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ANALYSIS OF THE STUDIES CONDUCTED ON THE INTERNET OF THINGS IN LOGISTICS BY SCIENTIFIC MAPPING METHOD

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Abstract

This research aims to examine the concept of "Internet of Things in Logistics" from a bibliometric point of view and evaluate the studies conducted on this subject. For this purpose, the keyword "Internet of Things" was scanned from the studies conducted between 1998-2023 in the Web of Science database on 24.07.2023. The studies included in the SCI-EXPANDED, CPCI-S, SSCI, ESCI, CPCI-SSH, BKCI-S, BKCI-SSH indexes of the Web of Science core collection formed as a result of the limitation in the research were evaluated. In terms of disciplines, the vast majority of studies are limited to areas such as Computer Science, Telecommunications, Business Economics, Transportation, Logistics. When these fields were selected, 2451 data were obtained, and when articles, early appearance and book chapters were evaluated, 1380 results were reached. From the results obtained, 261 data were obtained when the Internet of Things was scanned in the logistics sector. For the scientific mapping method, the VOSviewer mapping program was used. The obtained data were analyzed according to the parameters of the most cited document, source, author, institution, country and keywords. This study is an important resource for studying research trends in Internet of things applications in the field of logistics.

Keywords: Internet of Things, Logistics, Web of Science, VOSviewer, Bibliometric
JEL Classification: M10, N70, 014

LOJİSTİKTE NESNELERİN İNTERNETİ KONUSUNDA YAPILAN ÇALIŞMALARIN BİLİMSEL HARİTALAMA YÖNTEMİ İLE ANALİZİ

Öz

Bu araştırma, "Lojistikte Nesnelerin İnterneti" kavramını bibliyometrik açıdan incelemeyi ve bu konuda yapılan çalışmaları değerlendirmeyi amaçlamaktadır. Bu amaçla, 24.07.2023 tarihinde Web of Science veri tabanında 1998-2023 yılları arasında yapılmış çalışmalardan "Nesnelerin İnterneti" anahtar kelime taranmıştır. Araştırmadaki sınırlandırma sonucunda oluşan Web of Science çekirdek koleksiyonu SCI-EXPANDED, CPCI-S, SSCI, ESCI, CPCI-SSH, BKCI-S, BKCI-SSH indekslerinde yer alan çalışmalar değerlendirmeye alınmıştır. Disiplinler açısından çalışmaların büyük çoğunluğu, Computer Science, Telecommunications, Business Economics, Transportation, Logistics gibi alanlarla sınırlandırılmıştır. Bu alanlar seçildiğinde 2451 veri elde edilmiş, makaleler, erken görünüm ve kitap bölümleri değerlendirildiğinde ise, 1380 sonuca ulaşılmıştır. Çıkan sonuçlardan lojistik sektöründe nesnelerin interneti tarandığında 261 veri elde edilmiştir. Bilimsel haritalama yöntemi için VOSviewer haritalama programından yararlanılmıştır. Elde edilen veriler, en çok atıf alan doküman, kaynak, yazar, kurum, ülke ve anahtar kelimeler parametrelerine göre analiz edilmiştir. Bu çalışma, lojistik alanında nesnelerin interneti uygulamalarında araştırma eğilimlerini incelemek için önemli bir kaynak niteliğindedir.

Anahtar Kelimeler: Nesnelerin İnterneti, Lojistik, Web of Science, VOSviewer, Bibliyometrik
JEL Sınıflaması: M10, N70, 014

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1. Introduction

The Internet has brought an important dimension to the activities of humanity such as working, living, and learning. The fact that billions of people around the world connect to the internet with billions of devices and as a result exchange data with billions of interconnected objects shows that the communication capacity and speed of the internet has reached an extraordinary level (Turak, 2015). With the developing technologies, it has been ensured that all kinds of devices and objects are connected. The concept of the Internet of Things (IoT) has become a concept that is increasing in popularity day by day with the development of modern wireless communication technologies. Internet of Things technology enables two different smart devices to communicate. Today, this system, which finds its place in many areas from urban planning to small household appliances, offers a wide range of benefits for both people and companies. It provides the transformation of the economy and societies in areas such as logistics, health, transportation, production, and tourism (Delgosta et al., 2021:1).

The importance of the internet of things is increasing day by day. The Internet of Things is predicted to be among the technologies that will become widespread within 5-10 years. Although the internet of things is used in a wide variety of areas, it is known that it will add speed, time and traceability to logistics processes. When the literature is examined, it is seen that research on this subject is limited. There is limited research in the literature on the Internet of Things in logistics businesses. In this study, studies in logistics were examined in the Web of science database and current trends were revealed. In the research, only articles published on the web of science between 1998 and 2023 were considered and the Vosviewer mapping model was used. This method was preferred because VOSviewer involves creating maps based on network, bibliometric and text data, visualizing and detailing the studies in the literature.

IoT is a new wave of digital transformation that brings together billions of devices that enable real-time sensing, data collection, and sharing that can be communicated over the internet. Relevant devices are technology that detects the physical world, sends and retrieves observation data, and allows us to act with these data (Fizza et al., 2021:1). In our age, there are radical changes in software and hardware technology. With the use of information technologies, great benefits have been achieved in almost every field (Qi and Tao, 2018: 3585).

Relative to the report of Statista Online Services in 2021, the number of IoT devices worldwide was 8.74 billion in 2020, and this number is expected to exceed 23,4 billion in 2030. IoT vehicles are used in electricity, water, logistics, business, marketing, production, and many

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similar areas, and their use is increasing day by day. It is estimated that it will reach 8 billion in 2030 (Statista, 2021). From IoT technologies, people, companies, and governments perform various activities by exchanging data. Intelligently working wired and wireless networks increase the usability of information obtained from non-traditional calculations over the Internet. In this way, businesses will also develop along with the devices (El Khodr et al., 2019: 47).

IoT technology has been used in many branches of science and much research has been done. Some of these studies, human life in design and production (Barrios et al., 2022; Chen et al., 2023b), aviation (Ning et al., 2012; Möller and Vakilzadian, 2014; Korchagin et al., 2019; Chen et al., 2023a), sustainability (Palco et al., 2022; Ehsanifar et al., 2023), supply chain and logistics (Ivankova et al., 2020; Yao et al., 2022) bioengineering (Nath et al., 2021; Wang and Mu, 2022). We see areas such as etc. The common aspect of the studies is to increase efficiency and productivity, use smart systems, increase speed, spread electronic works, increase customer satisfaction and loyalty, and customer safety (Zhang et al., 2013; Dinesh Reddy and Gangadharan, 2016; Dharfizi, 2018; Ghouchani et al., 2020; Ivankova et al., 2020; Kurnia et al., 2020).

Businesses operating in various sectors benefit from IoT technologies to gain competitive power and increase efficiency. Thus, they become competitive by adapting to digital transformation. The logistics sector is also one of the areas where the highest possible technology is used. The advancement of advanced technologies makes significant contributions to the development of logistics. The benefits of IoT such as better forecasting, early warning of problems, development of decision support systems, increasing efficiency, ensuring security and full transmission of data are seen (Janakiraman, 2018; Lee et al., 2021; Chen et al., 2022; Qu et al., 2023; Memarzadeh et al., 2023; Shankar and Sahana, 2023; Xie et al., 2021).

Logistics systems with complex and dynamic features include the management of assets, finance, services, and information flows in supply chain management. The use of data in logistics systems and increasing its volume are realized with the Internet of Things. IoT is a new concept and one of the nine technologies considered fundamental in Industry 4.0 (Jagtap et al., 2021: 176). IoT technologies are systems that guide synchronized decision-making, taking into account the current state of the system, which allows the collection of data that provides the connection between factors such as equipment, materials, jobs, and employees in logistics processes (Agostino et al., 2020: 387). If it is desired to automate, simplify, and make

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the processes in the logistics sector efficient, IoT technologies should be used (Sergi et al., 2021: 21).

IoT technology helps logistics service providers track, route, and deliver goods to customers. In logistics processes equipped with IoT, slow deliveries in traditional logistics activities are reduced to a few days, thanks to the automatic and controlled movement of products from the sender to the receiver. Thus, logistics service providers gain a competitive advantage against rival companies (Golpira et al., 2021: 8). This study was planned to emphasize the importance of the internet of things, which is among the most important technologies in logistics, to determine current trends and to guide future studies. In the introduction section, general information about the Internet of Things and its usage areas are mentioned. In the second chapter, an extensive literature review was made and the usage areas of the Internet of Things in logistics were explained. In the third section, research on the subject and Vosviewer analysis are mentioned. The research method was mentioned. In the fourth chapter, the findings were examined and the locations were illustrated using the mapping method. In the fifth chapter, results and discussion are given and suggestions are made.

2. Review of Previous Literature

2.1. Efficient Applications with The Internet of Things in Logistics

Using this approach in various fields of activity such as the use of the Internet of Things in logistics, transportation management, warehouse management, handling, packaging, distribution, logistics information processing systems, and demand forecasting can offer a competitive advantage and productivity enhancement opportunities for businesses.

2.1.2. Transportation Management: Logisticians serving in the field of transportation management obtain various data with the Internet of Things technology. With this data, managers can ensure that the time to deliver the goods is estimated and the planning is done correctly (Singh and Roy, 2020: 310). Today, transport vehicles not only carry goods but also generate large amounts of data such as location, engine status, environmental conditions, vehicle data, driver behavior, and safety. This data is uploaded to a cloud-based data system, feeding other technologies and transportation processes, supporting routing, fleet management, driver performance, shipment tracking, and quality. In this way, information sharing will flow smoothly in the transportation system and a cycle will be formed (Taliaferro et al., 2019: 3-4).

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2.1.3. Warehouse Management: The Internet of Things ensures that the products in the warehouse always know where they are (Van Geest et al., 2021: 4). Since both products, shelves, and operators are monitored, it provides instant monitoring as it provides decision support to the management in the warehouse management system. In cases where there is no visibility of the products, product loss, and unknown storage locations cause various problems. A real-time monitoring system with the Internet of Things increases the status and traceability of the warehouse (Zhang et al., 2021: 3). These; it simplifies inventory management, eliminates frustration, allocates warehouse resources efficiently, improves warehouse efficiency and helps reduce human errors (Ding et al., 2021: 330; Zhang et al., 2012: 716).

2.1.4. Handling: The Internet of Things, which allows handling activities within the enterprise without employee intervention or with very light interventions, is an important technology in the more efficient and economical use of personnel and equipment. The logistics base structure managed by the employees becomes autonomous. When the Internet of Things is adopted, human errors are minimized (Buntak et al., 2019: 249; Rey et al., 2021: 585).

2.1.5. Packaging: Protection and communication features, which are the main functions of packaging, have become more comprehensive with nanoscale materials developed recently. The Internet of Things is changing traditional packaging methods, modern package formats are emerging with newly developed alternatives, and an industrial tool for store and customer communication is emerging (Lydekaityte and Tambo, 2020: 390). For customers, labeled packages provide more visibility in the transportation of products, and they are also informed about the location of the package, the estimated time of arrival, and the delivery address.

2.1.6. Distribution: Distribution is the most important element in the logistics industry. The use of the Internet of Things enables businesses to solve their problems to a large extent by reflecting digital developments on distribution channels. The increase in the scale of a logistics company, the change in the production volume, the increase in the product types, and the large size of the inventory assets cause the planning in the distribution centers not to be done at the desired level. Therefore, the usage areas are low and problems arise. Optimizing the transport, transfer, and distribution process can be achieved by modernizing the IoT (Zhang et al., 2021: 175).

2.1.7. Logistics Information Processing Systems: These are software systems that meet the planning or operational needs of the companies in the supply chain and can work in integration with other related systems inside and/or outside the company. Logistics computing

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systems are technologies that reorganize business processes, control and integrate the information of logistics activities, help sharing and effective use of information inside and outside, and increase economic benefit and competitiveness (Yu, 2019: 1756). It is thanks to the advanced sensing capabilities of the Internet of Things to monitor and control the locations and status of products remotely in logistics activities and to produce solutions to reduce costs (Verdouw et al., 2018: 755). IoT improves operational efficiency by phasing out old supply chain patterns. There are no interruptions in communication due to the adoption of real-time digital interaction in analog techniques (telephone, paper, and fax). Shipping costs, resource allocation, and the entire shipping process have been improved.

2.1.8. Demand Forecasting: Forecast plays an important role in strategic management decision-making activities in all sectors. While making logistics planning, the focus is on the estimation method and future goals. Short, medium, and long-term forecasts are needed in planning. In short-term plans, in planning the number of trucks, lorries, or delivery vehicles that will depart daily, it is necessary to estimate according to the demand, distance, and amount of the load. Medium-term plans are generally used to determine the raw material needs, to recruit temporary personnel, and to determine the source to be used in the purchase of machinery and equipment. Long-term plans, on the other hand, are the plans to be made for the future, such as entering and exiting the target market related to environmental factors. It makes forecasts related to demand forecasting, production process design, service process design, location and distribution design, resource utilization, sales planning, and operational planning. In the Internet of Things, demand forecasting with smart technologies, user behavior, current market trends, customer requests and preferences, consumers' reasons for purchasing and how the purchased products are used can be provided efficiently.

2.1.9. Optimization: IoT systems provide highly automated optimization in the logistics industry. Logistics 4.0 connected logistics network level provides optimization of outbound and inbound logistics through smart software in software and databases. Because these software exchange information about systems, they can improve logistics scheduling by connecting the global positioning system and mapping systems to enterprise resource planning systems. With this use, it supports issues such as making efficient decisions, increasing transportation capacity, optimizing transportation in cities, automatic exception reports, product orientation, and transparency (Anitha et al., 2021:1). Warehouse space optimization is also used in product layouts and architectural solution areas. Automatic storage systems using the Internet of Things support decision-making mechanisms (Song et al., 2021: 4262).

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In recent years, it can be seen that many bibliometric studies have been conducted in both national and international literature. Publications on bibliometric research are constantly increasing, especially in the international literature. In national publications, publications on bibliometric research techniques are few. Among bibliometric research, vosviwer bibliometric mapping is a preferred technique because it shows the relationship between scientific fields, specialties, documents and authors.

3. Methods and Materials

This study, which examines the research on the Internet of Things in logistics, aims to define the literature gaps and guide future research. For this purpose, the studies were examined by bibliographic analysis method and illustrated by mapping. Today, based on various existing research on the Internet of Things, the subject of the Internet of Things (IoT) in the logistics industry is considered an important issue, and various studies are being carried out. The use of bibliometric analysis methods in scientific evaluations is very useful and offers significant advantages over other research evaluations. Bibliometric analyses can be used to create quantitative and numerical indicators and can be considered as an interdisciplinary research measure (Ismail et al., 2012).

When the literature is examined, it is seen that bibliometric studies have been carried out on various subjects on this IoT subject (Guo et al., (2020); for example, Lim, M. K. et al., (2020), in their studies, of vehicle sharing (private vehicles) and IoT (internet of things) in terms of vehicle energy efficiency). It proposes a green distribution method with a combination of and emphasizes improving the energy efficiency of social tools and providing more convenient distribution services. It has also been explained that an IoT architecture has been created, consisting of a customer data layer, information collection layer, cloud optimization layer, and delivery task execution layer. Wang, J. X. et al., (2020) proposed an IoT-based intelligent logistics dispatch system that provides dynamic coordination between customers, order-picking robots, and cloud technology.

Emphasis was placed on demonstrating the ability to efficiently coordinate dispatch operations and outperform traditional dispatch methodologies through IoT technology to increase customer satisfaction. Zhao, Z. H. et al., (2020) conducted smart parking research in their work and explained that with the development of the Internet of Things (IoT), vehicle mergers and separations should be made for industrial hazardous chemical vehicles, tractors, and trailers to fulfill their logistics tasks. They stated that the real-time dynamic indoor location information

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of both tractors and trailers is of great importance among users. They emphasized the importance of using IoT technology, as excessive time and human effort spent locating vehicles will cause delays in transportation and irregular parking will exacerbate congestion in the parking garage. Song, Y. X et al., (2021), in their study, explained that the Internet of Things will solve complex relationships with the help of various analysis technologies in smart logistics.

As a result of their research, they stated that IoT will help the development of logistics and that the countries will gain competitiveness of the companies, thus providing development in the economy. Cuenca, R. I et al., according to the (2020) global economic scenario, adapting to the elasticity of demand will be realized thanks to the Internet of Things in industrial logistics. The importance of IoT is explained with the application of the PROKNOW-C method in industrial logistics. Yang, (2022) emphasizes the replacement of traditional methods aimed at the development and implementation of an internet-based system to increase the efficiency of the e-commerce logistics system. Companies around the world are starting to implement IoT technologies to provide the most efficient business possible. The importance of applying this technology has been particularly evident in improving logistics processes. Their study explained the importance of IoT applications in processes such as supply chain management, that is, control of the transportation and storage of goods and materials.

3.1. Relevance of Bibliometric Analysis

Bibliometric analysis tools are used in different literature. In the study, the VOSviewer program was preferred because of its strengths in terms of functionality. It seems to be an important program that facilitates researchers to explore evolutions, relationships, ships, and new concepts in the literature. In addition, since it provides visualization, mapping, and multidimensional analysis, it allows for in-depth examination of data sets.

The use of the Web of Science database in research is an essential factor in giving research confidence for a variety of analyses, including bibliometric analyses. Thanks to various control mechanisms, it covers qualified and reliable studies in terms of publication ethics.

In the study, Documents on Citation, Sources on Citation, Authors on Citation, Co-citation of Co-authors, Organizations on Citation, Countries on Citation, and Keywords on Citation analyses were used in the VOSviewer program to illustrate mapping based on bibliographic data. Strong links on authors, documents, sources, institutions, and countries with strong bibliographic links are discussed.

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On 24.07.2023, 2451 results were reached by selecting "All Fields" in Web of Science with the word "Internet of Things". The words Intelligent Logistics, Logistics Information, Smart Supply Chain, and Supply Chain were chosen as keywords. 1382 articles, 944 papers, 134 review articles, 69 early view studies, and 26 book chapters were identified. In the review, most of the studies in terms of disciplines, Computer Science (633), Telecommunications (309), Business Economics (151), Transportation (42), etc. Subjects other than Business, Telecommunications, and Logistics are not included in the data set. When only articles from different disciplines were selected between 1998-2023, the result decreased to 1380. When years, keywords, authors, organizations, countries, and research areas were selected, the number of data was found to be 261. The studies included in the Web of Science core collection SCI-EXPANDED, CPCI-S, SSCI, ESCI, CPCI-SSH, BKCI-S, BKCI-SSH indexes, which were formed as a result of the limitation in the research, were evaluated. The obtained data were analyzed as documents, sources, authors, authors' links, institutions, countries, and keywords. The data in the Web of Science database were analyzed in VOSviewer by taking the criteria. When researched as literature trends, it was seen that keywords related to the subject were searched in 1998 and the data were entered into the Web of Science database.

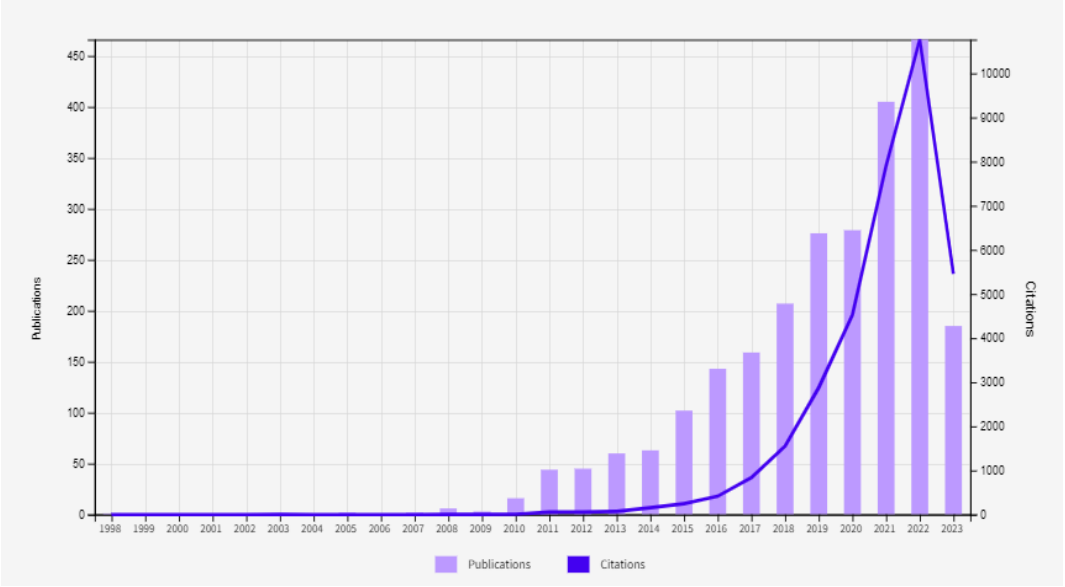

Figure 1. The Yearly Trend of Published Articles

As seen in Figure 1, as a result of the limitation made in the subject category, it is seen that the studies on the Internet of Things in logistics started mainly in 2010 and the highest number of

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publications was in 2022. The number of publications started to increase significantly in 2019 and 2020. It reached the highest level in 2021 and 2022.

4. Internet of Things According to Web of Science Database VOSviewer Mapping Technique

This research is between 1998-2023. Web of science also includes publications on the internet of things in logistics. Publications published in other databases were not included in the research. Scanning was done with the keywords internet of things, logistics companies, mapping method, VOSviewer**.**

In this section, the findings obtained under the title of Internet of Things are given. Documents, Sources, Authors, Co-citation of Co-authors, Organizations, Countries, and Keywords mapping based on Citation data regarding the concept of "Internet of Things" discussed within the scope of the study.

4.1. Citation of Documents Analysis

The list of documents on the Internet of Things, their works, attributions, and links are shown in Table 1.

Table 1. Citation of Documents

Documents	Years	Titles	Citations	Links
Lopes De. Sousa Jabbour et al.	(2018)	Industry 4.0 and the circular economy: A proposed research agenda and original roadmap for sustainable operations.	514	96
Mehmood et al.	(2017a)	Internet-of-Things-Based Smart Cities: Recent Advances and Challenges	328	35
Qiu et al.	(2015)	Edge Computing in Industrial Internet of Things: Architecture, Advances and Challenges	189	58
Zhong et al.	(2017)	Intelligent Manufacturing in the Context of Industry 4.0: A Review	176	78
Zhang	(2018)	An 'Internet of Things' enabled dynamic optimization method for smart vehicles and logistics tasks	156	93
Wang	(2022a)	Optimal Design of International Trade Logistics Based on Internet of Things Technology	126	73
Frederico	(2020)	Organizational learning and Industry 4.0: findings from a systematic literature review and research agenda	123	3
Sinha	(2019)	Impact of Internet of Things (IoT) in disaster management: a task-technology fit perspective.	119	174
Ganzha	(2017)	Semantic interoperability in the Internet of Things: An overview from the INTER-IoT perspective	99	25

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Hasan	(2019)	Resilient supplier selection in logistics 4.0 with heterogeneous information	94	13
Hopkins	(2018)	Big Data Analytics and IoT in logistics: a case study	84	1
Fortino	(2018)	Evaluating Critical Security Issues of the IoT World: Present and Future Challenges	79	1

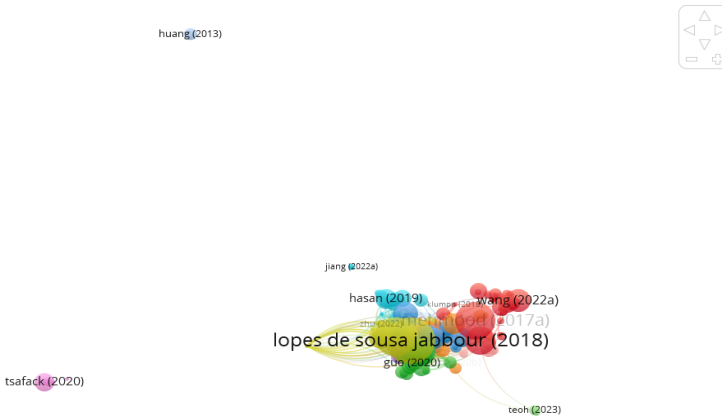

Figure 2. Mapping of Citation of Documents Contribute to IoT Research (Network Visualization)

While performing the analysis, the minimum number of documents was 5 the minimum number of citations received by a document was chosen as 2 and the number of citation links was calculated for each of the 261 documents with the highest link. It is seen that there is a complex and intense relationship between these documents that resulted on the map. Among these documents, more than one cluster, in different colors was formed. Among the documents shown on this map, the documents with the highest number of links; are Lopes de Sousa Jabbour et al., (2018), Mehmood et al., (2017a), and Qiu (2015).

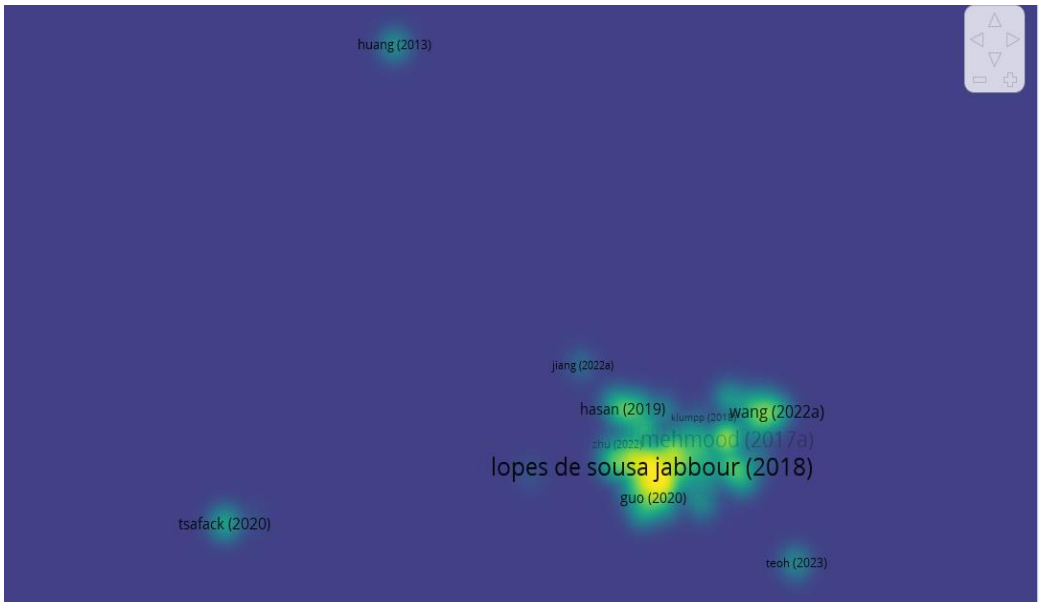

Figure 3. Mapping of Citation of Documents Contribute to IoT Research (Density Visualization)

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The network map in Figure 2 and the density map in Figure 3 are depicted according to the relationship strength between the documents in which studies on the Internet of Things are published. Documents above the yellow color intensity in the table show the most linked authors.

4.2. Citation Sources Analysis

The minimum number of sources of publications was 5 and the minimum number of citations received by source 2 was selected, and the relationship between 13 sources of 121 sources was determined. For each of the 121 sources, the total connection strength of citations with other sources was calculated. The network map was created by selecting the source with the highest total connection power. It is possible to say that the relationship between sources is intense. Table 2 is formed by ranking the journals with the highest number of citations. International Journal of Production Research (738), Computers and Industrial Engineering (392), and Ieee Access (370) were determined.

Table 2. Citation of Sources

Sources	Documents	Citations	Total Link Strenght
International Journal of Production Research	10	738	16
Computers and Industrial Engineering	11	392	14
Ieee Access	23	370	6
Ieee Transactions on Industrial Informatics	5	368	8
Ieee Internet of Things Journal	14	367	8
International Journal of Production Economics	5	235	7
International Journal of Logistics Management	5	226	4
Industrial Management and Data Systems	6	224	17
Future Generation Computer Systems	8	108	4
International Journal of Logistics	6	84	9
Internet of Things	5	83	0
Electronic	6	38	1
Computer Communications	5	33	2

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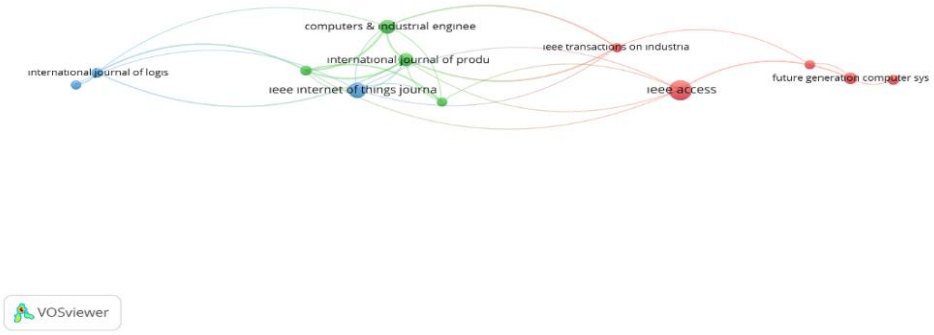

Figure 4. Mapping of Citation of Sources Contribute to IoT Research (Network Visualization)

The network map in Figure 4 and the density map in Figure 5 are depicted according to the strength of the relationship between the sources where studies on the Internet of Things are published.

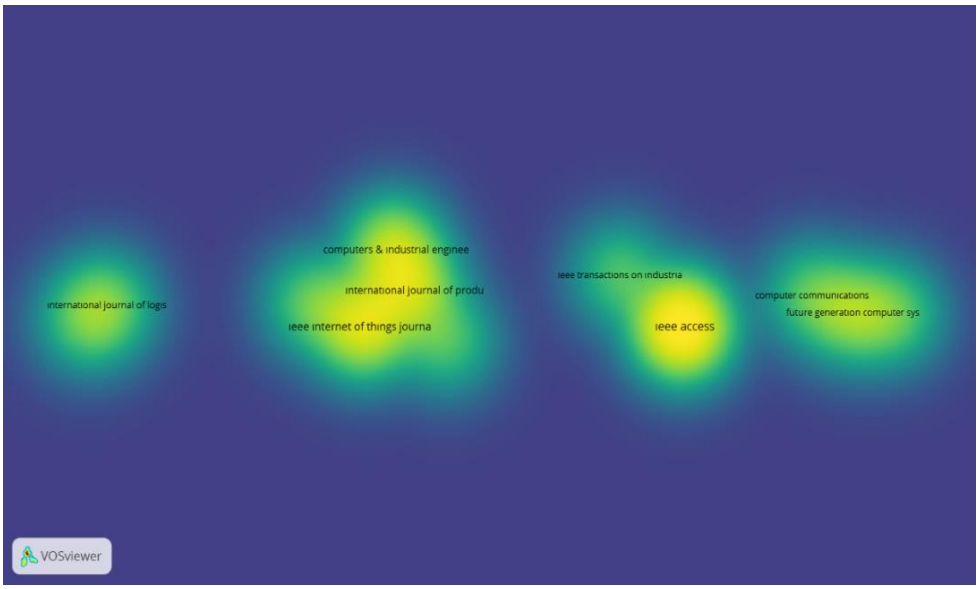

Figure 5. Mapping of Citation of Sources Contribute to IoT Research (Density Visualization)

Above is the network map of the sources where the studies on the Internet of Things are published. The sources with the highest total connection strength were selected and a map was created. It seems that there is a relationship between many sources on the map and this relationship is quite evident. The number of citations was taken into account while making the analysis.

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4.3. Citation of Authors' Analysis

To determine the citation networks, a network map of at least 5 publications and at least 2 citation criteria and author citation analysis was created. In the analysis made on 21 units that are seen to be connected, a total of 3 clusters, 41 connections, and the total connection strength were determined as 150. The number of works of the authors included in the visualization, their citation information, and the total link strength between the authors are given in the table below and the ranking is made according to the number of citations. The most cited authors are; Huang, George Q, who received 865 citations with 24 articles, Zhong, Ray, Y, who received 436 citations with 10 articles, and Liu, Fagui, who received 269 citations with 31 articles.

Table 3. Citation of Authors

Authors	Documents	Citations	Total Link Strength	Authors	Documents	Citations	Total Link Strength
Huang, George, Q.	24	865	77	Zhang, Mengdi	9	127	21
Zhong, Ray, Y.	10	436	33	Li, Ming	5	124	13
Liu, Fagui	31	269	57	Wu, Wei	7	98	20
Lim, Ming, K	5	207	0	Pratap, Saurabh	5	86	12
Zhao, Zhiheng.	12	178	30	Ding, Yi	5	63	0
Guo, Dagiang.	6	153	19	Fang, Weiwei	5	63	0
Qu, Ting	6	152	29	Wang, Bin	10	49	33
Shen, Leidi	6	144	15	Jiang, Jun	10	37	45
De Albuquerque, Victor H, C.	6	133	0	Tang, Quan	7	33	40
Kong, Xiang, T, R	6	127	31	Ng, Wing W.Y	5	18	24
				Zhong, Guoxiang	5	12	31

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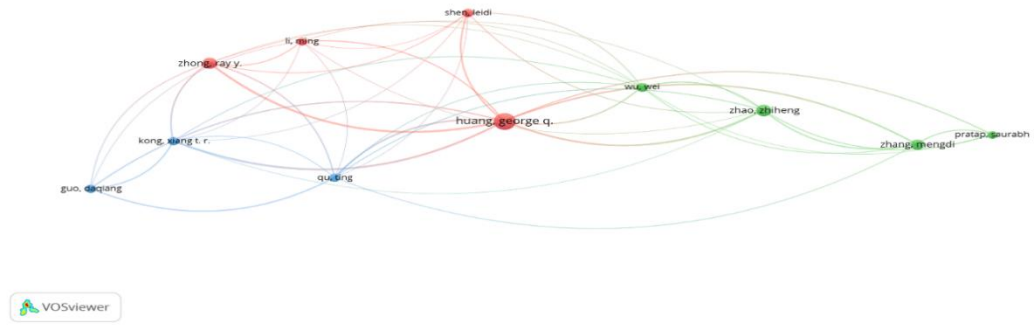

Figure 6. Mapping of Citation of Authors Contribute to IoT Research (Network Visualization)

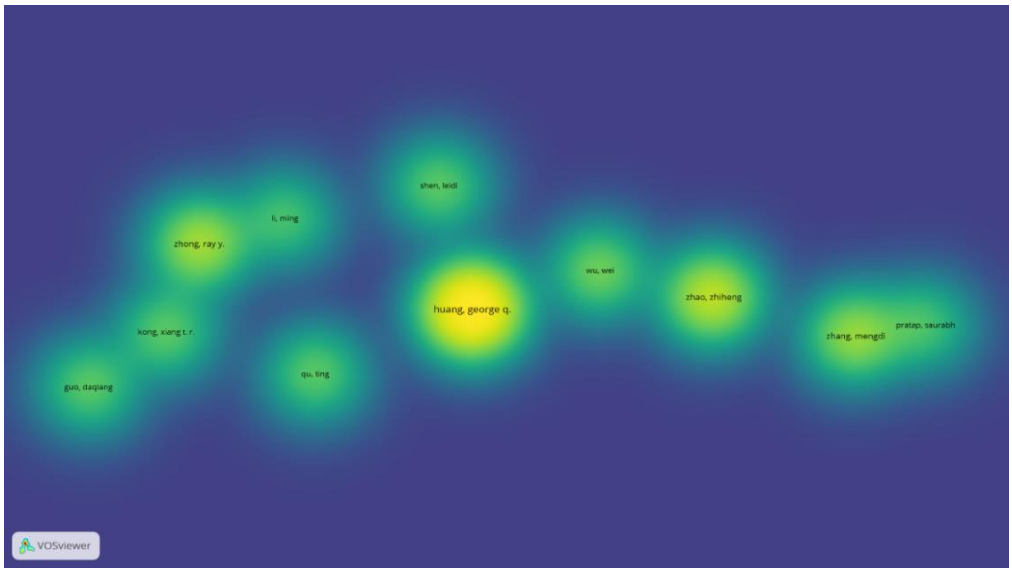

Figure 7. Mapping of Citation of Authors Contribute to IoT Research (Density Visualization)

The citations of the authors who published the studies on the Internet of Things are depicted in Figure 6 and the density map is in Figure 7.

4.4. Co-citation of Co-authors Analysis

According to the co-authorship links showing the cooperation between the authors, the most connected and collaborating authors were identified, and a table and network map were made by determining at least 5 publications and at least 2 citation criteria. According to the analysis made among the names with the highest connection, the names and total connections combined in a single cluster were revealed. Different sources cited in a publication are called co-citations. It is seen that 17 authors collaborated with a minimum of 2 citations. Most commonly cited authors Zhang, Y. F, (61) Link strength 323, Zhong, R. Y, (44) connection strength was determined as 212 and Qu T, (29) connection strength was determined as 165.

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Table 4. Co-Citation of Co-Authors

Authors	Citations	Total Link Strength	Authors	Citations	Total Link Strength
Zhang, Y.F.	61	323	Ivanov, D	22	59
Zhong, R.Y.	44	212	Sarker, Ih.	22	0
Qu, T	29	165	Wang, Y.	21	31
Tao, F.	37	150			
Xu, Ld,	29	103	Fortino, G.	21	24
Hofmann, E.	24	47	Huang, Gq.	20	118
Atzori, L	23	69	Zhao, Z. H.	20	77
Verdouw,C.N.	23	42	Kong, X.T.R.	20	74
Qiu, XIvanov, D.	22	112	Gubbi, J.	20	52

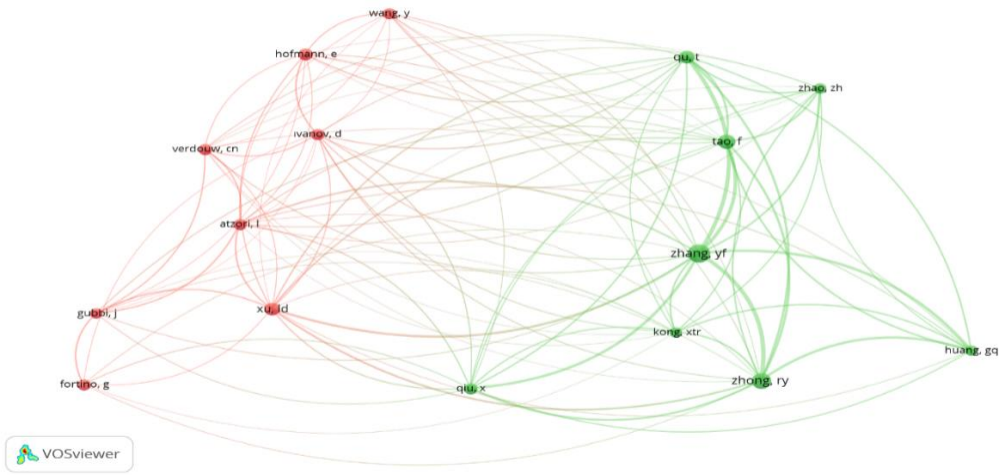

Figure 8. Mapping of Co-Citation of Co-Authors Contribute to IoT Research (Network Visualization)

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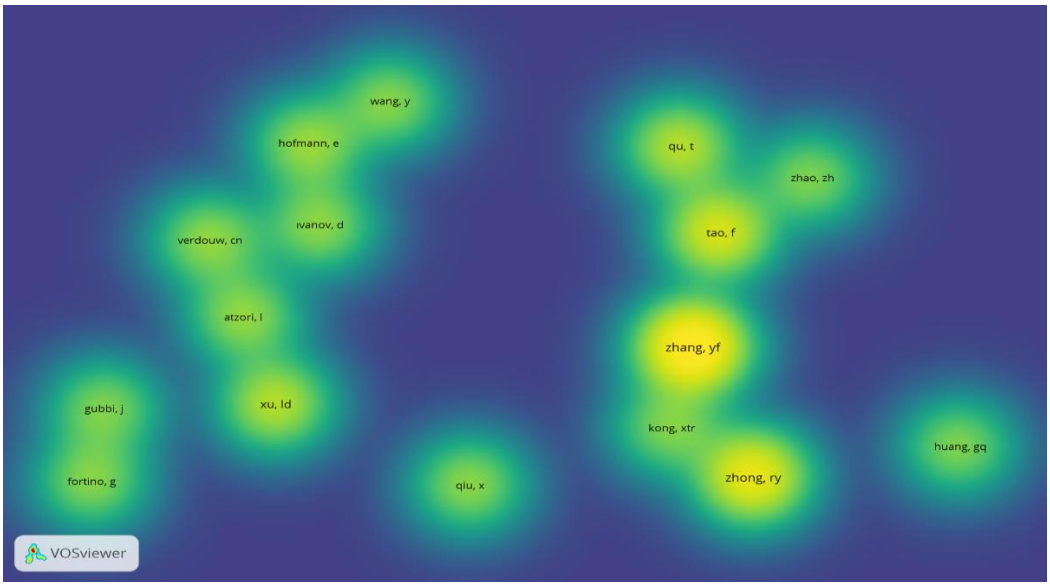

Figure 9. Mapping of Co-Citation of Co-Authors Contribute to IoT Research (Density Visualization)

The network map in Figure 8 and the density map in Figure 9 are depicted according to the strength of the relationship between the authors who published the studies on the Internet of Things.

4.5. Citation of Organizations Analysis

In this section, an analysis has been made of the institutions of the authors who carry out the most collaborative work on the Internet of Things in logistics. To create a network map of inter-institutional citations, results were obtained by publishing a minimum of 5 works by an institution and choosing a minimum of 2 as the number of citations. Considering the connections of 20 institutions among 431 organizations in line with the citation scope criteria, the following table was created. All visualizations are arranged according to the number of citations for the institutions of the collaborating authors. Table 5 below contains information on 20 institutions, the number of studies, and the number of citations. University of Hong Kong 30 works, 1053 citations; Hong-Kong Polytech University 10 works, 522 citations; University of Derby 5 works 521 cited; King Saud University 7 works, 492 citations; Shenzhen University 8 works have been cited 430 times.

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Table 5. Citation of Organizations

Organizations	Documents	Citations	Organizations	Documents	Citations
University, Hong-Kong	30	1053	Beijing Wuzi University	12	235
Hong- Kong Polytech University	10	522	Vellore İnst. Technology	5	220
University Derby	5	521	Nanjing uni. Posts and Telecommunications	14	194
King Saud University			Asia University		
Shenzhen University	7	492	Swinburne Uni. Technology	6	185
Dalian University Technology	8	430	Wuhan Uni. Technology	5	176
Chongqing University	5	335	Peng Cheng Lab.	5	150
South China University			Minist Education Nirma University	7	136
Jinan University	6	312	China Med. University	6	114
	33	271	Beijing Jiaotong University	5	95
	9	254		6	89
				6	64

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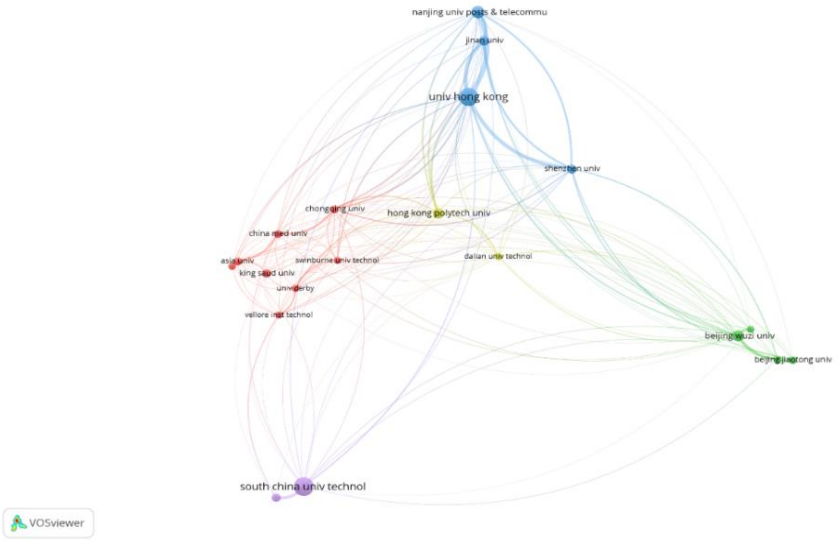

Figure 10. Mapping of Citation of Organizations Contribute to IoT Research (Network Visualization)

The network map of the important institutions that produce publications on the Internet of Things in logistics is given above. To obtain the results, the minimum number of documents of an institution is 5 and the minimum number of citations is 2. 20 of 431 institutions meet this link. The map was created by choosing the institutions with the highest connection power. Universities seem to have done the most work among institutions. It is possible to talk about the existence of an intense and complex relationship between these institutions. Among the institutions shown on the map, the institutions with the highest number of citations are; Institutions such as University Hong Kong (1053); Hong Kong Polytech University (522); University Derby (521); King Saud University (492); Shenzhen University (430); Dalian University Technology (335) are in the first place.

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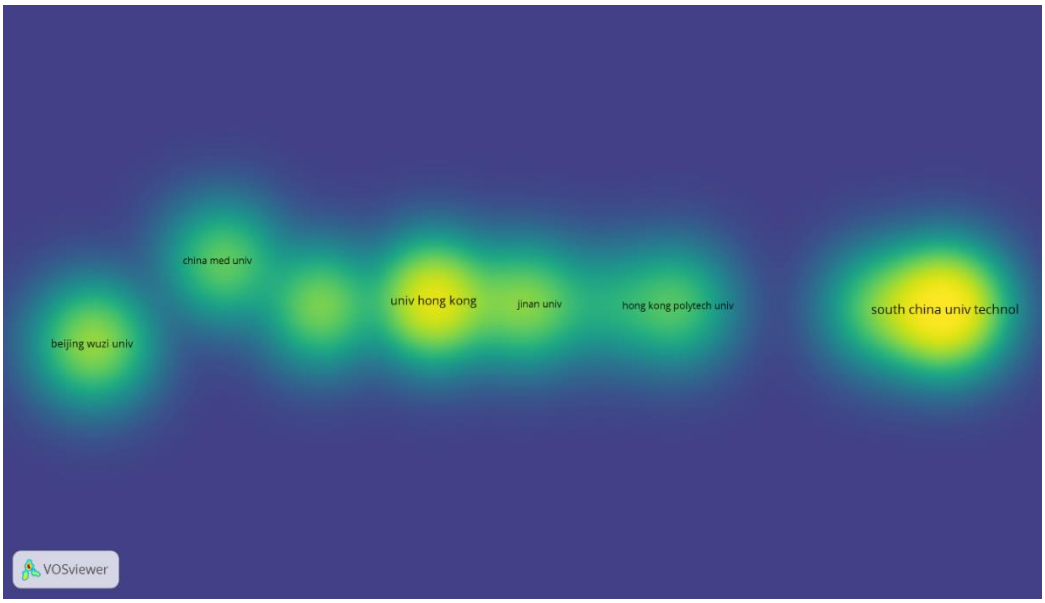

Figure 11. Mapping of Citation of Organizations Contribute to IoT Research (Density Visualization)

The network map in Figure 10 and the density map in Figure 11 are depicted according to the strength of the relationship between the institutions where studies on the Internet of Things are published. Universities, which are among the institutions that broadcast on the Internet of Things, occupy a key position in the yellow color intensity.

4.6. Citation of Countries Analysis

To create a network map of the citations received by the publications according to their country of origin, analysis was made based on the citation numbers over 21 observation units from 62 countries, which are related to each other, within the scope of the criteria of publishing at least 5 works by a country and receiving 2 citations. According to Table 6, when we look at the citations among the countries in the IoT research, it is seen that the continents of Asia, Europe, and America are mostly cited. China, England, India, and Brazil are among the countries that make the most references to each other on the Internet of Things. The country with the highest number of works and citations is the People's Republic of China 131 works, citation 3461; England, 26 works, 1121 citations; India 52 works, 1024 citations; Brazil 13 works, 839 citations; USA 31 works 757 citations.

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Table 6. Citation of Countries

Countries	Documents	Citations	Total Link Strength	Countries	Documents	Citations	Total Link Strength
Peoples R. China	131	3461	81	South Korea	14	362	17
England	26	1121	43	Spain	8	281	2
India	52	1024	35	Netherlands	6	226	5
Brazil	13	839	12	United Arab Emirates	7	167	11
USA	31	757	32	Canada	10	157	5
France	8	704	9	Sweden	7	131	13
Australia	19	694	19	Egypt	7	131	10
				Italy	6	126	10
Saudi Arabia	20	559	18	Pakistan	13	99	10
Germany	12	539	13	Portugal	5	41	2
Malaysia	8	493	13				
Taiwan	14	479	42				

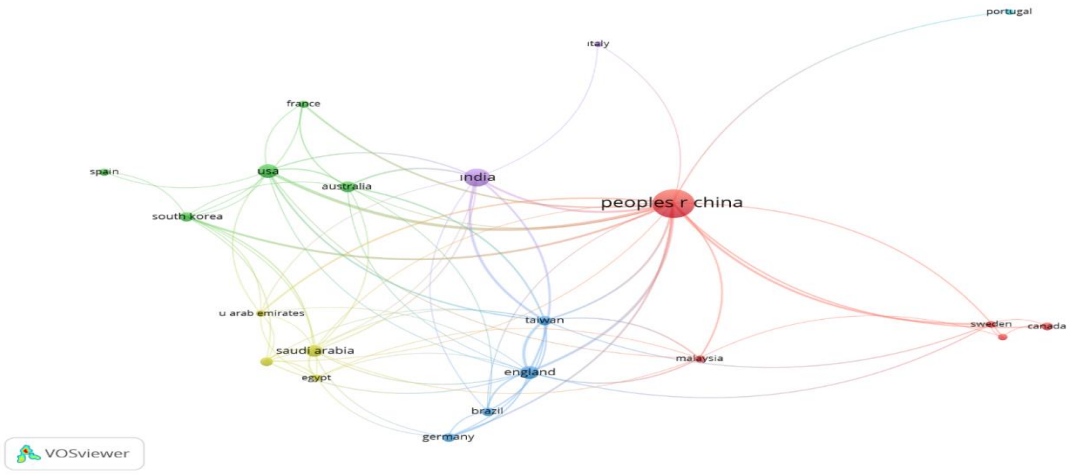

Figure 12. Mapping of Citation of Countries Contribute to IoT Research (Network Visualization)

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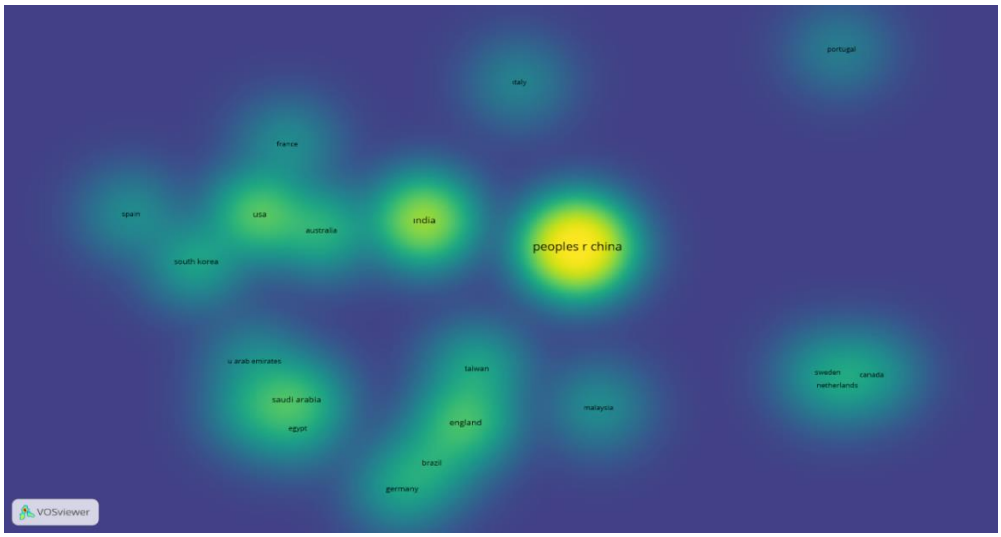

Figure 13. Mapping of Citation of Countries Contribute to IoT Research (Density Visualization)

The network map in Figure 12 and the density map in Figure 13 are according to the strength of the relationship between the countries where the studies on the Internet of Things are published.

4.7. Co-occurrence of All Keyword Analysis

When looking at the most frequently used keywords in publications related to the Internet of Things, the expressions 'Internet of Things' with 123 repetitions, 'Blockchain' with 20 repetitions and 'Logistics' with 18 repetitions are leading. The strongest expressions in terms of total connection strength were 'Internet of Things' 175. As a result of the analysis conducted with 35 observation units that have been seen at least 2 times and have a relationship between them, a total of 3 clusters, 77 connections, and 198 total connection strengths have been determined.

Table 7. Co-occurrence of All Keywords

Keywords	Occurrences	Total Link Strength	Keywords	Occurrences	Total Link Strength
Internet of Things	136	108	Cyber-Physical Systems	7	15
Blockchain	20	41	Edge Computing	7	13

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Logistics	18	33	Real-Time Systems	7	12
Cloud Computing	17	33	Rfid	7	7
Supply Chain Management	21	46	Fog Computing	6	19
Security			Logistic Regression	6	14
Machine Learning	13	31	Sustainability	6	12
Digital Twin	13	19	Deep Learning	6	10
Industry 4			Circular Economy	6	7
Industrial	12	11	Ethereum	6	7
Industry 4.0	11	26	Wireless Sensor Networks	5	14
Optimization			Cybersecurity		
Smart Contracts	8	13	Supply Chain	5	9
Artificial İntelligence	8	12	Production	5	9
Covid 19	7	23		5	7
Monitoring	7	20		5	6
	7	20		5	5
	7	18			

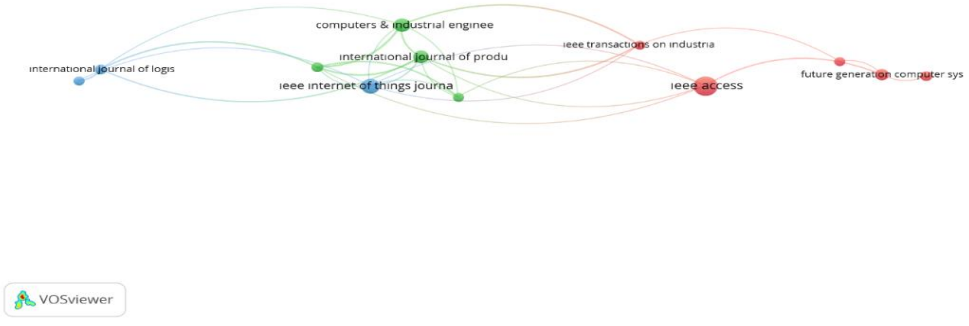

Figure 14. Mapping of Co-Occurrence of All Keywords Contribute to IoT Research (Network Visualization)

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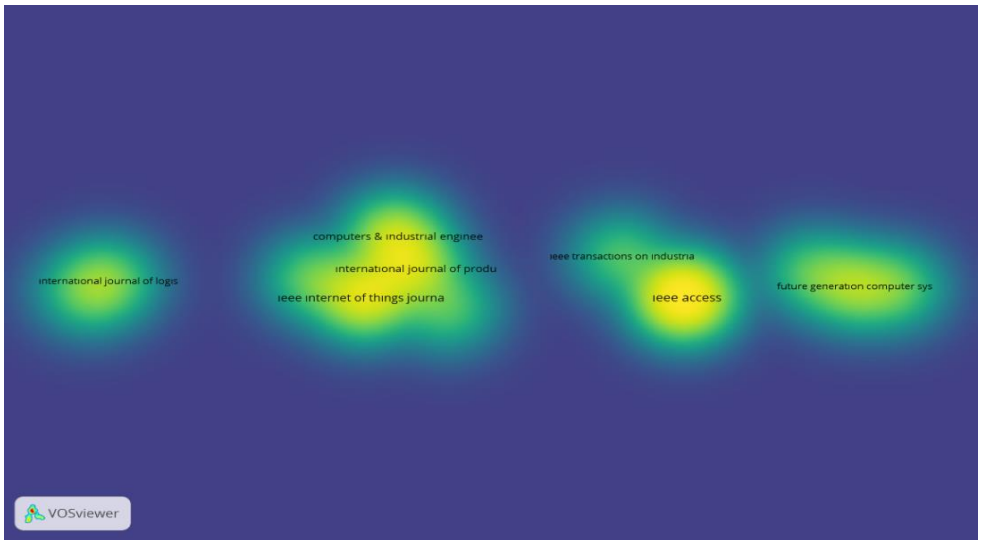

Figure 15. Mapping of Co-Occurrence of All Keywords Contribute to IoT Research (Density Visualization)

Network map in Figure 14 and density map in Figure 15 of the most frequently used keywords in studies on the Internet of Things. It is seen that these keywords are trend topics in the field of the Internet of Things in logistics.

5. Discussion and Conclusion

The Internet of Things is defined as a technology that changes the rules, with the potential to transform the way companies work, especially in the logistics industry. With this technology, devices and objects are connected, helping to collect and exchange data over the internet. Logistics companies increase their efficiency and productivity by optimizing their decision-making capabilities with real-time data. With these technologies, they will update their shipments, inventory levels, and the status of their products at the right time, shortening delivery times and gaining customer satisfaction.

In this study, the works on the internet of things in logistics have been examined and the importance of the subject has been pointed out. In the literature, it is thought that attention should be drawn to the fact that the subject is a new concept and offers suggestions for the future. In the literature, there are various studies on the Internet of Things in logistics, Milic et al., (2023) emphasized that IoT technologies are prominent in improving logistics processes. They explained with examples that technologies such as NB-IoT and 5G should be researched and that these technologies should be adapted to the logistics industry with smart solutions. Ding et al., (2021) with their bibliometric analysis based on publications between 2008 and 2019, revealed the main technologies and effects of IoT-based smart logistics research and applications, and their industrial and geographical distributions. Wu et al., (2022) proposed a

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system architecture that uses the industrial Internet of Things and digital twin technologies to provide seamless cyber-physical synchronization, spatiotemporal traceability, and visibility for product logistics in the workshop. They also conducted a real-life case study at a world-leading computer manufacturer's factory to demonstrate the feasibility and practicality of the proposed systems and methods by developing hardware and software. Qiuxia and Yujie, (2022) examined the application of the Internet of Things in the development of international trade and economic and industrial growth through the data analysis method. Trachtman, (2019) explains the problem of cybersecurity-based concerns regarding investments in manufacturing or distribution facilities for trading IoT products, analyzes applicable international law that would limit national cybersecurity-based import or investment restrictions, and evaluates the availability of security. Wang, (2022), examining the optimization design of international trade logistics based on internet technology, proposed an Rfıd method in which it is possible to master a journey in the truly international trade logistics process. Jiang et al., (2022) with the rapid development of environmental intelligence in the Internet of Things (IoT), many data streams are generated from sensing devices in smart scenarios. Anomalous behavior may occur due to deployment issues of IoT devices and the complexity of the system, resulting in unstable data categories. They proposed a dynamic ensemble algorithm to address this imbalance problem. This research is the examination of the research of the logistics companies on the "Web of Science" site on the Internet of Things, using the scientific mapping method.

As a result of the search for "All Fields" with the keywords "Internet of Things in Logistics", 261 studies were found to be analyzed between the years 1998-2023. The studies were analyzed according to documents, sources, authors, institutions, countries, and keyword parameters. The data is illustrated using the visual mapping technique. The visual network analysis of the study was made with the VOSviewer program, which provides functional convenience and allows multidimensional analysis. When the maps are examined as a result of the analysis, it is seen that the authors who carry out the most collaborative work on the Internet of Things; "Huang, George, Q, Zhong, Ray, Y, Zhao Zhiheng, and Zhang, Mengdi, where the authors' institutions with the most collaborative work are “University Hong-Kong; Hong Kong Polytech University; University Derby; King Saud University; It has been determined that the countries of the authors who have done a lot of collaborative work are concentrated around “Peoples R. China; England; India; Brazil; USA”. Common word analysis results; the most repeated words are “Internet of Things; Internet of Things (IoT); Blockchain; Logistics; It has shown that it is Cloud Computing. As a result of the citation analysis, the most cited studies in the field of the

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Internet of Things in logistics were found to be “Lopes De. Sousa Jabbour et al., (2018); Mehmood et al., (2017a); and Qiu et al., (2015); It is seen that Zhong et al., (2017) concentrated around his work in the specified years. When the journals with at least 2 studies and at least 5 citations in the field of IoT in logistics are examined, the most influential journals are the International Journal of Production Research, Computers and Industrial Engineering, and Ieee Access.

Among the map approaches based on bibliographic data, the option create a map based on bibliographic data was used. There are different numbers of analysis units under each of these options, and two levels of data mapping were obtained by selecting each analysis unit separately. These are two levels; network visualization is listed as density visualization. These results are expected to help researchers in future studies in the field of IoT in logistics. The limitation of the study is the use of only the Web of Science. In future research, bibliometric analysis can be done using different keywords from different databases. However, this study was carried out using the VOSviewer package program. Comparative analyses can also be made using different package programs other than the VOSviewer package program. As a result, it is recommended to focus on the most cited authors, journals, institutions, and countries to conduct research.

Using internet of things technology in logistics processes provides benefits in terms of speed, time and traceability. It increases customer satisfaction and loyalty by increasing effectiveness and efficiency. Provides competitive advantage. It is known that the use of internet of things technology in sectors other than logistics will provide superiority to businesses. They can increase their performance by investing in such technologies in all sectors. When we look at the publications, we see that there are fewer publications in Türkiye. Internet of things technology is a current technology and its use will increase in the future and the studies carried out will increase.

The realization of the research by obtaining data from the Web of Science database, from other databases (Scobus, TR Index, etc.) not to be taken advantage of it constitutes the limitations of the study. In other researches, bibliometric by using different keywords from different databases analyses can be performed. In addition, with the exception of the VOSviewer program Bibexcel, Pajek, ıt may also be recommended to use programs such as Bibliometrix and SciMAT. In Review the author, journal, institution, country and keywords that have received the most citations it has been investigated. Cooperation between authors in future deceptions and an

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examination can also be made on the connections. These results, in the field of Internet of things, it is expected to guide researchers in the studies to be conducted.

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DOI: 10.14514/beykozad.1360651

References

Agostino, Í. R. S., Ristow, C., Frazzon, E. M., & Taboada Rodriguez, C. M. (2020). Perspectives on the application of ınternet of things in logistics. *Paper presented at the Dynamics in Logistics, Cham.* https://doi.org/10.1007/978-3-030-44783-0_37

Anitha, K., Palaksha Reddy, K., Krishnamoorthy, N., & Jaiswal, S. (2021). IoT enables the supply chain visibility and connectivity and optimization of performance. *Materials Today: Proceedings*. https://doi.org/10.1016/j.matpr.2020.12.343

Atzori, L., Iera, A., & Morabito. G. (2010). The Internet of things: a survey, Comput. Netw. 54 (15) (2010) 2787–2805. *Elsevier.* https://doi.org/10.1016/j.comnet.2010.05.010

Barrios, P., Danjou, C., & Eynard, B. (2022). Literature review and methodological framework for integration of IoT and PLM in the manufacturing industry, *Computers in Industry,* Vol. 140, 103688. https://doi.org/10.1016/j.compind.2022.103688

Buntak, K., Kovačić, M., & Mutavdžija, M. (2019). Internet of Things and smart warehouses as the future of logistics. *Tehnički glasnik,* 13(3), 248-253. https://doi.org/10.31803/tg-20190215200430

Chen, Q., Li, M., Xu, G., & Huang, G.Q. (2023a). Cyber-physical spare parts intralogistics system for aviation MRO, *Advanced Engineering Informatics,* Vol. 56, 101919. https://doi.org/10.1016/j.aei.2023.101919

Chen, Y., Wang, X., Liu, Z., Cui, J., Osmani, M., & Demian, P. (2023b). Exploring building information modeling (BIM) and Internet of things (IoT) integration for sustainable building, *Buildings,* Vol. 13 No. 2, 288. https://doi.org/10.3390/buildings13020288

Chen, N., Sun, Y., Wang, Z., & Peng, C. (2022). Improved LS-SVM method for flight data fitting of civil aircraft flying at a high plateau, *Electronics,* Vol. 11 No. 10, 1558. https://doi.org/10.3390/electronics11101558

Cuenca, RI., Tokars, R.L., Warnecke, V, C., Deschamps, F., & Valle, P. D. (2020). Systematic literature review on the use of the Internet of Things in industrial logistics. *P:151-160. Proceedings of the 27th ISTE Internatıonal Conference on Transdisciplinary Engineering,* July 1-July 10,2020.

Delgosha, M. S., Hajiheydari, N., & Talafidaryani, M. (2021). Discovering IoT implications in business and management: A computational thematic analysis. *Technovation,* 102236. https://doi.org/10.1016/j.technovation.2021.102236

Dharfizi, A. D. H. (2018). The energy sector and the Internet of Things – sustainable consumption and enhanced security through industrial revolution 4.0, *Journal of International Studies,* Vol. 14, pp. 99-117. DOI: https://doi.org/10.32890/jis2018.14.7

Dineshreddy, V., & Gangadharan, G. R. (2016). Towards an "Internet of Things" framework for the financial services sector, *2016 3rd International Conference on Recent Advances in Information Technology (RAIT),* Dhanbad, pp. 177-181. DOI: 10.1109/RAIT.2016.7507897

Ding, Y., Jin, M., Li, S., & Feng, D. (2021). Smart logistics based on the internet of things technology: an overview. *International Journal of Logistics Research and Applications,* 24(4), 323-345. https://doi.org/10.1080/13675567.2020.1757053

Gönderim tarihi: 14.09.2023 Kabul tarihi: 03.05.2024
DOI: 10.14514/beykozad.1360651

Ehsanifar, M., Dekamini, F., Spulbar, C., Birau, R., Khazaei, M., & B_arb_acioru, I.C. (2023). A sustainable pattern of waste management and energy efficiency in smart homes using the internet of things (IoT), *Sustainability,* Vol. 15 No. 6, 5081. https://doi.org/10.3390/su15065081

Elkhodr, M., Alsinglawi, B., & Alshehri, M. (2019). A privacy risk assessment for the Internet of Things in healthcare, *Applications of Intelligent Technologies in Healthcare, Springer International Publishing*, pp. 47-54. https://doi.org/10.1007/978-3-319-96139-2_5

Fizza, K., Banerjee, A., Mitra, K., Jayaraman, P., P. Ranjan., R. Patel, P., & Georgakopoulos, D. (2021). QoE in IoT: a vision, survey and future directions. *Discover Internet of Things,* 1, 4. https://doi.org/10.1007/s43926-021-00006-7

Fortino, G., Savaglio C., & Spezzano, G. (2020). Internet of Things as system of systems: A review of methodologies, frameworks, platforms, and tools. *IEEE Transactions on Systems, Man, and Cybernetics: Systems.* Volume: 51, Issue: 1.

Frederico G. F. (2019). Supply chain 4.0: concepts, maturity, and research agenda. *Supply Chain Management An International Journal*. 25(2):262-282. *https://doi.org/10.1108/BPMJ-12-2016-0248*

Ganzha, M., Paprzycki, M., Pawlowski, W., Szmeja. P., & Wasielewska, K. (2018). Towards semantic ınteroperability between ınternet of things platforms. *https://www.researchgate.net/publication/318510298*

Ghouchani, B.E., Jodaki, S., Joudaki, M., Balali, A., & Rajabion, L. (2020). A model for examining the role of the Internet of Things in the development of e-business, *VINE Journal of Information and Knowledge Management Systems,* Vol. 50 No. 1, pp. 20-33. https://doi.org/10.1108/VJIKMS-04-2019-0058

Golpîra, H., Khan, S. A. R., & Safaeipour, S. (2021). A review of logistics Internet-of-Things: Current trends and scope for future research. *Journal of Industrial Information Integration,* 22, 100194. https://doi.org/10.1016/j.jii.2020.100194

Gubbi,J., Rao, S. A., Ngo, T., Mendis, P., & Palaniswami, M. (2016). Internet of Things for structural health monitoring. *CRC Press Taylor &Francis Group Boca Raton London New York.* P:89-121.

Guo, H.-f., Xu, C.-y., Zhang, R., Shi, J.-c., Qu, T., Li, C.-d., Cai, Y.-g., Luo, X.-f. & He, Z.-h. (2020). Bibliometric analysis of Internet of Things based on CiteSpace, in Chien, (Eds), *IE&EM, Springer, Singapore.*

Guo, D., Li, M., Lyu, Z., Kang, K., Wu, W., Zhong, R. Y., & Huang, G.Q. (2021). Synchroperation in industry 4.0 manufacturing. *International Journal of Production Economics,* 238, 108171. https://doi.org/10.1016/j.ijpe.2021.108171

Harish, AR., Liu, X., Li, M., Zhong, RY., & Huang, G. Q. (2023). Blockchain-enabled digital assets tokenization for cyber-physical traceability in E-commerce logistics financing. *Association for Computing Machinery.* https://doi.org/10.1016/j.compind.2023.103956

Hasan, W. K. A., Alraddad, A., Ashour, A., Ran, Y., Alkelsh, M. A., & Ajele, R. A. M. (2019). Design and implementation of smart transformer based on IoT. International Conference on Computing, Electronics & Communications Engineering, 16-21

Hofmann, E. (2005). Supply chain finance: Some conceptual ınsights. *Logistic Management*, 203-214.

Hopkins J., & Hawking. P. (2018). Big data analytics and IoT in logistics: a case study, Int. J. *Logistics. Management.* 29 (2). 575–591. https://doi.org/10.1108/IJLM-05-2017-0109

Hossain, Md. S., Rahman, M., Sarker, Md. T., Haque, Md. E., & Jahid, A. (2019). A smart IoT-based system for monitoring and controlling the sub-station equipment. *Internet of Things*, 7, 100085. https://doi.org/10.1016/j.iot.2019.100085

Ismail. R., Farhadi. M., & Fooladi M. (2012). Information and communication technology use and economic growth, *Plos One Collecıon Psychology.* https://doi.org/10.1371/journal.pone.0048903

Ivankova, G. V., Mochalina, E. P., & Goncharova, N. L., (2020). Internet of Things (IoT) in logistics, *IOP Conference Series: Materials Science and Engineering,* Vol. 940, 012033 doi:10.1088/1757-899X/940/1/012033.

Jagtap, S., Duong, L., Trollman, H., Bader, F., Garcia-Garcia, G., Skouteris, G., & Rahimifard, S. (2021). Chapter 5 - IoT technologies in the food supply chain. In C. M. Galanakis (Ed.), *Food Technology Disruptions (ss. 175-211): Academic Press.*

Janakiraman, V. M. (2018). Explaining aviation safety incidents using deep temporal multiple instance learning, *Proceedings of the 24th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, Association for Computing Machinery,* pp. 406-415. https://doi.org/10.1145/3219819.3219871

Jiang, J., Liu, F. G., Liu, Y. H., Tang, Q., Wang, B., Zhong, G. X., & Wang, W. Z. (2022). A dynamic ensemble algorithm for anomaly detection in IoT imbalanced data streams. *Computer Communications.* Volume: 194, Pp:250-257. https://doi.org/10.1016/j.comcom.2022.07.034

Jiang, J., Liu, F., Wing W. Y. Ng., Tang, Q., Wang, W., & Pham, Q, V. (2022). Dynamic ıncremental ensemble fuzzy classifier for data streams in green Internet of Things. *IEEE Transactıons On Green Communıcatıons And Networkıng,* Vol. 6, No. 3. DOI: 10.1109/TGCN.2022.3151716

Kai Lin., Chensi Li., Giancarlo, F., & Joel J.P.C Rodrigues. (2018). Vehicle Route Selection Based on Game Evolution in Social Internet of Vehicles. IEEE Internet Of Thıngs Journal, Vol. 5, No. 4. DOI: 10.1109/JIOT.2018.2844215

Korchagin, A., Deniskina, A., & Fateeva, I. (2019). Lean and energy-efficient production based on Internet of things (IoT) in the aviation industry, *E3S Web Conference,* Vol. 110, 02124. https://doi.org/10.1051/e3sconf/201911002124

Kong, X, T, R., Clyde Z. L., Zhe C., Fan X., Bing X., Xulu L., & Zhao, Y. (2021). A blockchain- and IoT-based smart product-service system for the sustainability of prefabricated housing construction. *Elsevıer, Journal of Cleaner Production.* Volume 286, 125391. https://doi.org/10.1016/j.jclepro.2020.125391

Kurnia, R., Mulyanti, B., & Widiaty, I. (2020). Internet of Things application in mechanical learning in automotive engineering, IOP Conference Series: Materials Science and Engineering, Vol. 830, 042098. doi:10.1088/1757-899X/830/4/042098

Lee, H., Puranik, T.G., & Mavris, D.N. (2021). Deep spatio-temporal neural networks for risk prediction and decision support in aviation operations, *Journal of Computing and*

Information Science in Engineering, Vol. 21 No. 4, 042098. https://doi.org/10.1115/1.4049992

Li, M. (2022). Operation twins: production-intralogistics synchronization in Industry 4.0. *July 2022International Journal of Production Research.* 61(7):1-19. https://doi.org/10.1080/00207543.2022.2098874

Lim, M. K., Muhammad Shoaib,, Ming K. Lim., & Chao Wang. (2020). An integrated framework to prioritize blockchain-based supply chain success factors Industrial Management & Data Systems *WWW.emerald.com/insight/0263-5577.* doi/10.1108/IMDS-04-2020-0194/full/XXX/full/html

Liu, Fagui., Jiang, J., Wing. W.Y.N. g., Tang, Quan., Wang. W., & Pham. QV. (2022). Dynamic ıncremental ensemble fuzzy classifier for data streams in green Internet of Things. *Ieee. Ieee Transactıons On Green Communıcatıons And Networkıng*, Vol. 6, No. 3. DOI: 10.1109/TGCN.2022.3151716

Lopes De Sousa Jabbour, A. B., Jabbour, C. J. C., Godınho Fılho, M., & Roubaud, D. (2018). Industry 4.0 and the circular economy: a proposed research agenda and original roadmap for sustainable operations. *Annals Of Operations Research.*270:273–286 https://doi.org/10.1007/s10479-018-2772-8

Lydekaityte, J., & Tambo, T. (2020). Smart packaging: definitions, models, and packaging as an intermediator between digital and physical product management. *The International Review of Retail, Distribution and Consumer Research*, 30(4), 377-410. https://doi.org/10.1080/09593969.2020.1724555

Mehmood, I., Ullah, A., Muhammad, K., Deng, D., Meng, W., Al-Turjman, F. Sajjad, M., & Albuquerque, V.H.C. (2019). Efficient image recognition and retrieval on IoT-assisted energy-constrained platforms from big data repositories. *IEEE Internet of Things Journal*. DOI: 10.1109/JIOT.2019.2896151

Memarzadeh, M., Matthews, B., Templin, T., Rohani, A.S. & Weckler, D. (2023). Semi-supervised active learning for anomaly detection in aviation, *Journal of Aerospace Information Systems*, Vol. 20 No. 4, pp. 181-194. https://doi.org/10.2514/1.I011083

Milic, D.C., Dujmenović, I., & Peko, M. (2023). An approach to the application of the ınternet of things in logistics. *Tehnıckı Glasnık/Technıcal Journal*. Volume,17, 1(2023), 134-140. https://doi.org/10.31803/tg-20220609190233

Möller D. P.F., & Vakilzadian, H. (2014). Ubiquitous networks: Power line communication and Internet of things in smart home environments. *IEEE International Conference on Electro/Information Technology*. DOI: 10.1109/EIT.2014.6871832

Nath, D., Kallepalli, S., Rao, L. T., Dubey, S.K., Javed, A., & Goel, S. (2021). Microfluidic paper microbial fuel cell powered by Shewanella putrefaciens in IoT cloud framework, *International Journal of Hydrogen Energy*, Vol. 46 No. 4, pp. 3230-3239. https://doi.org/10.1016/j.ijhydene.2020.04.294

Ning, H., Hu, S., He, W., Xu, Q., Liu, H., & W., C. (2012). NID-based internet of things and its application in airport aviation risk management, Chinese Journal of Electronics, Vol. 21 No. 2, pp. 209-214.

Palco, V., Fulco, G., De Capua, C., Ruffa, F., & Lugar_a, M. (2022). IoT and IAQ monitoring systems for the healthiness of dwelling, *in 2022 IEEE International Workshop on*

Metrology for Living Environment (MetroLivEn), Cosenza, pp. 105-109. DOI: 10.1109/MetroLivEnv54405.2022.9826946

Qi, Q., & Tao, F. (2018). Digital twin and big data towards smart manufacturing and industry 4.0: 360-degree comparison, *IEEE Access*, Vol. 6, pp. 3585-3593. DOI: 10.1109/ACCESS.2018.2793265

Qiu, M., Lin, K., Wang, W., Bi, Y., & Hassan, M.M. (2015). Human localization is based on inertial sensors and fingerprints in the industrial of things. *Computer Networks, In press.* https://doi.org/10.1016/j.comnet.2015.11.012

Qiuxia, H., & Yujie, H. (2022). The application of İnternet of Things data analysis in the development of ınternational trade. *National Library of Medicine*. PMID: 35769269. PMCID: PMC9236831. https://doi.org/10.1155/2022/5507951

Qu, J., Wu, S., & Zhang, J. (2023). Flight delay propagation prediction based on deep learning, *Mathematics*, Vol. 11 No. 3, p. 494. https://doi.org/10.3390/math11030494

Qu, T., Lei, S. P., Wang, Z. Z., Nie, D. X., Chen, X., & Huang, G. Q. (2016). IoT-based real-time production logisticssynchronization system under smart cloud manufacturing. The International Journal of Advanced Manufacturing Technology. 84 (1–4): 147–164.

DOI 10.1007/s00170-015-7220-1

Rey, A., Panetti, E., Maglio, R., & Ferretti, M. (2021). Determinants in adopting the Internet of Things in the transport and logistics industry. Journal of Business Research, 131, 584-590. https://doi.org/10.1016/j.jbusres.2020.12.049

Sergi, I., Montanaro, T., Benvenuto, F. L., & Patrono, L. (2021). A smart and secure logistics system based on ıot and cloud technologies. Sensors, 21(6), 2231. https://doi.org/10.3390/s21062231

Shen, L. (2022). Just Trolley: Implementation of industrial IoT and digital twin-enabled spatial-temporal traceability and visibility for finished goods logistics. *Advanced Engineering Informatics 52(5):101571. ELSEVIER. https://doi.org/10.1016/j.aei.2022.101571*

Singh, S. K., & Roy, S. (2020). Internet of Things (IoT) Based green logistics operations for sustainable development in the ındian context, Singapore. https://doi.org/10.1007/978-981-15-2854-5_27

Sinha, A., Kumar, P., Rana, N.P., Islam R., & Dwivedi Y. K. (2019). Impact of Internet of Things (IoT) in disaster management: a task-technology fit perspective. *AnnOper Res*, Vol: 283,pp:759–794.https://doi.org/10.1007/s10479-017-2658-1

Shankar, A., & Sahana, B.C. (2023). Early warning of low visibility using the ensembling of machine learning approaches for aviation services at Jay Prakash Narayan International (JPNI) Airport Patna, *SN Applied Sciences*, Vol. 5 No. 5, p. 132. https://doi.org/10.1007/s42452-023-05350-7

Sodhro, A, H., Pirbhulal, S., Luo, Z., & de Albuquerque, V, H, C. (2019). Towards an optimal resource-management for IoT based Green and sustainable smart cities, Journal of Cleaner Production, Vol.220, pp.1167-1179. https://doi.org/10.1016/j.jclepro.2019.01.188

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DOI: 10.14514/beykozad.1360651

Song, Y., Yu, F. R., Zhou, L., Yang, X., & He, Z. (2021). Applications of the Internet of Things (IoT) in smart logistics: A Comprehensive Survey. *IEEE Internet of Things Journal,* 8(6), 4250-4274. DOI: 10.1109/JIOT.2020.3034385

Taliaferro, A., Ernst, R., Ahmed, U., Harolikar, A., & Ray, S. (2019). Creating IoT ecosystems in transportation: Logistics companies are looking to connect IoT technologies to traditional systems. *Retrieved from Toronto, Canada.*

Tang, G., Hung, E. P., Au-Yeung, H. K. C., & Yuen, S. (2020). Politically motivated internet addiction: Relationships among online information exposure, internet addiction, FOMO, psychological well-being, and radicalism in massive political turbulence. *International Journal of Environmental Research and Public Health,* 17(2), 633. doi:10.3390/ijerph17020633

Tao, F., & M. Zhang. (2017). Digital twin shopfloor: A newshopfloor paradigm towards smart manufacturing. *Pieces*. 5: 20418–20427. DOI: 10.1109/ACCESS.2017.2756069

Trachtman. J. P. (2019). The Internet of Things cybersecurity challenge to Trade and Investment: trust and verify? *SSRN*: 3374542. https://dx.doi.org/10.2139/ssrn.3374542

Turak Y. (2015). Nesnelerin interneti ve güvenliği. *Bilişim Teknolojisi Hukuku Enstitüsü, Bilişim Hukuku Anabilim Dalı, İstanbul Bilgi Üniversitesi.*

Van Geest, M., Tekinerdogan, B., & Catal, C. (2021). Design of a reference architecture for developing smart warehouses in Industry 4.0. Computers in Industry. 124, 103343. https://doi.org/10.1016/j.compind.2020.103343

Verdouw, C. N., Robbemond, R. M., Verwaart, T., Wolfert, J., & Beulens, A. J. M. (2018). A reference architecture for IoT-based logistic information systems in agri-food supply chains. *Enterprise Information Systems,* 12(7), 755-779. https://doi.org/10.1080/17517575.2015.1072643

Wang, C., Lim, M. K., Zhao, L., Tseng, M.-L., Chien, C.-F., & LEV, B.J.O. (2020). The evolution of omega-the International Journal of Management Science over the past 40 years, A Bibliometric, Overview, *Omega,* Vol. 93, p. 102098. https://doi.org/10.1016/j.omega.2019.08.005

Wang, Y. (2022). Optimal design of ınternational trade logistics based on Internet of Things Technology. *Computational Intelligence and Neuroscience.* *https://doi.org/10.1155/2022/8781095*

Wang, J., Lim, M. K., Wang, C., & Tseng, M.-L. (2021). The evolution of the Internet of Things (IoT) over the past 20 years. Computers & Industrial Engineering. 155, 107174. https://doi.org/10.1016/j.cie.2021.107174

Wang, Q., & Mu, Z. (2022). Risk monitoring model of intelligent agriculture Internet of Things based on big data, Sustainable Energy Technologies, and Assessments. Vol. 53, 102654. https://doi.org/10.1016/j.seta.2022.10265

Wu, W., Shen, L. D., Zhao, Z. H., Li, M., & Huang, G. Q. (2022). Industrial IoT and long short-term memory network-enabled genetic ındoor-tracking for factory logistics. *Ieee Transactions On Industrial Informatics.* Volume: 18, Issue: 11. Pp:7537-7548. DOI: 10.1109/TII.2022.3146598

Gönderim tarihi: 14.09.2023 Kabul tarihi: 03.05.2024
DOI: 10.14514/beykozad.1360651

Xie, Y., Pongsakornsathien, N., Gardi, A., & Sabatini, R. (2021). Explanation of machine-learning solutions in air-traffic management, Aerospace. Vol. 8 No. 8, p. 224. https://doi.org/10.3390/aerospace8080224

Yao, Y., Zhang, H., Lin, L., Lin, G., Shibasaki, R., Song, X., & Yu, K. (2022). Internet of Things positioning technology based intelligent delivery system, *IEEE Transactions on Intelligent Transportation Systems, Vol. ahead-of-print No. ahead-of-print,* pp. 1-15, doi: 10.1109/TITS.2022. 3155638.

Yu, W. (2019). Research on optimization of logistics management information system based on Internet of Things. *Paper presented at the 2019 5th International Conference on Education Technology, Management and Humanities Science. DOI: 10.25236/etmhs.2019.371*

Zhang, Y., Guo, Z., Lv, J., & Liu, Y. (2018). A framework for smart production-logistics systems based on CPS and Industrial IoT. *IEEE Transactions on Industrial Informatics.*14 (9): 4019–4032. DOI: 10.1109/TII.2018.2845683

Zhang, G., Shang, X., Alawneh, F., Yang, Y., & Nishi, T. (2021). Integrated production planning and warehouse storage assignment problem: An IoT assisted case. *International Journal of Production Economics.* 234, 108058. *https://doi.org/10.1016/j.ijpe.2021.108058*

Zhao, L., Brandao Machado, Matsuo, I., Zhou, Y., & Lee, W. J. (2019). Design of an ındustrial ıot-based monitoring system for power substations. IEEE Transactions on Industry Applications. 55(6), 5666-5674. DOI: 10.1109/TIA.2019.2940668

Zhao, Z., Wei W., Leidi S., Zhiheng Z., Ming Li., & Huang, G. Q. (2022). Industrial IoT and long short-term memory network enabled genetic ındoor tracking for factory logistics. *IEEE, Transactıons On Industrıal Informatıcs.* Vol. 18, No. 11. DOI: 10.1109/TII.2022.3146598

Zhong, R. Y., Xu, C. C., & Huang, G. Q. (2017). Big data analytics for physical ınternet-based ıntelligent manufacturing shopfloors. *İnternational Journal of Production Research.* 55 (9): 2610–2621. https://doi.org/10.1080/00207543.2015.1086037

www.statista.com, Number of Internet of Things (IoT) connected devices worldwide from 2019 to 2030, *https://www.statista.com/statistics/1183457/iot-connected-devices-worldwide/,* (Erişim Tarihi: 27.07.2023).

www.webofscience.com. (Erişim Tarihi: 24.07.2023).