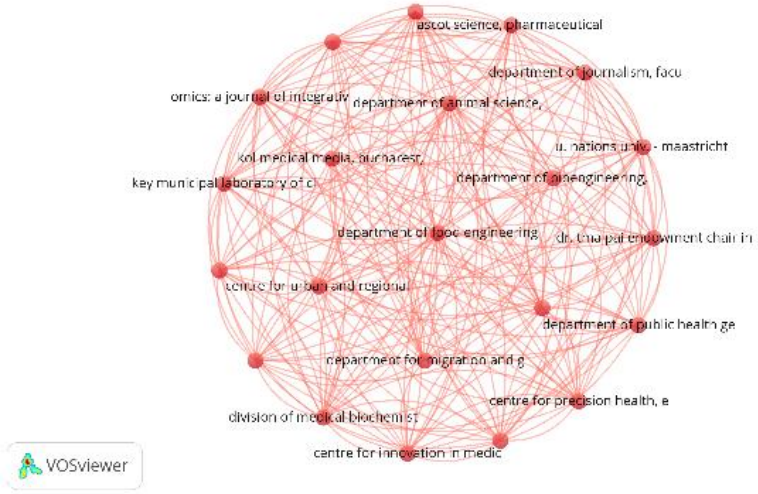

Figure 2. Institution-Level Visualization

Source: Data Analysis

This graph represents the existence of an institution network with many connections among them, which shows the intense cooperation in IoT research from different institutions. A number of institutions are linked in several ways, implying that collaboration among them is quite common. Highly connected nodes on this graph point to institutions serving as important hubs due to the central position they occupy in terms of encouraging collaboration. Such institutions probably have great research potential as well as funding support, enabling them to make a valuable contribution to IoT research.

Furthermore, the architecture of the network demonstrates extensive globalization, meaning there is much collaboration between organizations based in different geographic locations rather than clustering according to regions. Such an observation is attributed to the interdisciplinary and practical nature of the field of IoT studies and hence the need for collaboration across borders. Additionally, the extensive network connectivity shows that innovations in the field of IoT depend on collaborative efforts among various sectors such as academic and research institutions.

The network of country-level collaboration in IoT research is depicted in Figure 3 through the use of VOSviewer, considering articles indexed by Scopus. In this case, nodes correspond to countries, whereas connections between nodes signify cooperation in terms of joint publications. Thus, through the clustering and location of nodes, one may determine the degree of international cooperation and see how countries interact in the global landscape of IoT research.

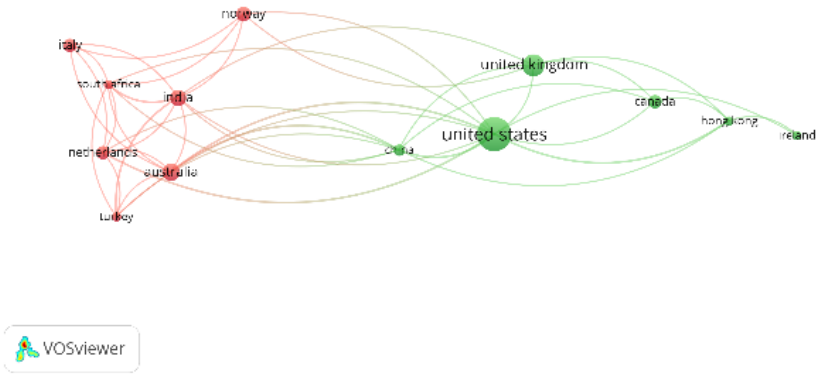

Figure 3. Country-Level Visualization
Source: Data Analysis

The visual representation demonstrates that there are clusters evident in the network and each cluster represents different collaboration practices in the various regions. In one of the clusters, most of the nodes represent countries in Asia that are interconnected, thereby showing the degree of intra-regional collaboration within the region. The second cluster can be characterized by a large number of countries that have been linked to the USA. This is because the USA acts as a center where connections emanate to many other countries including the UK, Ireland, and others.

Moreover, the network graph highlights the existence of bridging links between clusters, which signify cooperation between regions, thus combining several aspects of the global scientific community into one cohesive research community. While there are nations that are more closely linked in terms of clusters within their respective regions, the existence of these connecting bridges implies that IoT research does not occur in isolation based on geographical locations alone. On the contrary, this signifies that the area of study is a globally interconnected field where ideas transcend borders.

3.2 Citation Visualization

Citation analysis acts as an important technique to analyze the intellectual structure and the significance of publications in the area of Internet of Things. The present chapter examines the leading authors, publications, and sources through the frequency of citations and linking strength. In this way, it would be easier to determine the key publications that have made significant contributions towards directing the course of studies related to IoT. Citation analysis not only helps in determining knowledge dissemination and influence, but it also reveals the prevailing research paradigm and its evolution over time.

Table 1. The Most Impactful Literatures

Citations	Authors and year	Title
247	[10]	Information systems solutions for environmental sustainability: How can we do more?
196	[11]	Smart Earth: A meta-review and implications for environmental governance
182	[12]	Technology, entrepreneurship, innovation and social change in digital economics

Citations	Authors and year	Title
153	[13]	Convenience and energy consumption in the smart home of the future: Industry visions from Australia and beyond
100	[14]	The paradox and continuum of digital disengagement: denaturalising digital sociality and technological connectivity
100	[15]	"It's Like Learning a Whole Other Language": The Role of Algorithmic Skills in the Curation of Creative Goods
82	[16]	The potentials, challenges, and future directions of on-chip-antennas for emerging wireless applications - A comprehensive survey
59	[17]	Technological interventions in social business: Mapping current research and establishing future research agenda
58	[18]	Digital methods III: The digital mundane
54	[19]	Children's privacy in the big data era: Research opportunities

Source: Scopus, 2026

The most important literatures of IoT as well as other digital technologies can be found in Table 1 based on the numbers of citations. The most cited articles show that there is an obvious connection of IoT research to the interdisciplinary theme, including environmental sustainability, digital governance, and socio-technological transformation. Information systems solutions for environmental sustainability: How can we do more? is the most cited literature showing that the relationship between information systems and sustainability is important. In addition, Smart Earth: A meta-review and implications for environmental governance can show the increasing role of IoT in environmental governance frameworks. Moreover, the latest citation of Technology, entrepreneurship, innovation and social change in digital economies shows the emerging need to integrate IoT into digital economy and innovations framework. From the table, the contribution of literatures is not only in terms of technology but also social aspects as well as behaviors, ethics, etc. The literatures such as Convenience and energy consumption in the smart home of the future and The paradox and continuum of digital disengagement are good examples. Meanwhile, works addressing algorithmic skills, privacy, and everyday digital practices emphasize the human-centric challenges accompanying technological advancement.

3.3 Keyword Co-Occurrence Visualization

This approach can be applied for the examination of Internet of Things research in terms of concepts and themes. Through the analysis of keyword frequencies and connections, the identification of prominent research groups and thematic clusters becomes possible. The visualization of a network shows the way various themes are interconnected and how the direction of IoT research has changed through time. It can be highly beneficial in recognizing the frontiers of research, links between disciplines, and trends that have appeared recently.

Figure 4 shows the co-occurrence network of keywords for Internet of Things (IoT) studies based on Scopus-indexed papers and generated with the help of the VOSviewer tool. In this map, every point stands for a keyword, and the connections between points show how many times these two keywords have occurred in the same articles. As the colors vary by theme, we can see the different fields in the IoT study domain.

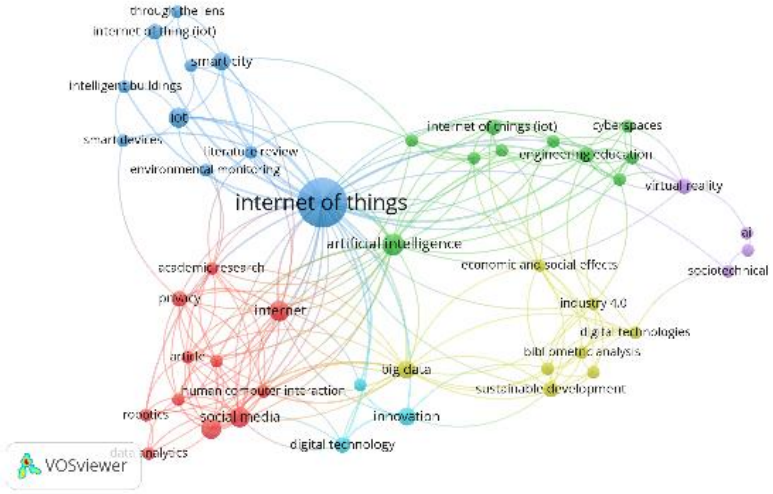

Figure 4. Network Visualization
Source: Data Analysis

As seen in Figure 4, internet of things becomes the main keyword within the network as it connects a number of themes together. Its centrality shows that IoT research functions as a unifying theme that links different sectors, from technological advancements to socio-economic uses. The clustering around the keyword denotes the extent to which it is integrated into other themes, meaning that IoT research does not exist in isolation but as a part of wider technology.

Another major group includes keywords like "smart environment," "smart city," "smart devices," "intelligent buildings," and "environmental monitoring." It underscores the importance of urban development and infrastructure improvement, showing how IoT technology has been used extensively to develop modern, efficient cities. The existence of words like "monitoring" and "automation" indicates the critical role played by data collection and quick responsiveness in driving innovations in this field.

Yet another noteworthy cluster pertains to technology innovation and engineering, such as Internet of Things (IoT), engineering education, cyberspace, and virtual reality. This clearly points to the fact that the study of IoT is inherently tied to progress in information technology and technological prowess. The inclusion of education-based terms further underscores the importance of developing competent human resources to facilitate IoT ecosystems.

Another cluster that is evident in this network is that which surrounds topics related to data and innovation. Words such as big data, innovation, digital technology, and artificial intelligence show strong links within this cluster. It becomes clear that the importance of making decisions based on data as well as intelligent processes in improving the performance of the Internet of Things becomes increasingly important. In addition, the link between the two concepts shows that Artificial Intelligence of Things is an important area for academic research.

An emerging socio-economic cluster can be observed here as well, characterized by key words such as sustainable development, impact on economics and society, and Industry 4.0. The emergence of such a cluster implies that IoT research has been gradually changing towards a more comprehensive consideration of technological advances. These changes manifest themselves through studying the implications of adopting the technology with regard to economic development, social changes, and environmental sustainability.

Figure 5 shows the keyword co-occurrence overlay visualization for IoT studies created through VOSviewer using articles indexed by Scopus. Contrary to

conventional network diagrams, the present visualization tool features an element of time. The gradient colors of the keywords indicate their average years of publication. Darker colors (blue) denote older research areas, whereas brighter colors (yellow) denote newer research areas. This allows researchers to track the development of themes over time and identify trends in IoT studies.

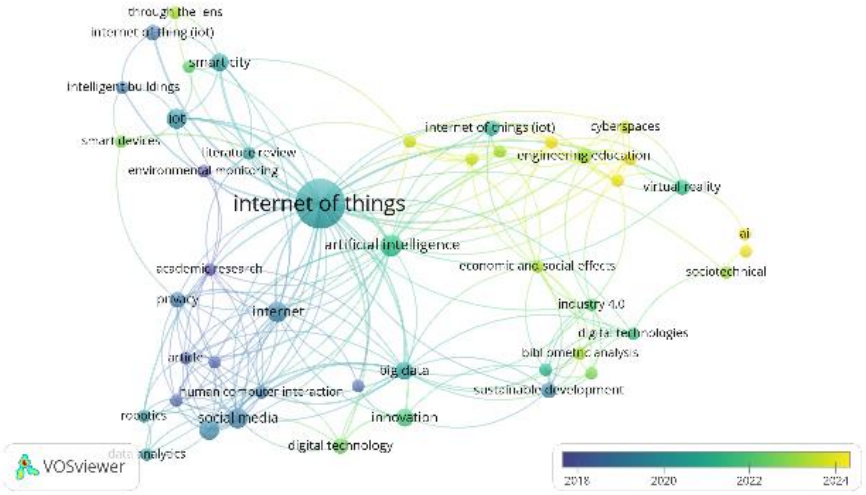

Figure 5. Overlay Visualization

Source: Data Analysis

It can be observed from the network visualization that key research issues of IoT, including Internet of Things, smart city, environmental monitoring, and human-computer interaction, are shown in dark colors since they have emerged earlier than other keywords in scientific literature. This group of keywords was initially used for studying IoT, and their relevance is explained by the fact that these research issues form the basis of the field under consideration.

On the other hand, the newer keywords like artificial intelligence, big data, digital technology, and industry 4.0 shown in lighter shades of green to yellow suggest an emphasis on modern and integrated technological approaches. This reveals how IoT research has progressed from its foundational aspects like connectivity and devices to data-driven environments and intelligent technologies. This combination of IoT, AI, and data analytics suggests that automation, prediction, and real-time decision making have become significant aspects of current research studies.

Furthermore, the emergence of topics such as sustainable development, socio-economic impacts, and socio-technical approaches in later timeframes highlights an expansion in research topics beyond the scope of purely technological fields. Researchers have become more interested in the wider consequences of the adoption of IoT technology and how it affects sustainability, social transformation, and even ethics. This transition marks the development of a body of literature in which IoT is considered not just a technology but a system catalyst.

The visual representation of keyword density analysis is presented in Figure 6 above and was performed using VOSviewer software. The analysis used articles indexed in Scopus to generate the density map above. Colors used in the figure show the frequency of keyword occurrences with bright colors like yellow and green showing high keyword density while dark colors like blue show less density or less-frequently studied themes.

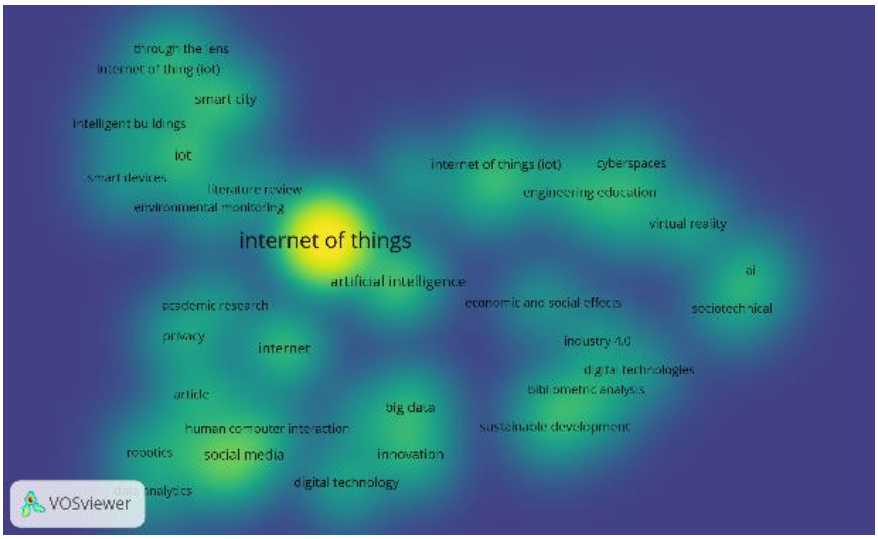

Figure 6. Density Visualization

Source: Data Analysis

As evident from the visual representation, internet of things appears to be the densest and most prominent cluster of concepts among all others, thus supporting the conclusion that this concept is a major focus area in the sphere of scholarly research. In close proximity to the central concept, there also appear several other dense clusters that refer to artificial intelligence, big data, and digital technology. The clustering indicates that the research on Internet of Things involves numerous connections between related concepts, and that is why IoT research relies much upon data processing and intelligence systems. Moreover, moderately dense zones can be observed for topics related to smart cities, environmental monitoring, human-machine interaction, and sustainable development. These topics remain relevant but have a somewhat lesser density in comparison to the key technology-related ones. On the other hand, sparsely distributed zones include topics related to virtual reality, cyberspace, and socio-technologies, representing novel topics of research for the Internet of Things field.

Discussion

The results of this bibliometric analysis show that Internet of Things (IoT) studies have witnessed considerable growth and expansion from 2010 to 2026, which is evidence of the evolution of the discipline from being essentially technical in nature to becoming a multidisciplinary field of studies. The findings about author collaborations suggest that the IoT research community operates in a strongly collaborative way with knowledge creation being an outcome of interdependent author networks. The existence of important nodes in these collaboration networks is indicative of the development of key opinion leaders and research centers that shape the future direction of the field.

Citation analysis also shows that the most influential articles in the IoT domain do not merely focus on technological innovations but also touch upon wider concerns like sustainability, digital governance, and socio-economic change. Highly cited papers underscore the significance of connecting information systems with sustainable development goals, along with the governance dimensions of smart technologies. It appears that scholarship in IoT is moving away from purely technical approaches towards an interdisciplinary and comprehensive outlook. The presence of interdisciplinary publications implies that IoT scholarship is now driven by the intersection of technology and social science disciplines.

Conceptually, the co-occurrence analysis of the keyword reveals many major thematic categories, including smart environment, technology, engineering

application, and socio-economic implications. The strategic position of internet of things and its close associations with the other related topics like artificial intelligence, big data, and digital technologies point towards the rise of technological ecosystem formation. Especially, the amalgamation of IoT and artificial intelligence, known as AIoT, has become a key research area, in which intelligent technologies increase the effectiveness and flexibility of connected devices.

In terms of conceptualization, there is a multitude of major themes that emerge as a result of keyword co-occurrence analysis, such as smart environment, technology, engineering applications, and socio-economic effects. In particular, the strategic importance of IoT and its strong connections to other themes, like artificial intelligence, big data, and digital technologies, imply the emergence of technological ecosystems. Specifically, the combination of IoT and artificial intelligence (AIoT) is considered one of the most important research areas since intelligent technologies improve device efficiency and flexibility.

This paper provides valuable insight for future research in terms of developing a roadmap for IoT research studies. This research demonstrates the significance of interdisciplinary approaches, the growing significance of sustainability issues, and the appearance of technological breakthroughs. For future researchers, it is necessary to focus on the underresearched topics, including ethical regulation, digital disparities, and long-term ecological effects. It is critical to enhance cooperation between scientists, business, and public sector representatives to ensure that IoT developments will not only be innovative but also socially beneficial and sustainable.

4. CONCLUSION

The bibliometric analysis highlights that the field of IoT studies has become a vibrant and multidisciplinary area of research from 2010 to 2026, as demonstrated by the results. First, it becomes apparent that scholars are highly influenced by their connections through co-authorship, important interdisciplinary research, and dynamically changing clusters, incorporating IoT into artificial intelligence, big data, and other digital technologies. Second, the increased attention paid to sustainability, sociotechnical aspects, and economic ramifications reflects the development of IoT research beyond purely technological approaches. Overall, the analysis presents an exhaustive review of the intellectual structure and frontiers of research in IoT studies, which is important for all parties involved in research and practical activities within this area.

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