Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

Internet of Things and Smart Cities: A Bibliometric Analysis

Bülent YILDIZ[1] 0000-0002-5368-2805

Assist. Prof., Kastamonu University, Department of Management, byildiz@kastamonu.edu.tr, Turkey

Article Type: Original Research Article *Received: 10.05.2021*
Vol 3 (Issue 1) 2021: 27-44 *Revised: 19.06.2021*
Accepted: 26.06.2021

To Cite As: Yıldız, B. (2021) Internet of Things and Smart Cities: A Bibliometric Analysis , Quantrade Journal of Complex Systems in Social Sciences, Vol 3, Issue 1. pp:27-44

Abstract

For several years, the 21st century has seen a global shift toward concentrated population in a select few metropolitan cities. However, being a larger and more crowded city has certain advantages, such as being more productive, innovative, and taking progressive environmental action. Additionally, major cities present many positives, such as development, traffic congestion, garbage management, access to resources, and negatives, such as unregulated growth, worsened traffic, garbage collection issues, and limits on resources. Conversely, the global economy has increased connectivity between cities worldwide in hitherto unseen ways of competitiveness. Experiments in urban infrastructure and services, usually referred to as Smart Cities, are related to difficulties. A number of these methods could be used in the future to address new information technology jobs. The smart city concept revolves around organizational structures and urban life in a new form that is expected to shift production and consumption from the global to the local, with business remaining with multi-stakeholder shareholders. One of the critical problems in these new cities is implementing information technology, especially the internet of things. Through a bibliometric examination of studies published in SCOPUS and Web of Science on the ideas of smart cities and the internet of things, this research uncovered some insights about the academic climate in the field. For example, the field's active actors (writers, institutions, and countries, for example) were identified, and their contributions were attempted to be exposed. Among the research findings is a content analysis of terms used in related studies and the evolution and interplay of concepts across time. This study has presented an overview of the field and several predictions about the possible directions it will go in the future.

Keywords: Smart City, Internet of Things, Bibliometric Analysis

1. Introduction

Cities' populations are predicted to have doubled by the year 2050, according to WHO projections. Cities, huge and growing ones, face more complex difficulties such as providing transportation, managing expansion, and managing population increases. This concept, known as the "Smart City," seeks to cope with all of these issues by relying on information and communication technology to make the city itself, as well as all of its structures, communications channels, and other equipment, as smart as possible (Gheisari et al., 2020:3).

Cities are a creative source of invention and ecosystems where players with various interests are given space to interact to support long-term sustainability and prosperity. Cities served by education, technology, and innovation result from ethereal and tangible forces acting together (e.g., institutions and digital infrastructure). ICT infrastructure combined with human capital, social capital, and economic development results in sustainability and higher quality of life (Macke et al., 2018:718).

Today, cities must address several global issues, such as economic growth, financial stability, job development, environmental sustainability, etc. For these kinds of difficulties, the Internet has emerged as a critical component in the long-term strategy. The value of IoT and the difficulties faced by cities both play a role in fueling increased interest in digital urbanism among architects, transportation, and public organizations. The core IoT architecture empowers cities to bring groundbreaking urban ideas to life while adapting to changing user needs. We can help optimize IoT architectures using leading technologies, software-defined network services, and virtualization. The architecture of the Internet of Things (IoT) is highly recommended for smart city initiatives (Ahmed & Rani, 2018:942).

[1] *Corresponding Author: byildiz@kastamonu.edu.tr*

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

The use of digital technology to improve city life is key to making cities smarter. Reforming critical services such as housing, education, health, transport, energy, water, utilities, surveillance, and law enforcement is one of the critical goals of smart cities. Cities that promote social, commercial, and physical infrastructure that reduce population growth and urbanization are considered intelligent cities (Majeed et al., 2021:1).

There are not many cities in the developed world with modern infrastructure while also providing up-to-date digital services for their inhabitants. They are referred to as "smart cities" since all of their modern amenities and infrastructure are built on IT systems. Information and Communication Technology (ICT) has changed the urban environment dramatically in recent years (ICT). As a result of providing e-governance-related services to city people while also developing the city's economy, these cities also increase their intelligence (Chatterjee & Kar, 2018:190).

We are all being connected via the Internet of Things (IoT). This digital world fosters the emergence of creative applications that apply Internet technology to construct intelligent communities. In today's society, the rise of internet technologies such as cloud computing, the Internet of Things, and mobile technology has caught the attention of city planners, who are trying to build sustainable ecosystems (Sharma et al., 2020:3).

The wide availability of new technologies and services as facilitators and value carriers in smart city implementations, especially from a ubiquitous and pervasive perspective, is encouraging. Real-time processing and reliable, high-quality services in various application areas, including robots, crewless vehicles, and drones, are enabled by 5G networks with unpredictable capabilities. Real-time sentiment analysis and opinion mining can be applied to extensive distributed systems through data mining techniques. The new cyber-physical systems designed to integrate the physical and virtual worlds are part of the IoT. In addition to virtual and augmented reality and advanced image processing technologies, this next revolution in human-computer interaction utilizes virtual and augmented reality and advanced image processing technologies (Lytras et al., 2021:3).

There have been substantial changes in our lives due to Internet of Things (IoT) applications. Everyday things have sensors, wireless networks, and new computing capabilities integrated into them now. Because of this, we have seen the rise of smart devices, home automation systems, medical care applications, "smart cities," and industrial automation. For the past few years, IoT has lingered in the background of business, but it appears to be ready to emerge into the forefront. A physical device's processing and networking capabilities are used to collect information in bulk in real-time due to the Internet of Things (Sestino et al., 2020:1).

Industrial systems already in place, like transportation, energy, and manufacturing, are likely to transform due to the IoT. Tightly interconnected Internet of Things (IoT) gadgets are vital components of a smart city, and their usage is becoming increasingly ubiquitous in day-to-day life. The IoT can help households and businesses use less energy, help the environment, help consumers, and lead more sustainable lifestyles. Websites, mobile applications, wearables, connected appliances, and more all employ internet-based information design to communicate data, information, and services linked to a network. Cities are transitioning towards a vehicle-integrated, connected, and intelligent living area, which is projected to rely heavily on IoT, mobile technologies, and next-generation networks (Janssen et al., 2019: 1590).

In the development of smart cities, the Internet of Things (IoT) is of extreme importance. In particular, it is beneficial to the city's industrial and commercial development and those industries that take place in the city's central area. In a broad sense, the successful implementation of IoT technology is crucial for the city's industrial restructuring. It encompasses central resource usage and smart city optimization (Zhang, 2020: 631).

2. Theoretical Framework

2.1. Internet of Things

Internet infrastructure will be a key player in connecting physical items, thanks to using the Internet as a worldwide platform. One of the essential components of creating new and novel innovation will be the utilization of electronics embedded in things and harnessed inside the fabric of our world (Khajenasiri et al., 2017:770).
The notion of IoT was developed by Kelvin Ashton in 1999 when he coined the term Internet of Things (IoT). A platform is created by connecting internet-enabled objects to enable particular activities. The device uses the network

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

and everything connected to it to accomplish any function. One idea is to make nearby items speak to one other over the Internet. The system is completed by utilizing in-built wireless connectivity to connect everyone and everything at any time and wherever. It can be a helpful connection with the rest of the environment because it simplifies monitoring and controlling the environmental aspects via the Internet (Gamil et al., 2020:1092). IoT makes an object able to perceive by hearing, seeing, listening and communicating all at once. It will no longer be viewed as a computer network by the Internet. The billion-device combination will also comprise smart gadgets and embedded systems. The IoT will dramatically develop in size and scope, bringing new opportunities and increasing the number of problems (Rathore et al., 2016:64).

IoT, or the Internet of Things, has been enabled by new software, hardware, and communication technologies. IoT is a network of interconnected and associated physical devices that collect, transport, and share data (Ma et al., 2020:165). A young technology utilizes networked sensing and communication to bring out automated devices, machinery, sensors, and actuators (Qureshi et al., 2020:1). IoT is the Internet of Things, in which everyday objects connect. The Internet is still the cornerstone of IoT, but in this instance, communication and object interaction is of vital importance. Ultimately, information communication aims to satisfy the basic requirements of human beings (Liu et al., 2020:326).

Connectivity is provided, but real-time intelligent control of things is also possible due to the IoT. A significant number of sensors are placed on the IoT, which means IoT can collect a great deal of data. Each sensor provides data. There are a wide variety of sensors, which provide varying information content and formats of information. Real-time sensor data and environmental information are both gathered regularly, and the data is updated regularly. Intelligent technologies, such as cloud computing and pattern recognition, extend the application possibilities for IoT. The sensor can collect an incredible amount of data through this method, which is then studied and processed (Huang, 2020:284).

By connecting various sensor-based devices, IoT is better able to collect data more conveniently. The innovative way to tackle complex sensing applications like telemedicine systems, intelligent traffic management systems, and environmental monitoring systems is an example of what is meant by practical use of computer technology. Real-time data can be obtained by placing a large number of sensor-based devices in a significant quantity. The amount of data acquired from sensors increases geometrically as the number of sensors grows. Nonetheless, enormous amounts of data are not sufficient on their own. The concept of Smart Data came to be as a result. Intelligent IoT serves a wide range of use cases for making intelligent decisions (Teng et al., 2019:351).

As with other IoT systems, cloud computing solutions are critical to IoT. Users gain the capacity to view information remotely by using the internet cloud services. Large amounts of data can be collected in the cloud and processed using cloud-based apps due to interactions between the cloud and sensors (Bogatinoska et al., 2016:707). A great deal of AI research has advanced significantly in the last few years. There are various fields in which AI technologies are applied. Examples include identification, communication, and the application of Internet of Things (IoT) machine learning algorithms, such as deep learning, neural networks, and big data (Ma et al., 2020:168).

The rapid proliferation of IoT technology boosts cyber-attacks daily. Developing IoT creates new problems. The IoT network should also be monitored to defend it against cyberattacks. However, cybersecurity solutions have become more commonplace in the IoT environment in recent years. Researchers have been developing these systems and frequently using them to safeguard sensitive information and computer systems from illegal access. Similarly, identifying anomalies and intrusions in an IoT network environment is a daunting task, and academics are constantly working to combat this challenge (Shafiq et al., 2020:433).

2.2. Smart Cities

Citizens, buildings, transportation systems, grid systems, industries, education, and health services all go through a change process during the notion of smart cities. The implementation of smart technology was used to implement monitoring, control, recognition, and understanding to boost efficiency, impartiality, and economic growth while also improving the quality of life. Urbanized areas are referred to as "smart cities" because they possess a wide array of advanced technologies supporting the network and providing data services. The primary goal of this approach is to help people, reduce the cost of their products, and increase their economy. The Smart City digital systems and environments can be utilized for smart city applications, including efficient municipal operations and data transfer. People's systems have evolved into the digital age due to these new technologies (Qureshi et al., 2020:2).

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

A smart city depends on applying ICT in tandem with human capital to provide sustainable economic development and resource management while increasing the quality of life for people. City models are also a great city model because they improve citizens' and society's relationships. These models are focused on maintaining and growing those relationships (Pinochet et al., 2019:75). Citizens will benefit from smarter cities since they will enjoy a higher quality of life and access more services. To properly design and administer these services, the input of individuals must be given due consideration (Yeh, 2017:556).

A city that employs information and communication technologies (ICT) and other instruments to raise the quality of life, efficiency, and competitiveness while helping to meet the requirements of future generations is defined as a smart and sustainable city by the International Telecommunication Union (Angelidou et al., 2018:151). We might alternatively define the smart city as an approach that integrates a wide range of services for particular needs, develops collective skills and abilities, and fosters overall well-being. Because of this, it provides access to government agencies, schools, businesses, residents, health, and social services for all communities (Roy, 2001:7). Sustainable, innovative, holistic, and connected cities feature Information and Communications Technologies (ICT) solutions alongside sustainability, overall technical performance, economic feasibility, and stakeholder input (Sharma et al., 2020:1).

This development is ever-changing and ever developing. The city development arm will be honored with the nation's advancement. Beginning as traditional development, the process shifts to a smart development process dedicated to rational resource utilization and environmental quality improvement (Zhang, 2020:632). The smart city prioritizes the people who live there and their requirements. One of its policies is to work with and via community and stakeholders to get the community involved in making choices and administering public services to express their demands better. The objective is to make the services citizens demand available, create a climate that invites involvement, and interface with public and private entities (Pinochet et al., 2019:76).

Urban development difficulties can be solved using the smart city as a valuable instrument. It can collect comprehensive and thorough information and send forth relevant and valuable information to the desired audience. This strategy can help with urban management and operational efficiency, and it also aids in improving the delivery of urban services. Cities are smart enough to create new forms of urban development independently, which means the public can experience the city's wisdom offered through the city's intelligence services and applications (Prakash, 2019:158).

Due to the fast growth of cities, modern cities are struggling with management efficiency and urban quality of life difficulties. There seem to be many possible answers to these and other current difficulties in urban areas due to smart city technologies. A modern city is functionalized to ensure sustainability and efficiency while at the same time keeping the design appealing. Achieving this goal can be done by combining numerous infrastructures and services into units equipped with smart devices to be monitored and managed. Smart cities focus on urgent and routine concerns, like crime management, education, energy, environment, health, public transport, employment, and trash management (Alavi et al., 2018:590). While a smart city can be defined as a city center with technologies that utilize digital data for improved public services and resource management, a smart city can also be viewed as a city center whose capabilities are enhanced by digital data and technology. Smart city, smart management, smart economy, smart residents, smart mobility, smart environment, and smart lifestyle are critical parts of the smart society concept (Alavi et al., 2018:591).

In solving the problem of real-time management of urban flows, smart city applications are being created. This century has seen an upsurge in demand for smart cities due to technological, economic, and environmental advancements. As a result of these changes, which include climate change, economic restructuring, an aging population, and financial pressure, these elements must be factored in. The smart city, house, grid, automobile, and traffic management are examples of other applications that might be considered applications that operate under the smart city concept (Khajenasiri et al., 2017:771).

A more intelligent means of public transportation improves the quality and efficiency of public transit. This process comprises systems that collect and disseminate information, including technology from smart cities that help reduce automobile dependency and increase sustainability. In a smart city, various smart city technologies draw attention to the automated driverless guided car. A guided vehicle that uses radio waves, cameras to assist navigation has been created. Autonomous processes remove human interference when parking is provided for vehicles in a smart city (AlZubi et al., 2021:1). A smart parking system is essential for parking lot management in highly populated places, such as retail

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

centers, arenas, and other prominent monuments. Sophisticated parking solutions address regular parking space distribution by working to lower the demand for parking. The Intelligent Parking System helps increase productivity, safety, and versatility, lowers parking fees and prevents vehicle jams. To ensure the security of auto parking facilities, a parking system to encourage parking has been established, implemented, and tested to oversee and manage the opening of parking facilities. It is a more accessible and more straightforward alternative to others. Thus it is necessary. The primary purpose of this project is to develop ways to reduce the amount of time needed to find a parking space. The proposed technique connected with this is to constantly monitor parking space vacancy; (Bedi et al., 2021:1).

To control the intensity and passage of streetlights, the smart street lighting system uses various sensors and controls. Light switches turn on as it becomes dark, and vehicles and pedestrians use a nearby light pole to cross the street. When it gets light, the streetlight automatically goes off. This intelligent street lighting system features a remote control that allows users to turn on and off streetlights, automatically dims headlights, diagnoses and isolates issues, detects theft, and collects data. The intelligent streetlight employs an infrared sensor to track vehicle movement and then operates the light when it is unnecessary to consume electricity, reducing energy consumption (Anguraj et al., 2021:2).

The essential issue to solve is providing an avenue for maintaining data security, privacy, and complete transparency across many channels. A blockchain can record many transactions that are characteristic of smart cities. Using smart contracts, people can conduct complex legal operations and exchange data automatically. By using smart contracts and decentralized apps, blockchain gives cities greater control of their operational processes, making cities more autonomous. A lot of new applications and services can be built on top of blockchain technology. A tremendous amount of effort has been devoted to exploring how blockchain applications will be used in smart cities (Majeed et al., 2021:2).

Permanent preservation of the digital records of city residents on the cloud is one of the significant benefits of smart cities. Though in many cases it takes the system less time to complete a task with the use of various digital service modes, such as speedier, paperless, seamless, etc., it is beneficial to overall system efficiency and possibly quality of life (Chatterjee & Kar, 2018:192).

2.3. Internet of Things in Smart Cities

Cities will become more economically, environmentally, and socially due to urbanization and competition. Cities are increasingly using the semantic web, cloud computing, gadgets, and emerging ICTs to create and plan local places. In terms of new technologies and sensors, the concept of IoT (which stands for "the Internet of Things") suggests integrating the virtual world of IT with the actual world (Bresciani et al., 2018:332).

Different technologies, such as Big Data, Cloud Computing, and the Internet of Things, are available in smart cities. While it is true that being "technical" is not synonymous with being "intellectual," we must emphasize that it is essential to be a well-informed and tech-savvy individual. An integrated system connected to the city's clean-up center will need a waste collector to be "smart." For these cases, it has been found that when there is a dialogue between technologies, the smart aspect appears. The data scientists aim to predict tiny factors in significant outcomes with a greater emphasis on nonlinear computations; for example, the ability to forecast environmental calamities with the aid of artificial intelligence, machine learning, and deep learning (Pinochet et al., 2019:74).

A smart city collects data using sensors and sensor-based technology to provide better services using several IoT applications. Many villages, cities, and municipal governments are currently looking to implement smart city technology as the next step in e-governance, which helps the public interact with city hall in new ways or streamlines existing ordinances. A new step has been reached in modern factory information development with the introduction of the smart factory. Using IoT and equipment monitoring technologies, smart factories and digital factories use the collected data to manage information, provide services, produce more, promote sales, raise manufacturing control, and minimize labor interventions in the production line (Zhang et al., 2020:574). When it comes to sustainable and smart city infrastructure, including the Industrial Internet of Things, IoT technology is also involved (IIoT). In the IIoT, industrial devices are designed to do all three things: manufacturing, operating, and maintaining industries. Smart cities also use smart technology to boost traditional industries' manufacturing and operational capacities (Qureshi et al., 2020:1).

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

As a meditation on the city's expansion to incorporate several ICT and IoT solutions to manage city resources better, smart cities and society are intertwined. It enhances the quality of life for inhabitants and provides high-quality services. Such things as surveillance, health, water, utility, business, parking, and the environment are included in the services. The fundamental objective of smart cities is to make sure traditional city services perform effectively (Babar et al., 2021:1). The IoT system plays an essential part in the creation of the smart city. Instead of placing sensors all over the place and connecting them to the Internet, IoT systems utilize sophisticated sensor networks to identify, locate, monitor, and intelligently manage points. Numerous significant challenges crop up while designing IoT systems for smart cities due to the vast size of cities (Teng et al., 2021: 310). In order to accommodate the current and future technological needs of the citizens, the smart city is built on top of modern information technologies, such as artificial intelligence, intelligent control software, expert decision-making technology, and sensing equipment. The information-sharing network system employs artificial intelligence to realize the sharing of information, resources, and tasks, and all operational intelligence of the city is then present. Cities can be described as 'smarter' because of IoT. IoT apps serve as the vehicle for realizing intelligent cities, the "goal" for which they are developed (Huang, 2020:284).

It is critical to obtain physical location information for smart city IoT applications. In applications such as smart transportation systems and smart parking lots, incorrect car location estimates might endanger people. The sensor must anticipate its location in smart grids, environmental monitoring systems, and other applications. The inaccuracy of the position measurement might lead to substantial financial losses. The sensor network is also guided by the physical position information of the sensors (Teng et al., 2021: 311).

Smart cities are now possible thanks to the Internet of Things. A critical feature of a smart city is the use of intelligent technologies across multiple sectors, including housing, energy, wastewater, transportation, agriculture, environment, health, and government. More specifically, IoT is used in the following industrial areas: oil and gas mining, production units. IoT is associated with improved production, optimized costs, enhanced employee capabilities, more accurate prediction of equipment maintenance, and a great degree of human comfort (Raghuvanshi & Singh, 2020:1). With the IoT, people's lives, such as health, safety, and transportation, will be affected. At the national level, it is critical in crucial policy decisions like energy conservation, pollution reduction, and more (Janssen et al., 2019: 1591).

In an IoT architecture, the service layer refers to the applications and services needed to support smart cities. An analytics system that relies on the collection and dispersion of data seeks to generate insights that may be used for smart services. While the middleware layer comprises data and device integration technologies, the infrastructure layer focuses on devices situated in cities that use advanced technology. For example, light and weather-responsive bulbs for intelligent and real-time monitoring of noise are installed on the streets, while pollution sensors used for real-time monitoring of noise are located in central places (Alavi et al., 2018:594).

It is relatively common to consider waste management to be a connected IoT service. It is commonly connected to the application of intelligent transportation in smart cities. Because this Smart City solution is founded on intelligent transportation systems and waste collection, it uses surveillance systems, sensors, and cameras to create an even more advanced platform in smart cities (Bogatinoska et al., 2016:709).

3. Methodology

In this study, a bibliometric analysis was performed on 2289 papers on the Internet of Things (IoT) and smart cities published between 2011 and 2021 in the Web of Science Core Collection and SCOPUS. To analyze and illustrate the results, the Bibliometrics package (Aria & Cuccurullo, 2017) in the R software was utilized. Despite the wide variety of tools, which includes packages, that can be employed in the bibliometric analysis, packages including the majority of the required bibliometric analyses in R and the visualization success of these packages can sway one's decision to utilize them in this study. It was also employed in the burst detection analysis, which was accomplished using Jon Kleinberg's burst detection technique.

A substantial portion of the study's conclusions consists of spreading the data throughout the data set by years, nations, universities, and journals and creating a map of the keywords contained in the data set. Additionally, studies on citation levels by year, journal impact levels, and country citation levels are included in the study's conclusions.

3.1. Data Collection and Pre-processing

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

The process of creating the data set logically consists of three stages. As a result of the literature review in the first stage, a database query was carried out with the keywords smart city and Internet of things. In this context, the query code performed to identify the articles written on related topics is as follows, and the query stages are shown in Table 2.

(TS=(("internet of things" OR "iot") AND "smart cit")) AND (TS=(("internet of things" OR "iot") AND "smart cit*")) NOT (TI = ("literature review" OR "bibliometric*") OR KP = ("literature review" OR "bibliometric*") OR AK = ("literature review" OR "bibliometric*"))) AND DOCUMENT TYPES: (Article)*

Table 1. Data Collecting Stages

Stage 1: database query: **Web of Science:** **Result: 1948 articles** **Scopus:** **Result: 2248 articles**	**Keywords:** **inclusion:** - internet of things - iot - smart cit* **exclusion** - literature review - bibliometric*
Stage 2: Combining results from both databases **Result: 2362 articles**	- Deleting duplicate studies and obtaining the original data set
Stage 3: Removal of studies with missing data from the data set **Result: 2288 articles**	Exclusion criterion: - No date information - No keywords

As a result of the query, 1948 articles were found in the WoS database, and 2248 articles in the Scopus database. Literature review and bibliometric analysis studies were excluded from the data set during the query. In the second stage, the results obtained from both databases were combined by eliminating the duplications. As a result of this phase, the number of articles was reduced to 2362. At the last stage, a data set consisting of 2288 articles was obtained by removing 74 publications that did not meet the necessary criteria for analysis.

The data set obtained in the data preprocessing stage was reviewed in detail and made ready for analysis. At this stage, some corrections were made regarding the keywords. For example, keywords such as "smart cities," "smart city," "smart city," "IOT," "internet of things," "internet of things technology" have been combined into a single keyword to express the concept. The words "internet of things," "iot," and "smart city," which were used during the creation of the publication pool, were excluded from the analysis. The purpose of removing these words is that they may overshadow other concepts in the analysis. Thus, it is aimed to focus directly on the concepts related to smart cities and Internet of things technology.

4. Findings

The bibliometric analysis carried out within the scope of this study includes publications between the years 2011: 2021. The data set consists of 2288 articles. Six thousand three hundred ninety-three authors wrote these articles. The number of single-author articles is 169, which shows that two or more authors wrote 6224 articles.

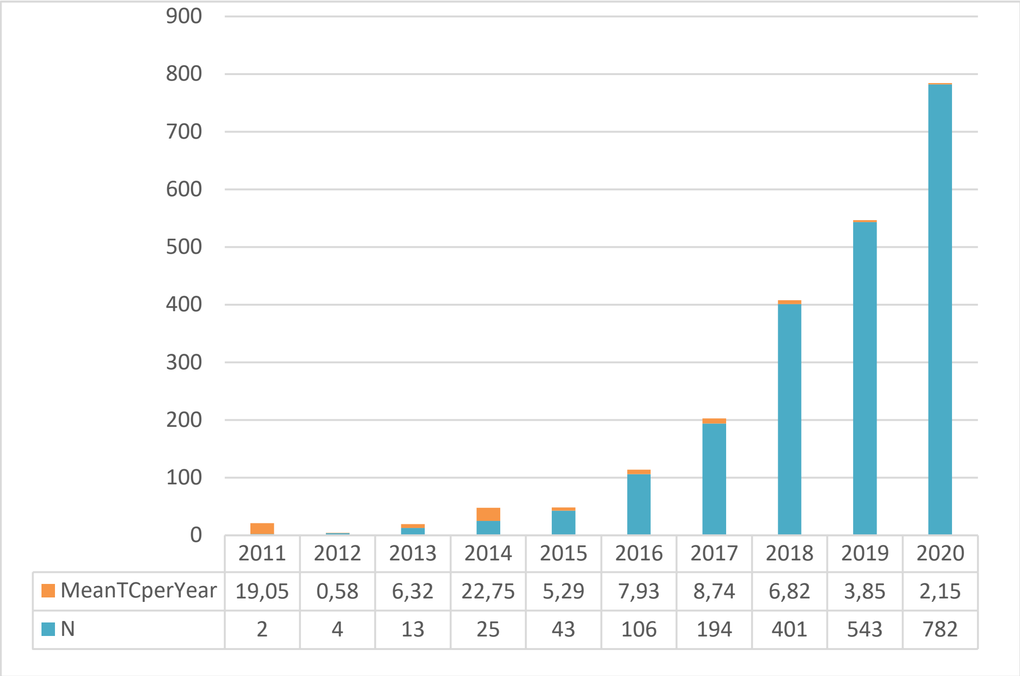
Table 2. Main Information About Publications

Timespan	2011:2021
Documents	2288
Authors	6393
Single-authored documents	169
Documents per Author	0.357
Authors per Document	2.79

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

Co-Authors per Documents	4.01
Total Citations	31,493
Collaboration Index	2.94

In Graph 1, the distribution of the number of articles examining smart cities and the averages of citations by years is seen. The blue part of each column in the graph shows the number of publications in the relevant year, and the green part shows the average number of citations per article in that year. It has been observed that the number of articles and citations on the subject has increased since 2016. Although the oldest publications on the subject date back to 2011, the increase in publications after 2016 maybe because concepts such as industry 4.0, the Internet of things, etc., have started to be popular in academia since these years and started to be studied together with smart city processes.

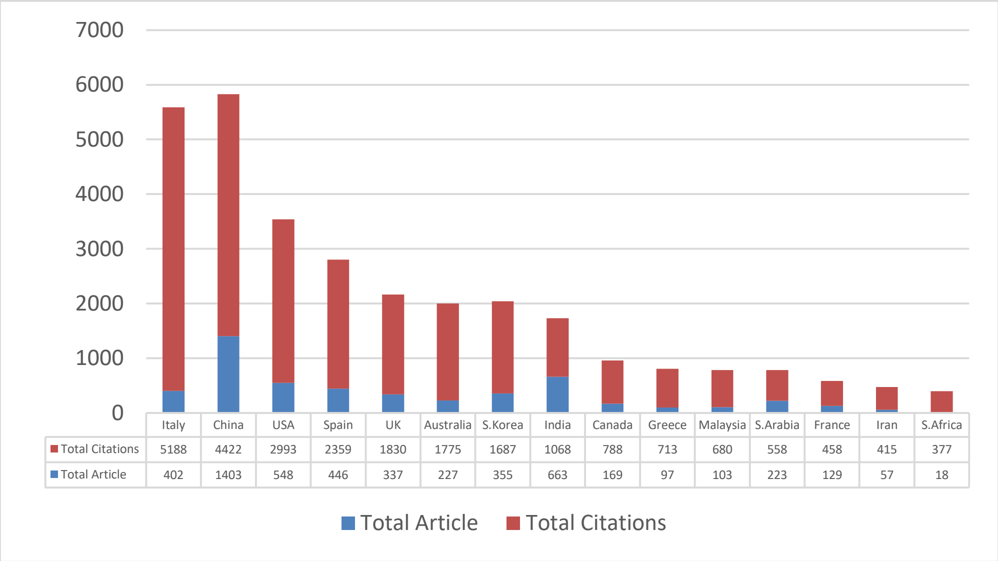


Graph 1. Annual Growth of The literature

4.1. Countries and Institutes

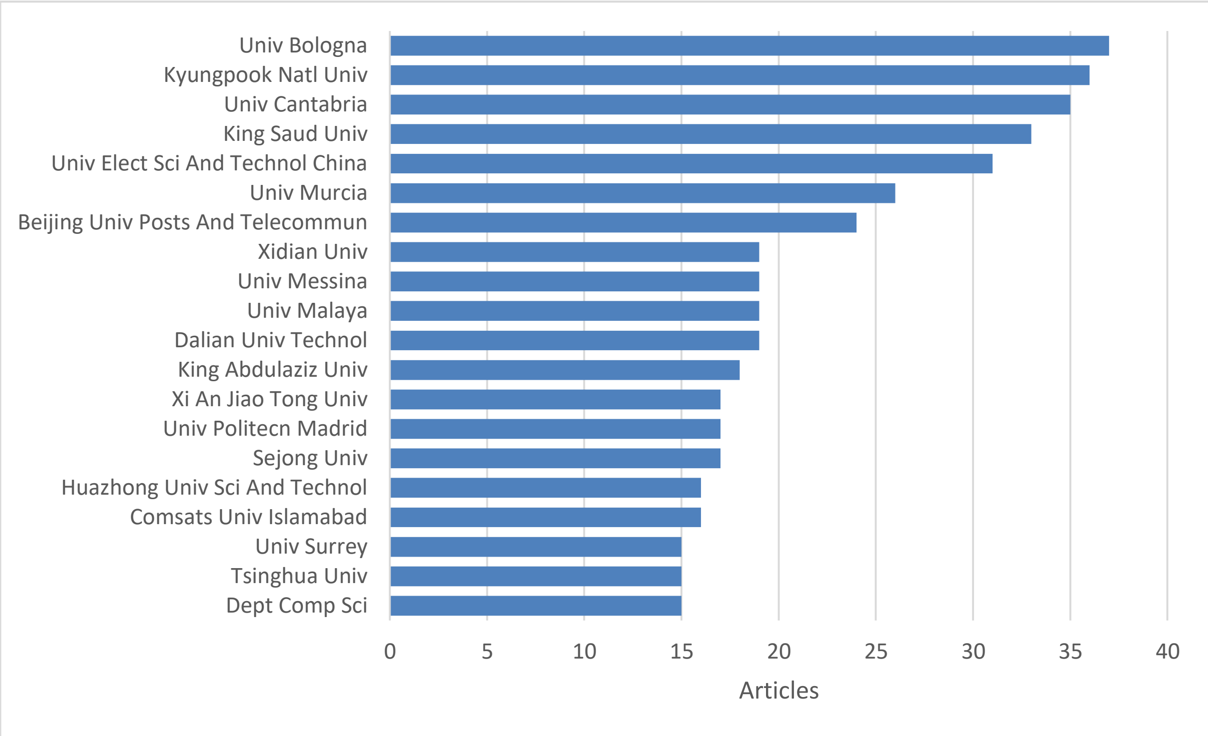
When country results are examined, it is seen that the publications originating in Italy are the most cited. Then it comes to China, USA, Spain, and England, respectively. However, when the number of publications is examined, Chinese authors come first, and US writers come second. This situation can be interpreted as Italy being more active academically.

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade



Graph 2. Top 15 Countries

University-based contributions to publications are given in Graph 3. When the graph is examined, it is seen that the most active university on the subject is the University of Bologna. When the top 20 university rankings are examined, it is seen that a specific country does not dominate the field, and many countries are active on the subject. The ranking includes universities from many countries such as Kyunpook national university (Korea), University of Cantabria (Spain), King Saud University (Saudi Arabia), University of Electronic Science and Technology of China.



Graph 3. Top 20Universities

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

4.2. Journal Statistics

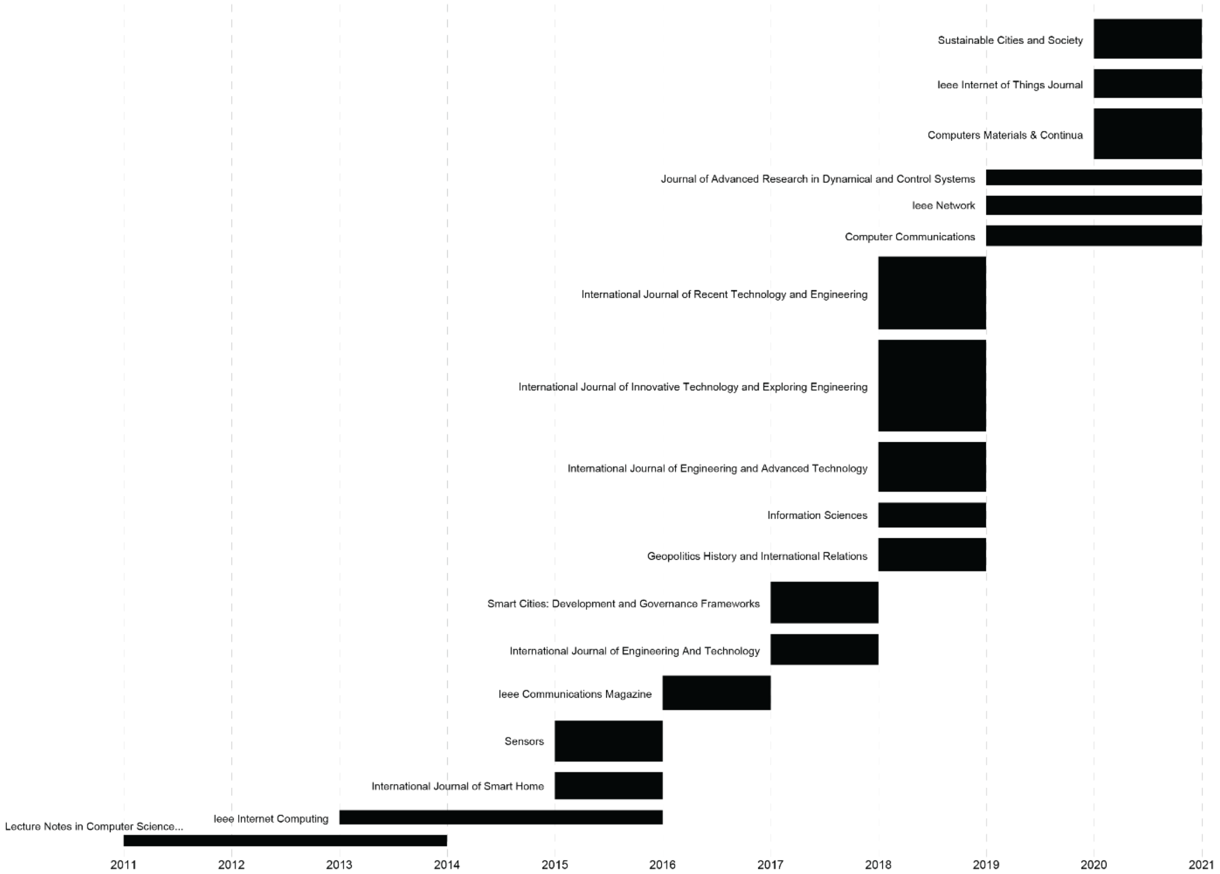
It is critical to assess the state of academic publications when researching an academic field's progress. The publication's influence is revealed by the subject of the publication, as well as the writers and publishers and the publisher's standing in the field (Kim et al., 2020). The first 15 journals in Table 4 have the numbers of publications, h.indexes, and citation numbers included. Ieee Internet of Things Journal and Ieee Access is now considered the two most active journals in the field. "Future Generation Computer Systems -The International Journal of E Science" is followed by these two periodicals. Despite having more articles published in the "Sensors" journal, the journal "Future Generation Computer Systems: The International Journal of E science" has a higher citation count and h.index score.

Table 3. Top 15 Journals

Journal	h_index	T.Cit	N.of Pub.	PY_start
Ieee Internet Of Things Journal	28	5329	162	2014
Ieee Access	27	3299	203	2015
Future Generation Computer Systems-The International Journal of E science	27	3188	96	2016
Sensors	22	1727	170	2013
Ieee Communications Magazine	14	953	20	2013
Ieee Transactions on Industrial Informatics	12	565	19	2017
Sustainable Cities and Society	11	465	50	2017
Ieee Communications Surveys and Tutorials	11	1091	17	2017
Sustainability	10	190	32	2016
Ieee Internet Computing	9	333	12	2013
Computer Communications	8	384	28	2015
Journal of Network and Computer Applications	8	325	16	2017
Technological Forecasting and Social Change	8	254	10	2018
Wireless Personal Communications	7	158	22	2014
Computer Networks	7	893	17	2014

The table here shows the total performance of the journals for ten years. While some journals lose their effectiveness over time, journals that were not active in the early period may become active later. The publication frequency of the journals affects the number of publications on the subject. It may cause the cumulative results of a journal that started its publication life to be higher. On the contrary, a journal that started its publication earlier may have too many publications on the subject in the early periods. Thus its cumulative scores may be high. It is possible to encounter a different picture when a more detailed and time-based analysis is made. For this purpose, a second analysis was made using the burst detection algorithm developed by Jon Kleinberg. The burst detection algorithm is an algorithm designed to detect activities that intensify over time and decrease (Kleinberg, 2003). With this algorithm, the publications of the journals on the subject were analyzed according to a specific period. As a result of the analysis, the journals whose activities are concentrated in specific periods in the field are shown in Graph 4. In the graph, the horizontal axis shows the period, and the black horizontal bars on the vertical axis show the impact forces of the magazines. The elongation of the black horizontal bars indicates that the magazine is more effective in more time intervals, and its thickening indicates that its effect increases.

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade



Graph 4. Journal Bursts by Year

The results in the graph will also contribute to a more accurate interpretation of Table 4. As shown in the figure, there is no absolute effectiveness of a single journal during the elapsed time. The effectiveness of "Ieee Internet Of Things Journal," which is in the first place in Table 4, was between 2020-2021. The journals "Ieee Access" and "Future Generations Computer Systems-The International Journal of E science," ranked second and third in the table, could not come to the fore in burst detection analysis. It means that some journals that could not be listed in the table despite being seen in the graph were more active than in the relevant years. "Sensors," which is in fourth place in the ranking in the table, exploded between 2015-2016. When the number of publications and citations of the "Ieee Internet Of Things Journal" is examined, it can be said that it significantly impacts the literature on the subject within the said 1-year period.

4.3. Keyword Analysis

The keywords in an article are a concise and accurate summary of the primary topic of the post. In the process of analyzing publications for bibliometric value, several emphasis points are utilized for content extraction. The focal points of the publication are its abstract, keywords, and structure. This study found that keywords were used as the primary focus to observe the subject's evolution through time. Because keywords do not require as much data preparation, they are better for search results. It is not straightforward to extract groups of two, three, and four words from full-text or abstract reviews. Even if an algorithm treats "cloud computing" and "cloud computing systems" as having very high consistency in a specific text, it is a problem that it does so. When requested to do binary grouping, the more likely outcome is that the algorithm will find all blocks labeled "cloud computing" and groups them under that term. In contrast, "systems" will be found as a different notion. Unlike traditional keyword-based keyword matching, there is no requirement to separate keywords, and concepts sought to be attained can be reached with very high consistency.

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

The 24 most frequently repeated words in publications are given in Table 5. Accordingly, the word with the highest frequency of observation is the word "cloud computing." The words "big data" and "security" follow. When the frequencies are examined, it is seen that the most repeated concepts are mostly current concepts. It is maybe due to the increase in publications over time. More detailed results will be mentioned in other analyzes related to keywords.

Table 4. Most Frequent Words

Words	Occurrences	Words	Occurrences
cloud computing	165	smart home	52
big data	164	artificial intelligence	46
security	143	internet	46
wireless sensor networks	116	authentication	38
edge computing	99	energy efficiency	37
blockchain	95	smart grid	34
fog computing	86	intelligent transportation system	32
machine learning	85	Lora	29
sensors	78	sustainability	29
privacy	68	cloud	28
5g	60	monitoring	28
deep learning	60	optimization	28

A popular exploratory data analysis tool is multidimensional scaling, which illustrates the connections between the studied topics. The keywords used in the multidimensional scaling analysis were found to be dispersed across the coordinate plane in the resulting graph. Because the keywords are moving closer together, their relative positions represent their convergence. In the context of our discussion, more convergent words create a set. They provide a foundation for relevant literature to the extent that a term is situated toward the middle of the cluster (Hoffman & De Leeuw, 1992). In the end, a factorial map of the clusters can be calculated as a result of the research. Figure 1 demonstrates the multidimensional scaling methodology used to generate the factorial map.

As a result of the analysis, the keywords were collected in 5 main clusters.

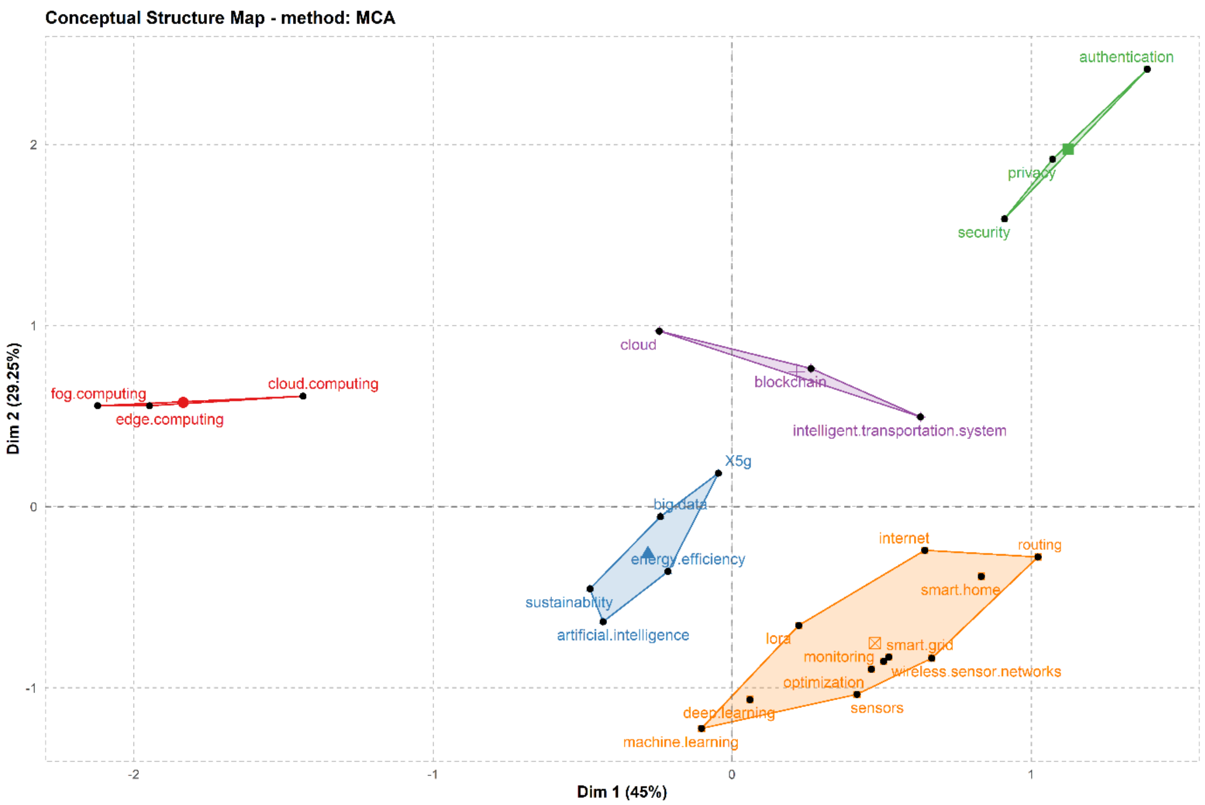


Figure 1. Multidimensional Scaling Analysis of Keywords

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

The first cluster includes the concepts of authentication, privacy, and security. The factorial map shows that the concept of privacy occupies a more central position. It can be interpreted as the importance of protecting personal privacy in studies on smart cities. For the sustainability of smart city systems, smart devices must be integrated into the system. Smart devices also need some environmental data to perform their functions. This data is collected from the environment via sensors or obtained from other smart devices. Since the system remains connected to each other and requires uninterrupted data flow, it will be vulnerable to attacks. Of course, some hackers want to abuse intelligent systems (Lin et al., 2017). Logically, academic studies on taking precautions against these pirates converge within the same cluster.

Cluster 2 includes cloud computing, edge computing, and fog computing, and edge computing is located close to the center. Developing digital technologies has dramatically increased the amount of data produced. Especially with the Internet of things, every object connected to the cyber-physical system has started to produce data at an incredible size. In the future, the Internet of things technology will be the biggest feeder of big data. Transmitting vast amounts of raw data over a network places a massive strain on network resources.

It is more efficient in some circumstances to process data as close to its source as possible and only transfer data of value to a remote data center (Yu et al., 2018). So, as a result, it is reasonable to conduct academic studies on the more efficient use of big data in smart city initiatives.

The third cluster includes the concepts of cloud, blockchain, and intelligent transportation systems. In this cluster, the concept of blockchain is more central. When the thematic evolution graph is examined (Figure 3.), it is seen that the blockchain has been the primary concept since 2019. It can be interpreted as researching the contributions of blockchain in intelligent transportation systems, especially in studies conducted in terms of smart cities in recent years. A new digital smart city ecosystem has emerged, and it is all because of the fast adoption of blockchain technology. Decentralized technologies such as blockchain and bitcoin could assist in risk management and financial services, IoT, and public and social services. Smart city network architecture is also being revolutionized by the confluence of Artificial Intelligence (AI) and blockchain technology, thus facilitating the establishment of sustainable ecosystems (Singh et al., 2020).

The fourth cluster consists of five factors: artificial intelligence, 5G, sustainability, big data, and energy efficiency. The concept of energy efficiency is the most prominent notion within this cluster. It is believed that these principles, because of their tremendous capacity to assist in making cities more sustainable, will be critical to the IT infrastructure of smart, sustainable cities, a method for city development (Bibri, 2018). There is numerous research on 5G, artificial intelligence, and big data as it relates to sustainability and efficiency in the literature (e.g. (Jiang & Song, 2016), (Orsino et al., 2016), (Plageras et al., 2018)). These notions are clustered since the process is comprehensible. The core premise is that there are aspects of smart city research in which energy efficiency can be viewed as a priority. Also, it is possible to say that another key goal is to make the building as energy-efficient as possible.

In the 5th cluster, there are the concepts of Internet, smart home, routing, machine learning, deep learning, iora, sensors, wireless sensor networks, optimization, smart grid, and monitoring. In the closest position of the cluster to the center, there is smart grid. After that, optimization, monitoring, and smart home are more central. It is understood from this that some of the studies on smart urbanism focus on the smart grid and smart home systems. Studies have dealt with tracking optimization issues in smart grid systems. Smart cities will be able to manage current resources using modern information and communication technology. For this purpose, smart grid systems emerge as complex systems where it is possible to monitor and control energy-producing and consuming assets in detail. It will result in better approaches to increase energy efficiency (Karnouskos & Holland, 2009). Therefore, it is understandable that studies centered around smart grids, monitoring, and optimization concepts.

Power, structure, and the theme content of publications can be seen through theme evolutionary analysis, shifting rules, evolutionary relationships, and trending content. Thematic evolutionary analysis can determine the field's evolutionary path, change in the field, and use the current moment to forecast future developments. The size of each node in the thematic diagram is related to the number of various keywords utilized in the subject. When connected a node to other nodes, it can discovered the relationship's relational significance. These connections demonstrate that the concept has

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

endured for a long period. The broader the relationships, the more similar the concepts are to one another. Stronger connections lead to broader lines (Cobo et al., 2011).

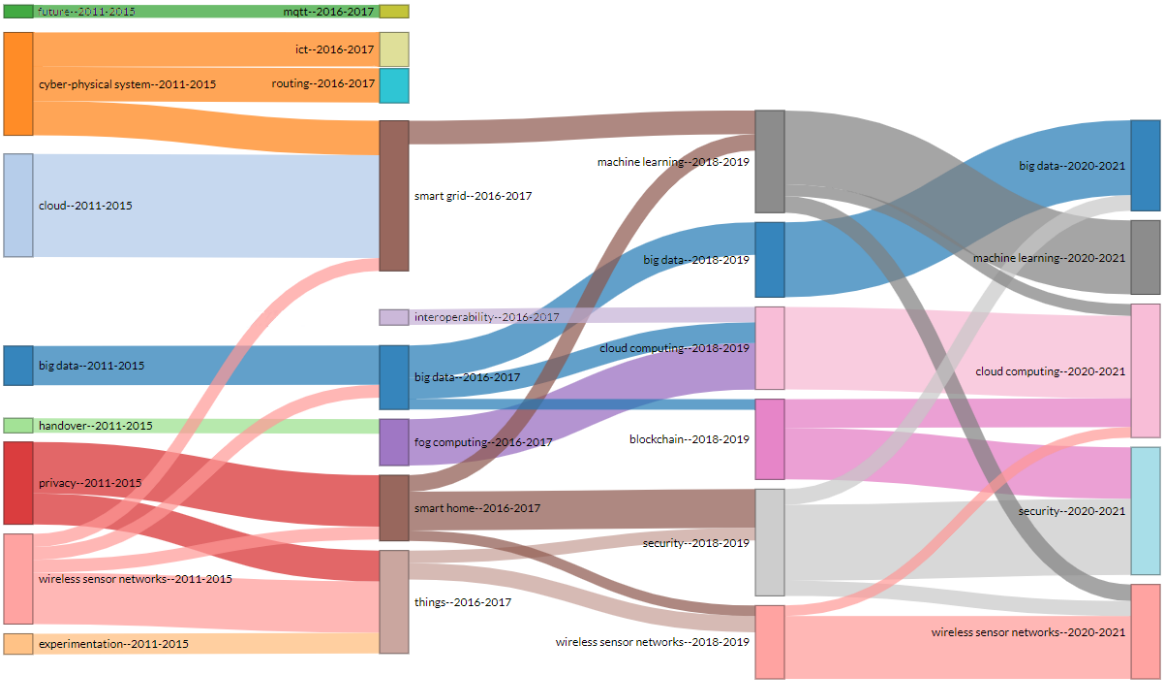


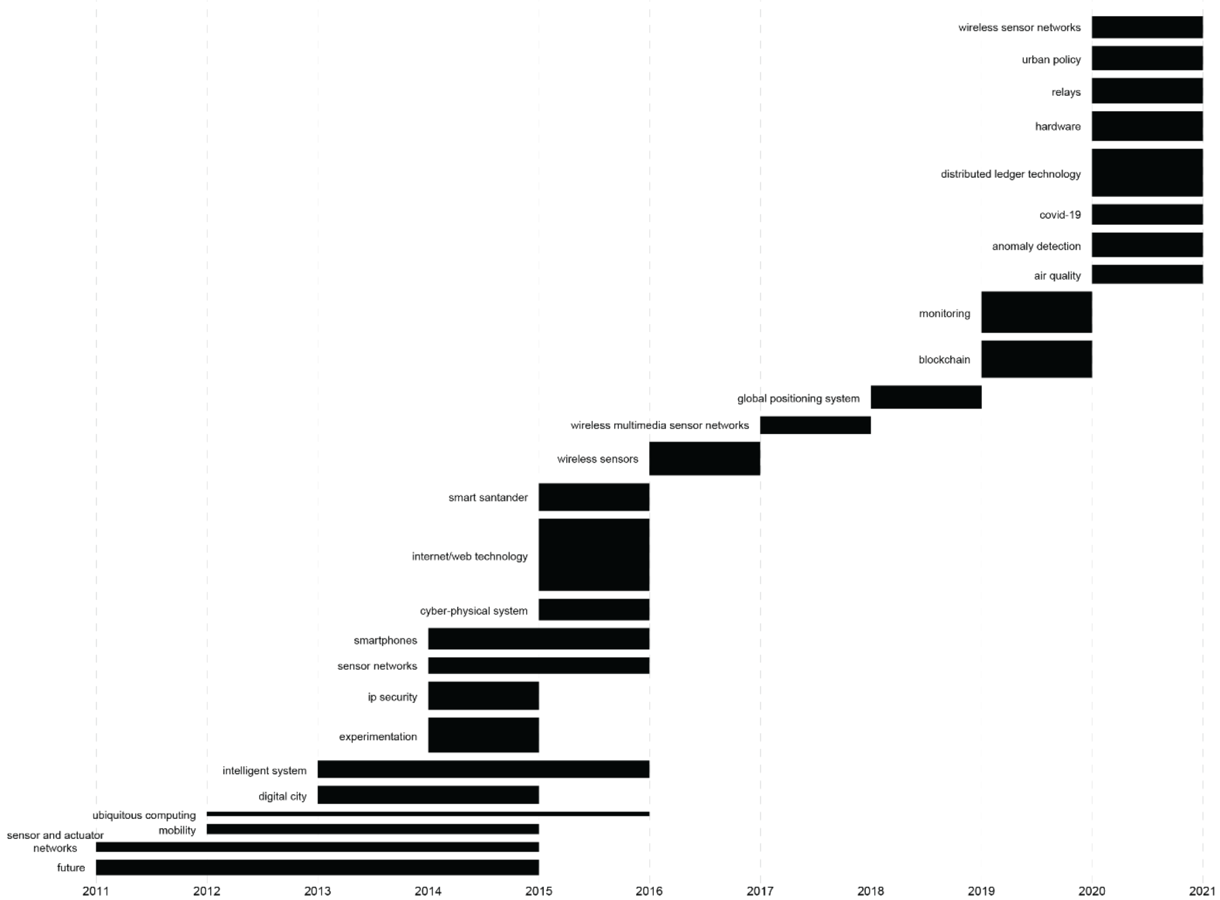
Figure 2. Thematic Evolution of Digitalization in Supply Chains

The literature on the subject was examined in four periods in proportion to the number of publications at specific intervals. In the first period between 2011 and 2015, it is observed that the concepts of a cyber-physical system, cloud, privacy, and wireless sensor networks related to smart cities and the Internet of things came to the fore, and other concepts were concentrated around these concepts. According to these results, it is understood that academic interest in smart cities and the Internet of things turned to infrastructure technologies in the first period. In the second period (2016-2017), it is seen that new concepts have emerged due to technological developments, and the interest in cyber-physical systems and related concepts has increased. The concepts of a cyber-physical system, cloud, and wireless sensor networks, which are among the concepts emphasizing the technological infrastructure in the first period, are related to smart homes and smart grids, cyber-physical system applications in the second period. In addition, the concept of objects gained importance in the literature in this period. When the third period (2018-2019) is examined, it is seen that the concepts of machine learning, security, blockchain, and cloud computing have come to the fore. In addition, the concept of wireless sensor networks has gained importance again. Recently (2020-2021), cloud computing and security concepts have come to the fore. Wireless sensor networks, security, and big data concepts also maintain their importance.

4.4. Burst Detection of Keywords

The burst detection analysis results of the keywords are given in Graph 5. In the first period, the concepts of future, sensor and actuator networks, mobility, ubiquitous computing, digital city, and intelligent system come to the fore. Among these concepts, the concept of ubiquitous computing has been active for the longest time, maintaining its effectiveness from 2012 to 2016. It is seen that the studies carried out in 2015 focused on the concept of internet/web technology at a very high level. In 2020, the concept of distributed ledger technology came to the fore.

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade



Graph 5. Bursts of Keywords

5. Conclusion

Technological development creates significant advantages in social life and changes the understanding of social welfare. However, it also brings with it several difficulties such as cost, know-how, and so on. There is an intense interest in the subject both in practice and in the academic community. This study aims to obtain a general perspective by presenting the available information on the subject. It aims to provide a guide for possible areas that can guide future work. In this context, studies on smart cities and the Internet of things have been examined. According to the results of the analysis, the trend towards the subject is increasing day by day. The most important actors of this trend were Italy, China, USA, Spain, and England. Of these countries, China has the highest number of publications, but Italy has the highest citations. If we consider the citations per publication as a measure of scientific productivity, the ranking will be Italy, USA, UK, Spain, China. This situation can be interpreted as an academic reflection of innovative urban practices in Europe and America.

Although the analysis to identify the relevant universities is similar to the analysis for countries, the results are pretty different. The top three countries in the country ranking are Italy, China, and the USA, while South Korea and Saudi Arabia universities are on the list. This situation reveals that some universities focus more on publications, especially on smart cities. While the USA is at the top of the country rankings, US universities are behind in the university rankings.
One of the elements affecting the visibility, citations, and effect of papers is the quality of academic publications. Additionally, journal articles must also be accounted for when performing bibliometric analysis on a field. Ieee Internet Of Things Journal, Ieee Access, Future Generation Computer Systems: The International Journal of E-Science, Sensors, and Ieee Communications are the most influential IoT and connected technologies in smart cities. Criteria such as

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

impact factor, indices, and H-index score are commonly used when evaluating academic publications. Two measurement methods were used to quantify the journals' contributions: published studies, H-index score, and citations. Though "IEEE Access" ranked second for publications, citation and h-index scores alter with time and activity. IEEE Internet of Things Journal has a higher h-index score and citations than most journals in this field.

Multidimensional scaling was made for the evolution of the literature, which is the primary focus of the study. Five clusters were obtained in the keyword analysis on the evolution of the literature. These clusters are shaped around edge computing concepts, blockchain, energy efficiency, smart grid, and privacy. Multidimensional scaling is a helpful analysis method to demonstrate the impact of IoT and connected technologies on smart cities.

With thematic evolution analysis, it is possible to see both the change and development of the subject. It may be projected that big data, machine learning, security, and wireless sensor networks will see additional development in the coming time because of the wide variety of research topics dedicated to the issues of smart cities and the Internet of Things. Energy efficiency is an idea that will always be critical in intelligent city designs. Furthermore, to successfully develop smart cities, it is needed to process enormous amounts of data with various machine learning techniques and artificial intelligence. Furthermore, as smart cities are networked systems, the system's security and wireless communication technology are vital components.

This study aims to contribute to the literature by creating a map of the Internet of things and connected technologies in smart cities with the results obtained. The bibliometric analysis method used in the research helps obtain the general map in question. Thus, it is thought that the study will give researchers an idea about the whole subject. Studying in this way can help increase knowledge on the subject by identifying key issues, trends, and directions of scientific evolution

.

The methodology applied in the study has some limitations. The most crucial criticism of this methodology is that the analyzed features of the articles (keyword, abstract) are too narrow. Therefore, it may not refer to the actual level of knowledge. With more comprehensive literature reviews, we can obtain more complete results on the subject.

The method applied here also has an advantage. It is not possible to conduct a comprehensive content analysis on the data set in the current study. The bibliometric analysis provides more consistent results with less effort on datasets of this size. In addition, combining both WoS and SCOPUS databases in the study is another vital aspect of the study.

Despite all these limitations, it is thought that the study will contribute to the relevant literature in terms of understanding how technological developments, especially the Internet of things technology, shape smart cities, determining and visualizing the current level of knowledge on the subject, and presenting an academic perspective on the subject.

References

Ahmed, S.H., Rani, S., 2018. A hybrid approach, Smart Street use case and future aspects for Internet of Things in smart cities. Future Generation Computer Systems 79, 941–951.

Alavi, A.H., Jiao, P., Buttlar, W.G., Lajnef, N., 2018. Internet of Things-enabled smart cities: State-of-the-art and future trends. Measurement 129, 589–606.

AlZubi, A.A., Alarifi, A., Al-Maitah, M., Alheyasat, O., 2021. Multi-sensor information fusion for Internet of Things assisted automated guided vehicles in smart city. Sustainable Cities and Society 64, 102539.

Angelidou, M., Psaltoglou, A., Komninos, N., Kakderi, C., Tsarchopoulos, P., Panori, A., 2017. Enhancing sustainable urban development through smart city applications. Journal of Science and Technology Policy Management 9, 146–169.

Anguraj, D.K., Balasubramaniyan, S., Saravana Kumar, E., Vakula Rani, J., Ashwin, M., 2021. Internet of things (IoT)-based unmanned intelligent street light using renewable energy. International Journal of Intelligent Unmanned Systems ahead-of-print.

Aria, M., Cuccurullo, C., 2017. bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics 11, 959–975.

Babar, M., Khattak, A.S., Jan, M.A., Tariq, M.U., 2021. Energy aware smart city management system using data analytics and Internet of Things. Sustainable Energy Technologies and Assessments 44, 100992.

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

Bedi, P., Ponnusamy, M., Ashokkumar, P., Saranya, S., Hariharan, S., 2021. Internet of things oriented elegant parking method for smart cities. Materials Today: Proceedings.

Bibri, S.E., 2018. The IoT for smart sustainable cities of the future: An analytical framework for sensor-based big data applications for environmental sustainability. Sustainable Cities and Society 38, 230–253.

Bogatinoska, D.C., Malekian, R., Trengoska, J., Nyako, W.A., 2016. Advanced sensing and internet of things in smart cities. In: 2016 39th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO). Presented at the 2016 39th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), pp. 632–637.

Bresciani, S., Ferraris, A., Del Giudice, M., 2018. The management of organizational ambidexterity through alliances in a new context of analysis: Internet of Things (IoT) smart city projects. Technological Forecasting and Social Change 136, 331–338.

Chatterjee, S., Kar, A.K., 2017. Effects of successful adoption of information technology enabled services in proposed smart cities of India: From user experience perspective. Journal of Science and Technology Policy Management 9, 189–209.

Cobo, M.J., López-Herrera, A.G., Herrera-Viedma, E., Herrera, F., 2011. An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the Fuzzy Sets Theory field. Journal of Informetrics 5, 146–166.

Gamil, Y., A. Abdullah, M., Abd Rahman, I., Asad, M.M., 2020. Internet of things in construction industry revolution 4.0: Recent trends and challenges in the Malaysian context. Journal of Engineering, Design and Technology 18, 1091–1102.

Gheisari, M., Wang, G., Chen, S., 2020. An Edge Computing-enhanced Internet of Things Framework for Privacy-preserving in Smart City. Computers & Electrical Engineering 81, 106504.

Hoffman, D.L., De Leeuw, J., 1992. Interpreting multiple correspondence analysis as a multidimensional scaling method. Marketing Letters 3, 259–272.

Huang, X., 2020. Multi-node topology location model of smart city based on Internet of Things. Computer Communications 152, 282–295.

Janssen, M., Luthra, S., Mangla, S., Rana, N.P., Dwivedi, Y.K., 2019. Challenges for adopting and implementing IoT in smart cities: An integrated MICMAC-ISM approach. Internet Research 29, 1589–1616.

Jiang, D., Zhang, P., Lv, Z., Song, H., 2016. Energy-Efficient Multi-Constraint Routing Algorithm With Load Balancing for Smart City Applications. IEEE Internet of Things Journal 3, 1437–1447.

Karnouskos, S., Holanda, T.N. de, 2009. Simulation of a Smart Grid City with Software Agents. In: 2009 Third UKSim European Symposium on Computer Modeling and Simulation. Presented at the 2009 Third UKSim European Symposium on Computer Modeling and Simulation, pp. 424–429.

Khajenasiri, I., Estebsari, A., Verhelst, M., Gielen, G., 2017. A Review on Internet of Things Solutions for Intelligent Energy Control in Buildings for Smart City Applications. Energy Procedia, 8th International Conference on Sustainability in Energy and Buildings, SEB-16, 11-13 September 2016, Turin, Italy 111, 770–779.

Kim, L., Portenoy, J.H., West, J.D., Stovel, K.W., 2020. Scientific journals still matter in the era of academic search engines and preprint archives. Journal of the Association for Information Science and Technology 71, 1218–1226.

Kleinberg, J., 2003. Bursty and Hierarchical Structure in Streams. Data Mining and Knowledge Discovery 7, 373–397.

Lin, J., Yu, W., Zhang, N., Yang, X., Zhang, H., Zhao, W., 2017. A Survey on Internet of Things: Architecture, Enabling Technologies, Security and Privacy, and Applications. IEEE Internet of Things Journal 4, 1125–1142.

Liu, K., Bi, Y., Liu, D., 2020. Internet of Things based acquisition system of industrial intelligent bar code for smart city applications. Computer Communications 150, 325–333.

Lytras, M.D., Visvizi, A., Chopdar, P.K., Sarirete, A., Alhalabi, W., 2021. Information Management in Smart Cities: Turning end users' views into multi-item scale development, validation, and policy-making recommendations. International Journal of Information Management 56, 102146.

Ma, Y., Ping, K., Wu, C., Chen, L., Shi, H., Chong, D., 2019. Artificial Intelligence powered Internet of Things and smart public service. Library Hi Tech 38, 165–179.

Macke, J., Casagrande, R.M., Sarate, J.A.R., Silva, K.A., 2018. Smart city and quality of life: Citizens' perception in a Brazilian case study. Journal of Cleaner Production 182, 717–726.

Majeed, U., Khan, L.U., Yaqoob, I., Kazmi, S.M.A., Salah, K., Hong, C.S., 2021. Blockchain for IoT-based smart cities: Recent advances, requirements, and future challenges. Journal of Network and Computer Applications 181, 103007.

Quantrade Journal of Complex Systems in Social Sciences e-ISSN: 2687-5098 Vol 3 (Issue 1) Spring 2021
http://www.dergipark.gov.tr/quantrade

Orsino, A., Araniti, G., Militano, L., Alonso-Zarate, J., Molinaro, A., Iera, A., 2016. Energy Efficient IoT Data Collection in Smart Cities Exploiting D2D Communications. Sensors 16, 836.
Pinochet, L.H.C., Romani, G.F., de Souza, C.A., Rodríguez-Abitia, G., 2018. Intention to live in a smart city based on its characteristics in the perception by the young public. Revista de Gestão 26, 73–92.
Plageras, A.P., Psannis, K.E., Stergiou, C., Wang, H., Gupta, B.B., 2018. Efficient IoT-based sensor BIG Data collection–processing and analysis in smart buildings. Future Generation Computer Systems 82, 349–357.
Prakash, A., 2019. Smart Cities Mission in India: some definitions and considerations. Smart and Sustainable Built Environment 8, 322–337.
Qureshi, K.N., Rana, S.S., Ahmed, A., Jeon, G., 2020. A novel and secure attacks detection framework for smart cities industrial internet of things. Sustainable Cities and Society 61, 102343.
Raghuvanshi, A., Singh, U.K., 2020. Internet of Things for smart cities- security issues and challenges. Materials Today: Proceedings.
Rathore, M.M., Ahmad, A., Paul, A., Rho, S., 2016. Urban planning and building smart cities based on the Internet of Things using Big Data analytics. Computer Networks, Industrial Technologies and Applications for the Internet of Things 101, 63–80.
Roy, J., 2001. Rethinking communities: Aligning technology & governance. LAC Carling Government's Review 6–11.
Sestino, A., Prete, M.I., Piper, L., Guido, G., 2020. Internet of Things and Big Data as enablers for business digitalization strategies. Technovation 98, 102173.
Shafiq, M., Tian, Z., Sun, Y., Du, X., Guizani, M., 2020. Selection of effective machine learning algorithm and Bot-IoT attacks traffic identification for internet of things in smart city. Future Generation Computer Systems 107, 433–442.
Sharma, M., Joshi, S., Kannan, D., Govindan, K., Singh, R., Purohit, H.C., 2020. Internet of Things (IoT) adoption barriers of smart cities' waste management: An Indian context. Journal of Cleaner Production 270, 122047.
Singh, S., Sharma, P.K., Yoon, B., Shojafar, M., Cho, G.H., Ra, I.-H., 2020. Convergence of blockchain and artificial intelligence in IoT network for the sustainable smart city. Sustainable Cities and Society 63, 102364.
Teng, H., Dong, M., Liu, Y., Tian, W., Liu, X., 2021. A low-cost physical location discovery scheme for large-scale Internet of Things in smart city through joint use of vehicles and UAVs. Future Generation Computer Systems 118, 310–326.
Teng, H., Liu, Y., Liu, A., Xiong, N.N., Cai, Z., Wang, T., Liu, X., 2019. A novel code data dissemination scheme for Internet of Things through mobile vehicle of smart cities. Future Generation Computer Systems 94, 351–367.
Yeh, H., 2017. The effects of successful ICT-based smart city services: From citizens' perspectives. Government Information Quarterly 34, 556–565.
Yu, W., Liang, F., He, X., Hatcher, W.G., Lu, C., Lin, J., Yang, X., 2018. A Survey on the Edge Computing for the Internet of Things. IEEE Access 6, 6900–6919.
Zhang, C., 2020. Design and application of fog computing and Internet of Things service platform for smart city. Future Generation Computer Systems 112, 630–640.
Zhang, W., Wu, Z., Han, G., Feng, Y., Shu, L., 2020. LDC: A lightweight dada consensus algorithm based on the blockchain for the industrial Internet of Things for smart city applications. Future Generation Computer Systems 108, 574–582.