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DYNAMIC URBAN INTELLIGENCE: A COMPREHENSIVE ANALYSIS OF THE EVOLUTIONARY TRAJECTORY OF SMART CITIES AND TRANSPORTATION SYSTEMS

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ABSTRACT

This study aims to analyze the characteristics of smart cities and smart transportation trends in the last ten years. The development of technology and the increasing level of mobility have created a concept of a smart city as an effort to embody an effective and efficient sustainable life, including in the transportation sector. The Smart City concept is an effort to integrate information and communication in city management, while smart transportation is one of the essential components of implementing a smart city that combines information and communication technology with the transportation sector. The adaptation of the two creates a system known as the Intelligent Transportation System (ITS). This research used a bibliometric analysis to analyze data from the last ten years using the Scopus database and CiteSpace software. The number of publications on smart cities and smart transportation trends has increased overall in the last ten years, with China having the highest number. A bibliometric analysis found that the trend consists of 15 significant clusters: smart transportation applications business model, geomatics, big data, enabling technologies security, cloud computing, cyber-physical system, traffic congestion level, city buses, comprehensive performance analysis, energy-aware intrusion detection model, privacy-preserving authentication protocol, communication-oriented perspective, intelligent transportation system, numerical calibration method, and cyber-physical system. The study also considers both macro and micro perspectives. It should evaluate how urban intelligence influences resource allocation, sustainability goals, and equitable access to services while also focusing on transportation systems, autonomous vehicles, and last-mile connectivity.

Keywords: *Bibliometric Analysis; Smart City; Smart Transportation; Smart Logistics*

INTRODUCTION

Information and communication technology is growing along with the times. This also influences the human mindset and has an impact on various aspects of daily life, creating a new

lifestyle. The development of technology is widely used to solve existing problems. For example, population growth that is not balanced with infrastructure has led to the massive movement of people from villages to cities to get more adequate facilities to fulfill their needs, as Cities have typically been the areas where breakthroughs in transportation, communications media, printing, publishing, information processing, and the production of new knowledge have been centered during the past 8000 years (Thompson, 2016). This condition results in new problems, such as increased vehicle usage, increased congestion, and accidents. With the advancement of technology, these problems are initiated to be addressed through a smart city concept, as digital technology helps the government deal efficiently with problems arising from changes in the urban landscape (Kummitha, 2020). The smart city concept is generally implemented to realize sustainable development through improving community services by integrating elements in urban areas, such as governance, quality of life, economy, environment, transportation, and human resources (Putri, 2021).

A smart city is a concept that combines the function of a community or society with information technology, as the widespread and rapid evolution of information and communication technology (ICT) provides tools that may support this strategy (Kurniawan & Andiyan, 2021; Zubizarreta et al., 2016). According to Khansari et al. in Purwantoro (2020), smart cities can be realized with the support of 3 main pillars: smart transportation, smart land use, and smart energy. Smart transportation is a concept managed with modern information technology to create transportation efficiency, comfort, safety, and environmental friendliness. This is also supported by Griffinger in Dewi (2017), who divides the smart city concept into six dimensions: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. This paper focuses on transportation, which is part of smart mobility. The smart mobility dimension specializes in transportation, community mobility, and infrastructure development. Smart mobility hopes to create good public transportation and mobility services and eliminate common transportation problems. In addition, several factors influence smart transportation: the increase in urban life the number of vehicles in cities, and the creation of sustainable smart transportation by smart logistics (Korczak & Kijewska, 2019; Soomro et al., 2018).

Recent years have witnessed accelerated advancements in vehicular transportation. Incorporating artificial intelligence and reform into an “intelligent transportation system” has revolutionized the concept of transporting people and products from one location to another (Zhao & Jia,

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2021). Intelligent Transportation System (ITS) is an advancement in the fields of electronics, telecommunications, and computers applied in the field of transportation to create an infrastructure that is more informative, safe, smooth, and provides a sense of comfort for its users and is friendly to the environment with various types of connectivity between vehicles and other parts in the system (Alsaffar et al., 2018; Pamudi & Suryani, 2018). ITS is the realization of technological developments that support changes in the transportation system. The existence of ITS is intended to help users access information, simplify transactions, increase the capacity of infrastructure and facilities, reduce congestion, improve safety and comfort, reduce environmental pollution, and make transportation management more efficient (Suryadithia et al., 2021). Nowadays, with the wide availability of open data, data mining has become a useful method for uncovering secrets and discovering the value in data that would not have been readily uncovered otherwise. It has advantages for supporting intelligent transportation services (Balbin et al., 2020).

Complex situations and conditions are a challenge in its implementation. However, through time, the presence of Internet+, Big Data Analytics (BDA), cloud computing, and Artificial Intelligence (AI) makes these goals very possible to realize. The significant increase in connected devices in urban areas has resulted in the accelerated growth of data, which has attracted the interest of numerous researchers from various fields of study (Hashem et al., 2016). Therefore, this paper aims to determine the trend of smart cities and smart transportation using bibliometric review and scientometric analysis based on the Scopus database.

Finally, this study also explores the nexus between technology, data, and urban development in the developing field of smart cities. This research tackles global urban environments' major issues, including pollution, traffic, and inefficient infrastructure, using data pertinent to current smart city initiatives and transportation issues. The urgency of this research lies in identifying long-term solutions to the urgent problems facing contemporary cities, opening the door to smarter, more resilient, and efficient urban landscapes. This is achieved by looking at the development of smart technologies and how they are integrated into transportation systems.

LITERATURE REVIEW

The most prominent and current iteration of the city of the future, “smart cities,” refers to cities that utilize technology to improve the management efficiency and sustainability of urban development (Fagundes & Matias, 2018). The idea of a smart city has been established as a natural response to the phenomenon of urbanization, the economic importance of cities, and the

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increasing need for more sustainable living. This response has come about due to three interrelated factors (Silva et al., 2018). Following along, the previous studies show that a variety of problems in a few different sectors, most notably social phenomena in metropolitan areas, led to the concept of the smart city. Based on the results of the bibliometric analysis conducted by Y.-M. Guo et al. (2019), the topic of smart cities became a field with extensive research from 1986 to 2019. The publication trend increased exponentially in 2010. This indicates an increasing interest in research on smart cities related to the urgency for urban development and life improvement.

According to Wu (2022), the initial concept of a Smart City needs to be rethought from five perspectives: 1) Initiation and "people-centered" objectives of a Smart City: Better City, Better Life; 2) The potential routes to approach Smart City; 3) The parties involved in developing Smart Cities; 4) The reliability of a Smart City evaluation system based on its inception; and 5) Academic debates on future development directions and education of the Smart City concept. By examining Smart City from the five perspectives above, we were able to identify what its 15-year history had demonstrated to be false, useless, wasteful, formalistic, and impractical. Moreover, we could propose for future Smart Cities what citizens need, what can be beneficial in real-world situations, and what is effective, motivating, and sustainable. There are usually three ways to construct a smart city. The first is provided by technology suppliers and is referred to as the Technology Approach (TA). The second is determined by the challenges of cities and the demand for enhancing life quality in cities and is referred to as the Demand Approach (DA). The Internet of Things (IoT), Artificial Intelligence (AI), Blockchain, and Big Data innovations will serve as the primary entry points and core foundations needed to foster the emergence of novel and creative solutions that will transform the current paradigm for cities and their citizen (Paiva et al., 2021).

Syed, S.-S., Kumar, & Elmaghraby (2022), in their paper entitled “Making Cities Smarter-Optimization Problems for the IoT Enabled Smart City Development: A Mapping of Applications, Objectives, Constraints,” states that IoT optimization in smart cities can be mapped in smart agriculture, smart homes, smart city services, smart industry, smart grid, smart infrastructure, smart health, and smart transport. Tyagi, Dananjayan, Agarwal, and Ahmed (2023) stated that smart cities aim to make human life better by solving problems in cities by utilizing the internet and modern technology. However, it cannot be denied that using cloud computing, Industry 4.0, and IoT (Internet-of-Things) can also cause new

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problems related to data, services, and applications. Blockchain, its decentralized network, and advanced cryptography ensure a secure working environment.

The main future trends in some key elements of smart cities are transportation, waste management, education, and energy (Al-qudah et al., 2022). According to this study, transportation is vital to the community because it allows residents to reach their destinations and distribute commodities and products to other areas. It also has an effect on other factors. One example is the adaptation of environmentally favorable and electric vehicles to reduce their environmental impact and fossil fuel consumption. In addition, distance education and a flexible work environment will reduce the use of transportation systems. Consequently, it can play a role in intelligent traffic management systems by administering existing transportation systems to reduce congestion and transportation times (Liang et al., 2019).

Smart transportation includes assistance for interconnected ICT infrastructure, integrated transportation, logistics systems, clean transportation, secure transportation, as well as smart urban and road transportation. Considering that the primary objective of intelligent transportation is to reduce air pollution and carbon footprint, clean transportation systems may include drones, hybrid vehicles, electric vehicles, and bicycles that produce the least amount of pollution (Attaran et al., 2022).

As a form of integration of smart cities with smart transportation, the Intelligent Transportation System (ITS) was created. According to Lin et al. (2017) in their article entitled "Intelligent Transportation System (ITS): Concept, Challenge, and Opportunity," the emergence of ITS helps improve transportation convenience and mobility, reduce environmental impacts, promote sustainable transportation development, and increase productivity through the integration of advanced communication-based information and electronic technologies into all transportation elements. The leading technologies found in urban ITS include Global Positioning System (GPS), Geographic Information System (GIS), and communication technology which can be said to be the process of transmitting data through system channels between the system and users (Liu, 2021). A study conducted by Zhu, Yu, Wang, Ning, & Tang (2018) found that there are several applications of Big Data analytics in ITS, including asset maintenance, road traffic flow prediction, road traffic accident analysis, public transportation service planning, personal travel route planning, and rail transportation control management. In addition, several open challenges in using Big Data analytics in ITS were also found, including data collection, data privacy, data storage, data

processing, and data opening. X. Guo and Guo (2023) also stated that the utilization of new-generation information technology, such as blockchain or big data, will significantly help the development of ITS.

Research conducted by Jabbar et al. (2022) identified blockchain applications for IoV (Internet-of-Vehicles) networks in intelligent transport applications. It classified them into six categories: security, transportation applications, energy, communication, networking, data management, and payment and optimization. Therefore, blockchain applications in smart transportation need to be deepened due to research conducted by Oladimeji et al. (2023), who found that blockchain can improve transportation security, efficiency, and reliability. Meanwhile, its relationship with IoT is supported by a study conducted by Rejeb, Rejeb, Simske, & Keogh (2021) related to the bibliometric analysis of blockchain technology, proving that the combination of blockchain and IoT can improve security in accessing data collected by sensors and maintaining data integrity.

RESEARCH METHOD

For this study, data trends of smart cities and smart transportation were collected from the Scopus database in the last ten years, from 2013 to 2022. As an extensive bibliographic database, Scopus is used to obtain bibliometric data to be analyzed in this study (Vujković et al., 2022). The data was collected with the search strategy based on the title, abstract, and keywords limited to open access, language, and document type. Accordingly, the following search query was utilized:

TITLE-ABS-KEY (“smart city”) AND TITLE-ABS-KEY (“smart transportation”) OR TITLE-ABS-KEY (“smart transportation”) OR TITLE-ABS-KEY (“smart transportation management system”).

Based on that search query, a database of 604 documents associated with smart city and smart transportation research was obtained. Subsequently, the documents are filtered with the search strategy (LIMIT-TO (OA, “all”)) AND (LIMIT-TO (DOCTYPE, “cp”) OR (LIMIT-TO (DOCTYPE, “ar”)) AND (LIMIT-TO (LANGUAGE, “English”)). The strategy results found that there are 156 documents related to smart city trends and smart transportation consisting of journal articles and conference papers in English. The data is displayed in documents by affiliation, documents by author, documents by country, documents by type, documents by funding sponsor, documents by source, documents by subject, and documents by year.

This study used an established technique, scientometric analysis, to analyze the data. A scientometric

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analysis or knowledge mapping is a quantitative study that uses colored theoretical graphs to objectively plot scientific understanding that relies on a scholastic database or pertinent subject. CiteSpace can make the greatest possible use of the information within the peer-reviewed literature in order to conduct a properly organized and chronological analysis of past research in the area of interest, for example, through the use of author, institution, and country information to describe authors, institutions, and countries that have made significant contributions to the field over the span of several decades (Azam et al., 2021; Che et al., 2022). Therefore, this study uses CiteSpace software to determine the relevance of publications, authors, and countries.

RESULTS AND DISCUSSION

1.1 Results

1.1.1 Annual Publications of Smart Cities and Smart Transportation

Publications on the growth of smart cities and smart transportation trends on the Scopus database from 2013 to 2022 are presented in **Figure 1.** In 2013 and 2014, there were two documents published each year. However, there was a decline in 2015; there was 1 document published. In the year that ensued, there was a rise in the number of published documents by 5. This trend continues to increase as it has for the years preceding. In 2017, 11 documents were published in total. In 2018, a total of 13 documents were published. There was a significant increase in 2019, with the publication of 29 additional documents. The year with the highest total number of publications, 34, will be 2020. In 2021, there were only 28 documents. However, by 2022, the number increased again to 31 publications.

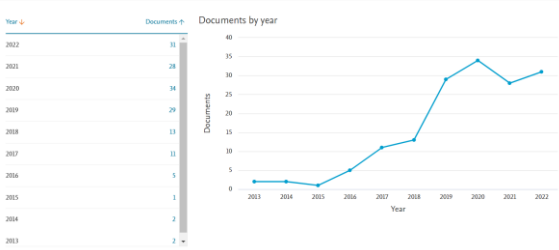

Figure 1. *Documents by Year*

Results show that the growth of the smart city and smart transportation trends have increased overall from 2013 to 2022 on the Scopus database. The findings are directly in line with a previous study conducted by Y.-M. Guo et al. (2019) state that the topic of smart cities became a field with extensive research from 1986 to 2019. It also shows that the trend of smart cities and their components, including smart transportation, is growing in people's interest. The rising smart city and smart transportation trends can also be linked to ongoing urbanization. The rapid pace of urbanization could increase urban problems. Therefore, the effort needed to resolve the issue strengthens. For this reason, many believe that the concept of smart cities can be utilized to address

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urban problems. Therefore, considerable research has been conducted on smart cities and their components. Smart Transportation has become one of the most-discussed components of smart cities, given that the transportation sector is a crucial aspect of urban mobility.

1.1.2 Documents by Type

Figure 2 shows the documents based on type, resulting in those publications being dominated by article types with a percentage of 67.3 percent, compared to conference papers with 32.7 percent.

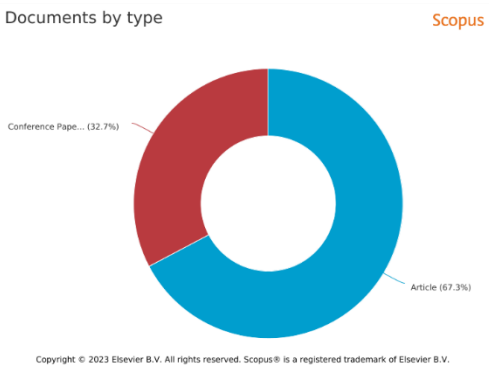

Figure 2. *Documents by Type*

This study differentiates between the types of journal articles and conference papers because they are the most frequently used, and therefore, they top the list for the greatest quantity amongst all types of documents. According to the research strategy, the total number of journal articles is 105 documents, and conference papers are 51 documents.

1.1.3 Subject Area of Publications

The scope of the topic of smart city trends and smart transportation is depicted in **Figure 3**. According to the Scopus database, this trend is discussed with the greatest frequency in the field of Computer Science at 27.3% with 99 documents. Other subjects include Engineering (21.6%), Social Sciences (7.9%), Physics and Astronomy (7.7%), Materials Science (6.6%), Energy (5.5%), Environmental Science (5.5%), Mathematics (3.6%), Earth and Planetary Sciences (3.3%), Chemistry (2.7%), and Other (8.8%).

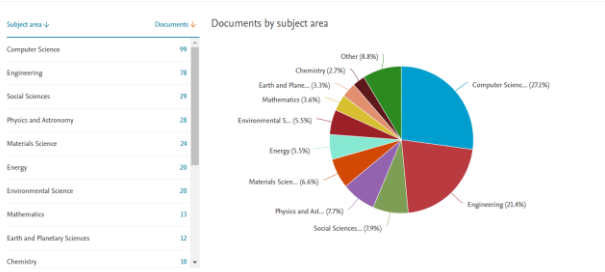

Figure 3. *Documents by Subject Area*

The results lead to a similar conclusion: a smart city is provided by technology suppliers and referred to as the Technology Approach (TA). Smart city and smart transportation trends are mainly discussed in science and technology, as the field with the highest numbers in computer science and engineering. VR/AR, Internet of Things (IoT), Artificial Intelligence (AI), blockchain, and other exponential technologies can potentially improve and accelerate positive change in the smart cities sector, but only if we pursue prudent municipal policies. Then, to enhance operational effectiveness in the transportation sector, it was deemed

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necessary to increase the use of information technology, which the Intelligence Transportation System facilitates.

1.1.4 Tops Affiliations Contributed to the Publications

Based on affiliation indexed on Scopus, there are ten institutions top the list. **Figure 4** shows the detailed list.

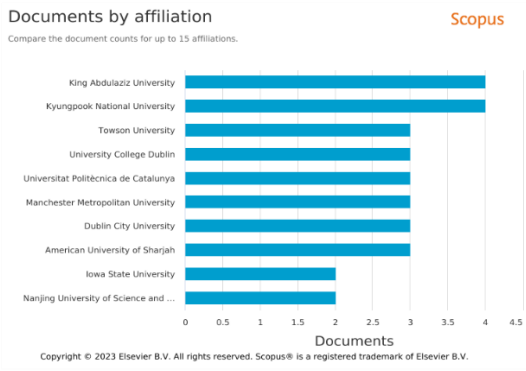

Figure 4. *Documents by Affiliation*

Figure 4 shows the top affiliations that contributed to smart cities and transportation trends. King Abdulaziz University tops the list with four publications, alongside Kyungpook National University. It is followed by Towson University with three publications, University College Dublin with three publications, Universitat Politècnica de Catalunya with three publications, Manchester Metropolitan University with three publications, Dublin City University with three publications, and the American University of Sharjah with three publications. Subsequently, Iowa State University has two publications, and Nanjing University of Science and Technology has two publications.

1.1.5 The Most Productive Authors

Out of 156 documents analyzed, the following figure (Figure 5) shows the top 10 most productive authors of smart cities and smart transportation trends from 2013 to 2022, indexed by the Scopus database in the established period.

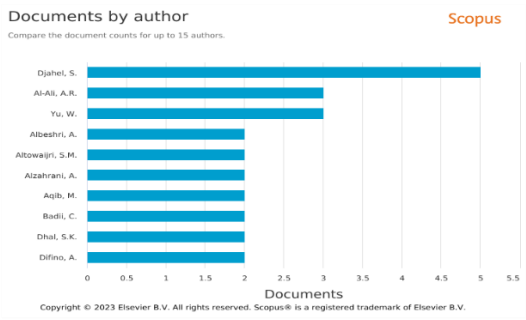

Figure 5. *Documents by Author*

According to the number of published documents, Djahel tops the list with five documents. Al-Ali, in the second position, presents three documents. You placed third with three documents. Consequently, Albeshri has two documents, Altowaijri has two documents, Alzahrani has two documents, Aqib has two documents, Badil has two documents, Dhal has two documents, and Difino has two documents.

1.1.6 Countries Contributions

Ten countries contributed to the global scientific research of the trend of smart cities and smart transportation from

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2013 to 2022. Statistical data of publications indexed by the Scopus database is provided below in **Figure 6**.

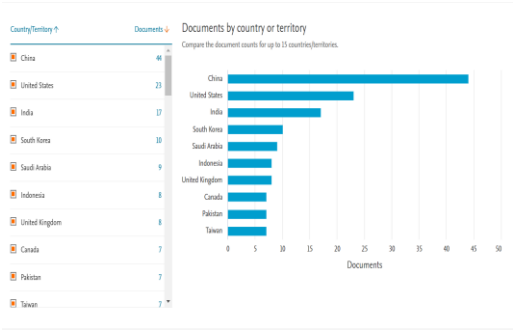

Figure 6. *Documents by Country*

China contributed the most to the publication of smart cities and smart transportation trends, with a total of 44 documents, as shown in **Figure 6**. The United States occupied the second-place spot with an overall total of 23 published documents. Thirdly, India contributed 17 documents in total. South Korea contributed ten documents, followed by Saudi Arabia with nine documents, Indonesia with eight documents, and the United Kingdom with eight documents. Subsequently, Canada followed with a total of 7 documents, Taiwan had seven documents, and Pakistan with seven documents.

This study highlights the fact that China is unquestionably the leader in smart city and smart transportation trends. China has played a role in the development of smart cities through digital and infrastructure advancements. Cities, for example, Beijing and Shanghai, are prominent examples of smart city initiatives and are accelerating the construction of smart cities throughout the entirety of the nation; in achieving the goals of the smart city concepts, governments and businesses in China have cutting-edge technology in numerous facets of urban life. This embraces utilizing software to increase the accessibility of government services and artificial intelligence to maximize traffic flow. In addition, China's adoption of a smart transportation system that incorporates shared mobility has increased over the past few years.

1.1.7 Sources of the Publications

There are five sources on the list that contributed to worldwide research of smart cities and smart transportation trends from 2013 to 2022. **Figure 7** shows the sources with detailed information.

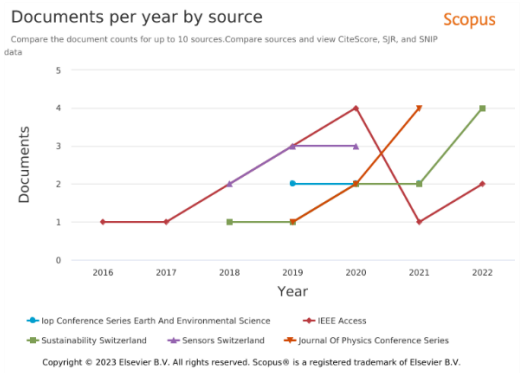

Figure 7. *Documents by Sources*

Figure 7 shows that Sustainability Switzerland tops the list with ten documents. The second is IEEE Access, with nine documents. Followed by Sensors Switzerland with eight documents, the Journal Of Physics

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Conference Series with seven documents, and the IOP Conference Series Earth And Environmental Science with four documents.

According to **Figure 7**, each source's publication increased by 2020. From this perspective, in that year, there was a pandemic, specifically COVID-19, which caused the emergence of new problems in the city due to the virus' rapid spread, particularly in urban areas. In relation to the country with the highest publication rate in this regard, China, the spreading virus also originates from China, and it can be presumed that this is the cause of the rising popularity of smart cities and smart transportation.

1.1.8 Mapping Visualization, Cluster Identification, and Analysis

Figure 8 depicts an illustration of the clusters generated by CiteSpace software. The number of the greatest cluster is 0, and the number of the smallest cluster is 15. The cluster is numbered in accordance with the total number of published papers it comprises.

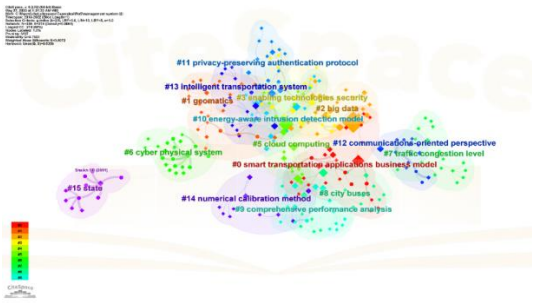

Figure 8. *Clusters of knowledge domains within smart cities and smart transportation*

CiteSpace's log-likelihood ratio (LLR) enables the clustering networks, as it assists in naming the clusters by extracting similar items from titles, keywords, and abstracts and calculating similarity rates. It also indicates a cluster's uniqueness and is ideal for producing high-quality clusters with intraclass and interclass similarity (Qi et al., 2021). Regarding smart cities and smart transportation trends for the last ten years, with 156 documents being used, CiteSpace provides the cluster analysis results, and the 15 largest clusters are enumerated below. Table 1 presents detailed information for each cluster.

Table 1. *Major Clusters within the terms. LLR--log-likelihood ratio.*

No.	Size	Silhouette	Year	Label (LLR)
0	27	0.873	2018	Smart transportation applications business model
1	24	0.887	2015	Geomatics
2	23	0.828	2017	Big data
3	22	0.906	2017	Enabling technologies security
5	21	0.907	2019	Cloud computing
6	21	1	2015	Cyber-physical system
7	17	0.875	2014	Traffic congestion level
8	17	0.854	2018	City buses
9	17	0.88	2016	Comprehensive performance analysis
10	16	0.933	2019	Energy-aware intrusion detection model
11	16	0.945	2020	Privacy-preserving

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				authentication protocol
12	15	0.982	2014	Communications-oriented perspective
13	15	0.935	2019	Intelligent transportation system
14	12	0.918	2019	Numerical calibration method
15	11	0.952	2013	Cyber-physical system

The greatest cluster (#0), consisting of 27 articles, is the smart transportation applications business model with a 0.873 silhouette value. The second cluster (#1) is geomatics, with 24 articles with a 0.887 silhouette value. The third cluster (#2) is related to big data, including 23 articles with a silhouette value of 0.828. The fourth largest cluster (#3) enables technology security, consisting of 22 articles with a 0.906 silhouette value. The fifth largest cluster (#5) is related to cloud computing, with 21 articles of 0.907 silhouette value. The following cluster (#6) is a cyber-physical system with 21 articles of 1 silhouette value. Followed by (#7) traffic congestion level consisting of 17 articles with 0.875 silhouette values. The eighth (#8) is city buses with 17 articles of 0.854 silhouette value. The ninth cluster (#9) is a comprehensive performance analysis consisting of 17 articles with 0.88 silhouette values. The next (#10) is the energy-aware intrusion detection model with 16 articles of 0.933 silhouette value. The eleventh (#11) largest cluster is the privacy-preserving authentication protocol with 16 articles of 0.945 silhouette value. The twelfth cluster (#12) is the communications-oriented perspective, comprising 15 articles with a 0.982 silhouette value. The thirteenth (#13) is an intelligent transportation system with 15 articles of 0.935 silhouette value. The fourteenth (#14) is the numerical calibration method with 12 articles of 0.918 silhouette value. Another large cluster (#15) is the cyber-physical system, with 11 articles of 0.952 silhouette value.

1.2 Discussion

From a geomatics point of view, a smart city is distinguished by several qualities, the most notable of which are its capacity for self-networking and self-maintenance, as well as its ability to integrate digital cities seamlessly (Li et al., 2013). In the future, data or information obtained from smart sensor networks can be updated and disseminated throughout the infrastructure framework of a digital city, which would result in easier interaction between humans and machines. In order to support the discussion, examples of the implementation of smart city surveillance, smart transportation, smart environmental monitoring, and smart tourism are provided. In the development of smart cities, finding environmentally sustainable and harmonious solutions to social problems will become a challenge and a priority.

The conversion of physical systems into cyber-physical systems (CPS) by integrating them with intelligence is a continuous process that may significantly help society and the environment by enhancing the safety, simplicity, as well as quality of life of citizens while decreasing the use of natural resources and minimizing environmental footprint. Cyber-physical systems include Smart Grid Networks, Smart Transportation Systems, Enterprise Cloud Infrastructure, and Utility Service Infrastructure for Smart Cities, among others (Majhi et al., 2015). Thus, endeavors to implement sustainable life can be made with both physical and cyber systems. Consequently, the big data trend will continue to grow as technological advancements necessitate its application in everyday life.

As a complex CPS/IoT application, smart cities are comprised of sub-applications or services, such as smart grid, smart transportation, the structural health of buildings, waste management, environmental monitoring, smart health, smart lighting, etc., that ought to be facilitated by an integrated communication network, infrastructure, or communication networks to establish a large-scale interconnected divergent network with the goal of maximizing the use of public resources. In smart transportation, IoT-CPS is the integration of intelligent transportation management, control systems, communication networks, and computation techniques to ensure the reliability, efficiency, and security of transportation systems (J. Lin et al., 2017). Thus, the Internet of Things (IoT) can be utilized in smart city services with efficiency, security, and convenience functions that can be implemented in both smart cities and smart transportation. However, some risks come with this change: it allows for fluid control and use of resources; it creates ways for information to leak out; and it is prone to configuration errors and attacks from both insiders and outsiders (Majhi et al., 2015).

A multi-modal smart traffic control system (STSC) is proposed for the smart city's infrastructure, which can be extensively put to use for intelligent transportation systems in smart city applications (W.-H. Lee & Chiu, 2020). Infrastructures that enable smart transportation services will be the primary factor for the success of intelligent transportation systems (ITS). This will help to alleviate traffic congestion and increase the effectiveness of public transport efficiency. One of the factors supporting the implementation of smart transportation in smart cities is the world's growing population, which urges humankind to establish a smart and sustainable city system. Nevertheless, the application ought to consider into the thought of other factors, including the environment, in addition to technology. As the goal of the concept of smart cities is a better and

more sustainable life, environmental considerations must be incorporated, as the environment is a living space for humans.

The goal of exploring and supporting sustainable forms of transportation is to build intelligent public transportation systems based on real-time information and create Traffic Management Systems (TMS) to avoid congestion, preserve people's safety, and require less fuel, gas, or energy. A study by Djahel et al. (2014) stated that TMS needs to leverage smart vehicle capabilities and advance parking systems to achieve the desired level of accuracy and control of the traffic to improve its efficiency. Mezarciöz et al. (2017) write in their article titled "Smart Transportation Applications for City Buses" that the application of a safety package consisting of Internet Protocol (IP) cameras and emergency buttons will make city transportation safer. Therefore, because drivers are aware that their every action is being monitored, they strive to adhere to traffic regulations and passenger safety rigorously.

Wireless sensor networks (WSNs) are assumed to be able to solve various problems in smart city, including smart transportation, but there are challenges in security and privacy. Xie et al. (2021) proposed a secure, privacy-preserving authentication protocol to fix the flaws. Furthermore, through the rise of WSN and the Internet of Things, IoT applications are progressively expanding. In order to provide secure IoT services, a secure authentication protocol is necessary. A comparative analysis conducted by J. Lee et al. (2022) reveals that PUFTAP-IoT is safer for real-world applications in IoT environments than other similar technologies because it offers highly secure services to service users despite having a higher computation cost than other authentication protocols. PUFTAP-IoT comprises three entities: the user, the sensing device, and the gateway.

Cloud computing significantly contributes to smart city infrastructure by providing the required structure. In terms of integration, cloud computing has provided a robust infrastructure for the development of smart cities. As most smart city deployments are centralized, the low-powered IoT-enabled smart city infrastructure must look into Blockchain-based solutions and distributed algorithms (Khalil et al., 2022). As a result, infrastructure development in smart cities must continue, as technological advances have led to the creation of innovations that can compensate for the deficiencies or failures of older systems.

2. CONCLUSION

The study concluded that 2020 had the highest publication figures on smart cities and smart transportation trends indexed in the Scopus database from 2013 to 2022. China ranks first out of

ten countries known to have high publication rates in this trend. Then, the source that publishes this trend most is Sustainable Switzerland, which has ten documents. Then, the most productive author in research on smart cities and smart transportation is Djahel S., with five publications. For affiliates with the most publications on this trend achieved by two institutions because of the same number, namely King Abdulaziz University and Kyungpook, with four documents each. In addition, a scientometric analysis with CiteSpace results in 15 significant clusters within the trends of smart cities and smart transportation. The clusters include 1) smart transportation applications business model, 2) geomatics, 3) big data, 4) enabling technologies security, 5) cloud computing, 6) cyber-physical system, 7) traffic congestion level, 8) city buses, 9) comprehensive performance analysis, 10) energy-aware intrusion detection model, 11) privacy-preserving authentication protocol, 12) communications-oriented perspective, 13) intelligent transportation system, 14) numerical calibration method, and 15) cyber-physical system. Although the study explains global trends in smart cities and smart transportation from 2013 to 2022, it is limited in some respects. Data is obtained only from Scopus with restrictions on all open access, article documents, and conference paper types, and English is the only language used. Therefore, conducting additional research with a broader scope on these tendencies is strongly suggested.

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