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USE OF THE INTERNET OF THINGS IN MARKETING

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ABSTRACT

The Internet of Things (IoT) is one of the key technologies for the digital transformation of both business and society. The paper primarily aims to investigate the structure and dynamics of academic publications in English dealing with issues of IoT development - from a marketing perspective, using methods of systematic mapping, i.e., co-citation analysis, bibliographic coupling, and analysis of the co-occurrence of keywords in the Scopus and Web of Science (WoS) databases. Analysis of research papers enables the identification of the most influential articles, papers, and journals, as well as visualization of the keywords and co-authorship co-occurrences. There has been an exponential increase in studies on IoT applications in marketing, indexed in Scopus and WoS citation databases. An insight into analyzed papers shows that companies utilize large amounts of data generated by the IoT to gain insights into customers' supply and value creation, which helps strengthen their relationships with customers and pursue more efficient marketing policies and practices, ultimately leading to a competitive advantage. The IoT is expected to evolve into a vast network that includes smart devices and significantly influences people's behavior, especially decision-making at different stages of the purchasing process.

KEYWORDS: *internet of Things, marketing, bibliometric analysis*

1. INTRODUCTION

We are living in the age of the fourth – digital - industrial revolution (Guven & Akkaya, 2020), whose main driver is data. How data can be collected, analyzed, and used for efficient decision-making and development has become a decisive competitive factor (Nagy et al., 2018). Customers today are looking for fast and flawless digital experiences. Therefore, companies should keep an eye on technological innovations and constantly improve to survive in both the real and digital worlds (Guven & Akkaya, 2020). Digital transformation is a new business imperative and significantly impacts marketing (Šestak & Dobrinić, 2019). The Internet of Things (IoT) is one of the technologies that offer the opportunity to gain a competitive advantage in marketing.

The IoT is the next generation of the Internet, which makes it possible to connect, address, and identify any physical object via the Internet (Li, Xu &

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Zhao, 2015). Stokes (2018) defines the IoT as *"the interconnection of everyday objects to the Internet via embedded computing devices, giving them the ability to send and receive data."* Thus, to be part of the IoT, an object must be able to communicate, receive, and transmit information (Sudharshan, 2020), i.e., automatically respond to changes or circumstances in the environment (Jain, Choudhari & Srivastava, 2021; Chen et al., 2014), while ongoing processes can run in response to environmental conditions, with or without direct human intervention (Vermesan et al., 2011). According to Miorandi et al. (2012), the characteristics of IoT systems are as follows:

- Everything communicates: smart things can communicate wirelessly with each other and between connected objects in an ad hoc network (Vermesan et al., 2011);
- Everything is identified: smart things are identified employing the digital name;
- Everything interreacts: IoT can interact with the local environment by scanning and activating existing possibilities.

A large number of devices connected to the Internet leads to the emergence of a large amount of data – big data (Yao et al., 2015), which, together with the property of the relationship between objects, enables the use of IoT technology in all areas of life, such as smart cities, smart homes, education, agriculture, healthcare, portable devices, industrial automation, marketing, etc. (Abdel-Basset et al., 2019). Many studies suggest that the economic impact of IoT on business activities worldwide will be large in the coming years (Manyika et al., 2015). IoT devices are predicted to create a value of between 3.9 billion USD and 11.1 billion USD a year in 2025, while according to IoT Analytics (2019), the number of connected IoT devices will increase to 28 billion by 2025.

2. INTERNET OF THINGS (IOT) AND ITS USE IN MARKETING

The development of technology, which includes IoT technology in particular, means that marketing, which was only focussed on the product and sales, is a thing of the past. This means that in the past, companies focussed on selling products and making profits and rarely considered the actual needs of consumers. Today, we can see that marketing has evolved into a form that prioritizes customers' needs (Tsai et al., 2017). The Internet, IoT, social media, and mobile marketing enable two-way communication between the brand and consumers and from consumers to consumers, which was not the case in traditional marketing (Dubash, 2016). This form of marketing can be called Marketing 4.0, i.e., marketing with a dimension of direct interaction between the customer and the product (Jara, Parra & Skarmeta, 2012). The data generated by various Internet-connected devices about consumers' daily lives and habits offers companies marketing advantages through IoT technology. Through appropriate analysis of the data, it is possible to predict consumer behavior, creating opportunities for companies to become more efficient, responsible, and proactive (Lo & Campos, 2018), i.e., it is possible to design a high-quality business strategy or marketing campaign that allows connecting with consumers by analyzing their purchasing behavior, ultimately leading to increased customer loyalty and satisfaction (Abdel-Basset et al, 2019; Balaji & Roy, 2017; Stokes, 2018; Abazi, 2016).

The IoT is a major producer of big data, and the analyzed data helps marketers analyze customers' purchasing behavior by identifying their preferences (Simoes, Barbosa & Filipe, 2019) and creating more relevant advertising thanks to the precise targeting of customers. Kumar, Ramachandran, and Kumar (2021) point out that due to personalized, contextual advertising and the consideration of their needs and desires, customers are more likely to contribute directly by purchasing the company's products or using its services, recommending the company's offer to other customers, sharing positive impressions on social networks and providing feedback. Eventually, there will be more connected IoT devices, which will gradually increase the number of interactions between companies and customers due to a greater amount of data generated, which can ultimately lead to greater customer loyalty and satisfaction (Brutyan, 2019; Simoes, Barbosa & Filipe, 2019). In addition, the data generated in real-time enables a quick response to customer requests, facilitates communication, and increases engagement, ultimately leading to greater customer satisfaction (Abdel-Basset et al., 2019). The fundamental intention behind the collection and utilization of data is to create greater value for customers. Value can be defined as any means by which a brand achieves its purpose; it is something that customers want and is relevant to them (Stokes, 2018). Data can help organizations identify what is relevant and useful and what helps to achieve their goals (Porter & Heppelmann, 2014; Stokes, 2018).

Customers are also more likely to recommend the company's offering to other customers and provide feedback on social networks (Kumar, Ramachandran & Kumar 2021). Pranavi (2016) points out that the main benefit of using IoT in marketing is that sensors and actuators enable personalized, interactive, real-time communication with consumers and customers, facilitating the customer journey.

As the IoT enables direct interaction between the product and customers and facilitates feedback on the product, companies can use IoT technology to improve product quality (Brutyan, 2019; Pranavi, 2016) and obtain useful data for developing new products.

As for the benefits of IoT technology in companies that conduct business through e-commerce, IoT has significant advantages related to efficient supply chain management. With the help of sensors and Radio Frequency Identification (RFID) tags, it is possible to track the entire path of the product, thus balancing the demand and supply process, which directly facilitates business for companies by delivering orders to customers in a timely and efficient manner; in addition, customers can access data on the current location of the ordered product, which leads to greater satisfaction with the service provided (Evdokimov et al., 2011). In addition to the data on the current location of the product, companies can detect errors and malfunctions that may occur on the way from the company to the customer and rectify them in good time (Prajapati et al., 2022), which also saves labor and time for companies.

In stores, IoT sensors can establish communication with applications on mobile phones so that the customer receives personalized offers and additional real-time information about products and advertising from the shop. This enables two-way communication between the brand and the consumer (Tsai et al., 2017; Dubash, 2016) and opens up the possibility of creating added value and business opportunities even after the product has already been sold and delivered to the customer (Saarikko, Westergren & Blomquist, 2017). RFID technology is widely used to optimize the retail business. The widespread use of RFID technology is due to improved supply chain management, real-time logistics (Evdokimov et al., 2011), order management, and order fulfillment processes, which can achieve customer satisfaction and increase customer retention and loyalty (Har et al., 2022). Stock management using RFID technology reduces manual labor in taking inventory, prevents stock-outs and surpluses (Caro & Sadr, 2019; Srivastava, 2004), and ensures the removal of expired products (Kamble et al., 2019). Smart shelves can be used for proper inventory management. These shelves have weight sensors that inform warehouse staff when the last item has been removed. Suppose the store has a backup inventory in the warehouse. In that case, this system reduces the number of lost sales and customer dissatisfaction with a lack of inventory thanks to the timely replenishment of products on the shelves. Along with the smart shelves, retailers can also use digital price tags that allow changes to be made remotely, resulting in great savings by reducing the labor required for weekly manual price updates.

Using sensors to automate activities associated with mechanical labor, such as tracking inventory levels or changing prices for individual items, gives retailers more time to interact with customers, further enhancing the in-store customer experience (Gregory, 2015).

Retailers can communicate with customers in real time by using IoT technology and personalizing their shopping experience. (Dubash, 2016). Particular importance for building communication can be given to the use of smartphones and portable devices in stores, which allow retailers to collect data about each purchase, the type of consumer (age, gender, etc.) and develop a statistical database that can later help the marketing team to improve the product, delivery method, advertising, targeting strategy and many other things (Abashidze & Dabrowski, 2016). Through the shop's mobile application, it is possible to collect feedback during each shopper's journey and utilize sensor readings from shoppers' smartphones to calculate their location, movements, and idle time, making it possible to send a relevant message at key moments. REAL hypermarkets in Germany, for example, enable their loyal customers to browse online coupons on their mobile phones as they walk through the aisles and scan products. This gives customers a personalized view and an enhanced experience (Desai, Potia & Brian, 2017).

Location-based beacon technology, which retailers can use to interact directly with customers while they are nearby or in-store, is being used similarly (Gregory, 2015). Beacons are low-power Bluetooth devices that transmit data to nearby smartphones and can trigger marketing messages such as push notifications and in-store applications (Inman & Nikolova, 2017) or instructions for a nearby product (Har et al., 2022; Stokes, 2018). Suppose a customer creates a shopping list in the smartphone application. In that case, they will be informed of the location of each item via their smartphone when they enter the store, saving time and increasing efficiency. With the help of Beacons, retailers can gain insights into customers' usual routes through the store, dwell time, or potential difficulties navigating the store. Ultimately, this can help managers improve the strategy for the layout and presentation of merchandise in the store (Gregory, 2015), leading to greater customer satisfaction and loyalty.

Autonomous scanning or self-scanning checkouts are another example of the use of IoT technology in retail that is increasingly attracting consumer interest. Self-scanning is an automated process that enables customers to scan, bag, and pay for their

purchases without the need for cashiers (Inman & Nikolova, 2017), ultimately leading to higher customer satisfaction and assisting them in their purchasing decisions (Evdokimov et al., 2011). For example, the retailer Kroger has introduced a new self-checkout system called QueVision, which reduces the waiting time in the checkout queue from over four minutes to less than 30 seconds. Customer satisfaction with checkout speed increased by 42%, increasing sales (Coolidge, 2013). The following table illustrates the use of IoT.

A major challenge for companies will certainly be to design a relevant and personalized message for a customer without being intrusive and without invading privacy, regardless of the possibilities of IoT.

TABLE 1. Examples of using the IoT technology

BRAND/COMPANY	APPLICATION	RESULTS
Nivea (Delagrave, 2015)	• GPS bracelet intended for children • Integrations of the bracelet with mobile application, control of the child's distance • Promotion of the Nivea Sun Kids product line	• Increased customer satisfaction • Increase in sales of 62% in Rio de Janeiro • 80% of respondents engaged with the encouraging advertisement.
Burger King (Schmitt, 2019)	• "Whooper DeTour" campaign • Geolocation sensors are positioned in a circle of 180 meters from the site of McDonald's restaurants. • Burger King mobile application • Whopper-hamburger for a penny (0.01 $)	• The app was downloaded by 1.5 million • Mobile sales tripled during the promotion • ROI for the campaign was recorded as 37:1.
Disney (Kumar, Ramachandran & Kumar, 2021)	• MagicBand bracelet, which works as the ticket, way of payment, key to the accommodation	• Improved customer experience • Provided personalized experiences
Coca-Cola (Myers, 2016)	• Vending machines with built-in sensors for soft drinks • MyCoke Rewards • Data analysis	• Development of new products based on data analytics. • Satisfaction • Increased sales
Heineken (Pranavi, 2016)	• Smart bottles of Heineken beer with a built-in accelerometer, GPS, vibration, and rotating lid are available in Amsterdam.	• Increased number of visitors to the brand's museum "Heineken Experience." • Increased customer satisfaction • Positive reactions on social networks
Nike (Abashidze & Dabrowski, 2016)	• Application NIKE + allows users to track the person's jogging routes, measure speed, and count burnt calories. • Application Nike+ is both a social network and a webshop.	• Collective data allows for sending personalized advertisements. • Increased number of users and increased sales.

Source: Adapted from Delagrave (2015), Schmitt (2019), Kumar, Ramachandran & Kumar (2021), Myers (2016), Pranavi (2016), Abashidze & Dabrowski (2016).

3. EMPIRICAL RESEARCH

3.1. Methods

The paper aims to review and analyze the literature dealing with the possibilities of using IoT in marketing and the effects of IoT on marketing in the age of digital business transformation, i.e., to examine the link between the concept of IoT and the concept of marketing and to answer the following research questions:

- *To what extent is the domain "Internet of Things in marketing" present in research papers, and what is the trend in the research?*
- *Who are the most important authors in the observed field, and to what extent are the most frequently cited works related?*

The research method applied is systematic mapping, more precisely, co-citation analysis, bibliographic coupling, and the co-occurrence of keywords in the data of the databases Scopus and WoS. One of the main objectives of the study of systematic mapping is to provide an overview of a research field and to identify the quantity, type of research, and the results available therein, as well as the frequency of publications over time in order to analyze trends (Petersen et al., 2008).

There are two fundamental assumptions when analyzing co-citations: If two papers are cited together in another paper, there is a cognitive relationship between them, and the strength of their interconnection is proportional to the frequency (i.e., number) of papers that cite them (Bušelić & Banek Zorica, 2020; Kovačević & Hallinger, 2019). This leads to the interpretation that if two authors frequently appear in the reference lists of other sources included in the references. These authors conduct research in similar fields and are intellectually connected (Kovačević & Hallinger, 2019). The bibliographic coupling method establishes a connection between two documents, a paper or an article. The paper cited in the two documents is defined as a bibliographic coupling unit. The number of bibliographic coupling units measures the strength of the link between two tracked documents, and the greater the number of bibliographic coupling units, the greater the likelihood that the two documents are related (Jokić, 2005). Word co-occurrence analysis examines the co-occurrence of keywords and terms extracted from the title, abstract, or full text. Words that occur together form a network. By analyzing the mutual relationships within this network, we obtain data on the research areas and topics most frequently associated with the analyzed domain (Bušelić & Banek Zorica, 2020).

3.2. Extraction and preparation of data

The data extraction was done in January 2022 using data from the citation databases Scopus and WoS. To ensure an appropriate extraction of relevant publications, identical search criteria were defined for both databases. All types of academic and reviewed entries with the desired keywords in the title, abstract, or documents written in English relevant to the research question were extracted, with no time limit on the publication period. The following word combinations were used for the search: "Internet of Things" AND "marketing," OR "IoT" AND "marketing" OR "Marketing of things".

The data stored included the author's name, article title, keywords, abstracts, and various citation data. Seven hundred forty-one records were extracted from the Scopus database and 1650 from WoS. After the data cleaning phase, in which duplicates, irrelevant articles, and articles with incomplete data were removed, the final number of records used to analyze the Scopus database was 679 and 1640 for the WoS database. The results of the performed method of systematically mapping data from the Scopus and WoS citation databases were visualized using the VOSviewer software tool. VOSviewer is used to create and visualize bibliometric networks, which can be created based on various citation relationships such as bibliographic coupling, co-citation analysis of documents, authors, journals, or the co-occurrence of words or terms (Bušelić & Banek Zorica, 2020). Network maps consist of circles in different colors and lines connected to them with different strengths. The circle size indicates the number of publications, depending on the type of analysis (co-occurrence, co-authorship, citation, bibliographic coupling, or co-citation), with circles in the same color representing a cluster (Miskiewicz, 2020). In addition, the distance between the circles indicates the frequency of the element that appears. The number of lines and links indicates how many interactions between the individual elements, i.e., how strong the connection is (Bouzembrak et al., 2019; Miskiewicz, 2020).

4. RESULTS

This section will present answers to the research questions.

RQ1: To what extent is the domain "Internet of Things in marketing" present in research papers, and what is the trend in the research?

Looking at the number of papers extracted from the Scopus and WoS databases based on the criteria described above - WoS with 1640 extracted research

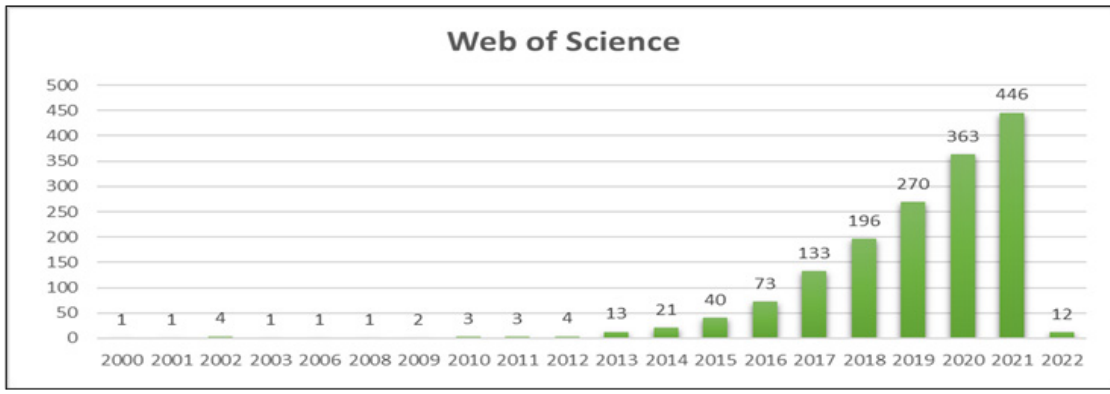
papers relevant to the topic of this study and the Scopus database with 679 research papers - it becomes clear that the number of papers in the two databases is disproportionate. This article does not carry out a detailed analysis that would explain why the number of selected articles in the above-mentioned databases is so different. The following figures present the development of research based on the number of articles published by year for the two databases.

The number of articles indexed in both databases has increased exponentially since 2011, indicating a growth trend in the research field of IoT in marketing. The WoS database recorded the largest number of indexed articles in 2021, while the Scopus database recorded the largest number in 2020.

A look at the most important countries with the most published articles in the relevant research area shows that the first four positions in both databases are identical. China is in first place and is followed chronologically by the US, India, and South Korea. The other countries in the top ten positions according to the number of indexed articles are listed in Table 2.

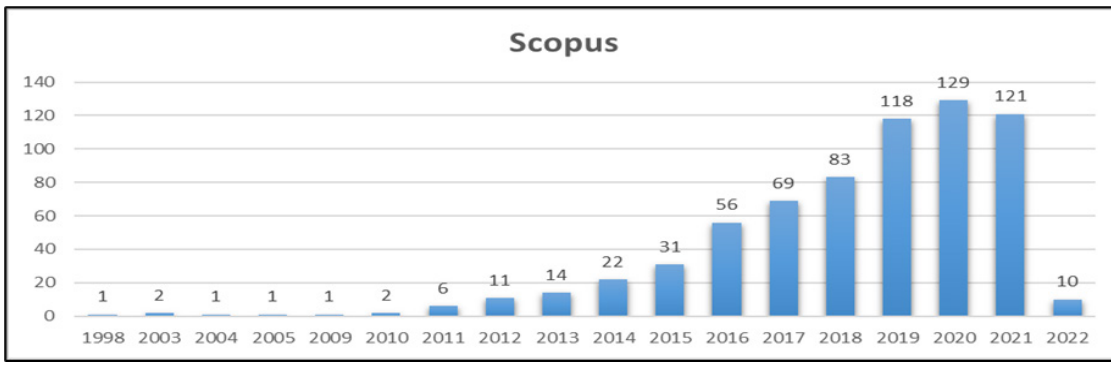
The most important journal in the Scopus database is *Advances in Intelligent Systems and Computing*, while this journal is not even in the list of the first ten journals in the WoS database. The most important journal in the WoS database is *IEEEE Access*, which is third in the Scopus database. The second most important journal in the Scopus database is *Lecture Notes in Computer Science*. In contrast, the second most important journal in the WoS database is the *IEEEE Internet Of Things Journal*. The journals in the top ten in both databases are *IEEEE Access*, *Sensors*, and *Sustainability*.

FIGURE 1. Number of published papers by year (Scopus)



Source: Authors

FIGURE 2. Number of published papers by year (WoS)



Source: Authors.

TABLE 2. Overview by countries - WoS and Scopus

Scopus		WoS	
Country	**Number of papers**	**Country**	**Number of papers**
China	130	China	350
US	98	US	267
India	85	India	139
South Korea	47	South Korea	139
Taiwan	38	Italy	136
England	34	England	124
Russia	25	Spain	97
Italy	21	Germany	76
Japan	18	Australia	65
Indonesia	16	Taiwan	65

Source: Authors.

In order to create the network map for the occurrence of keywords in the Scopus database, a minimum threshold of 12 keywords was set for the occurrence of keywords in selected documents. Of the total of 5267 keywords, 61 words met the defined threshold. In contrast to the Scopus database, a total of 7019 keywords were extracted for the WoS database, 68 of which met the specified threshold of 20. A higher threshold was set for the number of occurrences to make it easier to analyze the position of selected terms and their relationship to other closely related terms. Table 3 presents keywords with the most occurrences for the Scopus and WoS databases. At the same time, these terms provide information about the relevant research topics.

TABLE 3. Overview of keywords of WoS and Scopus databases

Scopus		**WoS**	
Keyword	Occurrence	Keyword	Occurrence
Internet of Things	353	Internet of Things	439
Marketing	238	Internet	268
Commerce	142	Big data	131
Big data	96	Management	122
Internet	60	Security	107
Sales	54	Blockchain	101
Artificial Intelligence	49	Challenges	87
Machine learning	42	System	86
Social networking	32	Design	85
Decision-making	31	Framework	83
Electronic commerce	29	Technology	83
Information management	29	Model	75
Smart devices	29	Performance	62
Cloud computing	27	Cloud computing	61
Data mining	26	Privacy	59

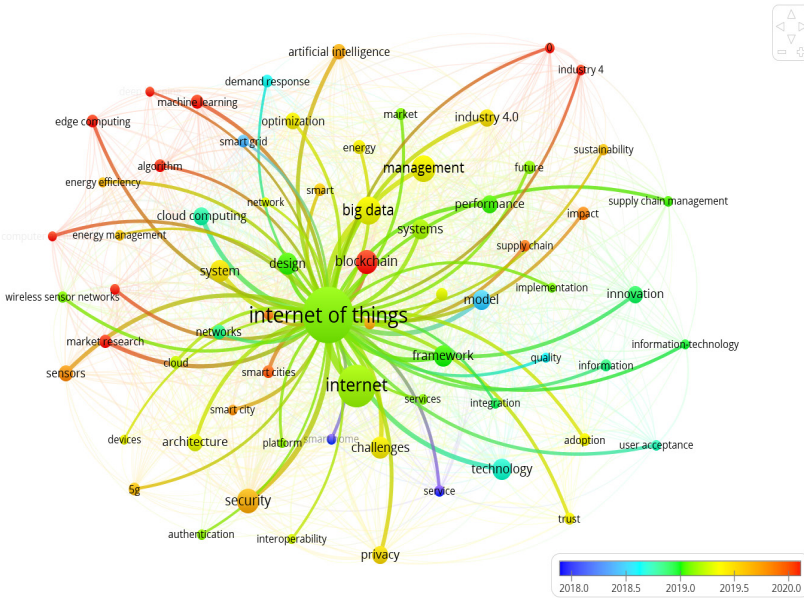
Source: Authors.

The keyword "*Internet of Things*" has the largest occurrences in both databases. Interestingly, the word "*marketing*" ranks second in the Scopus database, while the word is not even among the top 20 words by number of occurrences in the WoS database. Figure 3 presents the relationship between "Internet of Things" and other words in the WoS database. The larger the node, i.e., the line, the stronger the connection between the word "Internet of Things" and other extracted keywords. This interconnection has a strength of 1055 units; in the Scopus database, we find a link strength of 998.

The visualization of the correlation between the keywords for WoS shows that studies in IoT technology are particularly associated with the terms blockchain, security, sensors, management, cloud computing, framework, and big data. From this, it can be concluded that the topic of many studies is IoT technology itself, its basic framework, in combination with cloud computing technology and blockchain technology, which has been particularly active in recent years. In addition, many papers are concerned with investigating the security of using this technology. As the Internet of Things is a technology closely linked to collecting valuable personal data, the question arises regarding how secure such systems are from hacker attacks. From 2019 to 2020, links were identified between artificial Intelligence, machine learning, smart cities, optimization, impact and sustainable development, and IoT. This suggests that studies are currently focusing on the combination of artificial Intelligence and the IoT for digital transformation using everyday life as an example and how the IoT and its impact are used in optimizing cities and creating a greener and safer life.

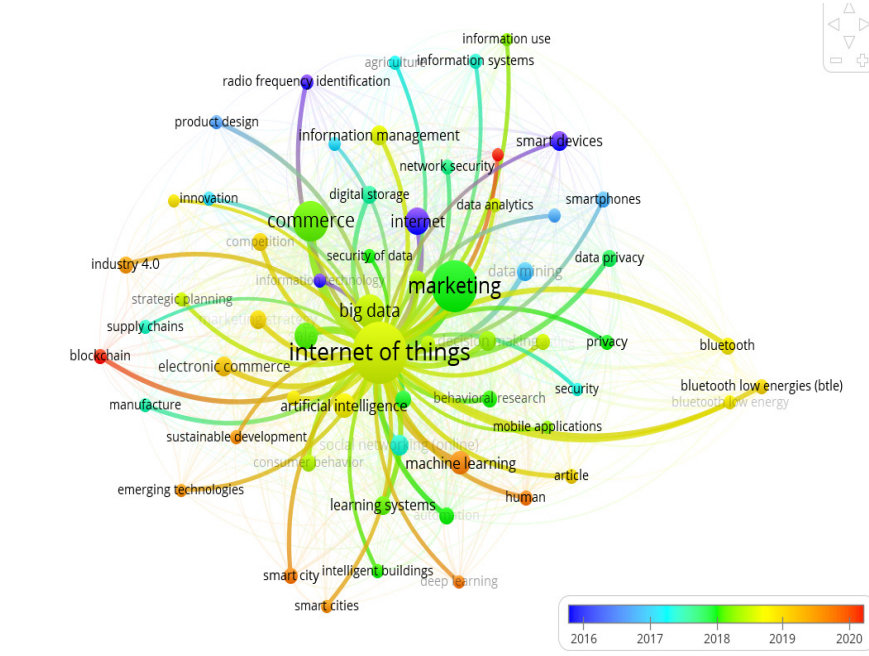
Figure 4 shows the relationship between the "Internet of Things" and other terms from the Scopus database. In contrast to the WoS database, the strongest connections with the term IoT that stand out in Scopus are marketing, commerce, big data, sales, machine learning, and artificial Intelligence. From this, we can conclude that the articles in the Scopus database are more concerned with using IoT in marketing, especially through sales and commerce over the Internet with the collection of customer data, which has already been discussed in the theoretical part of the article. We can see a similarity with the WoS database if we look at the terms from 2019 to 2020. Terms that stand out are blockchain, machine learning, human, smart city, sustainable development, and industry 4.0. The subject of the more recent studies increasingly refers to the use of IoT technology to improve sustainable development and the general quality of people's lives in combination with artificial Intelligence and machine learning.

FIGURE 3. Interconnections of the term Internet of Things - WoS



Source: Authors

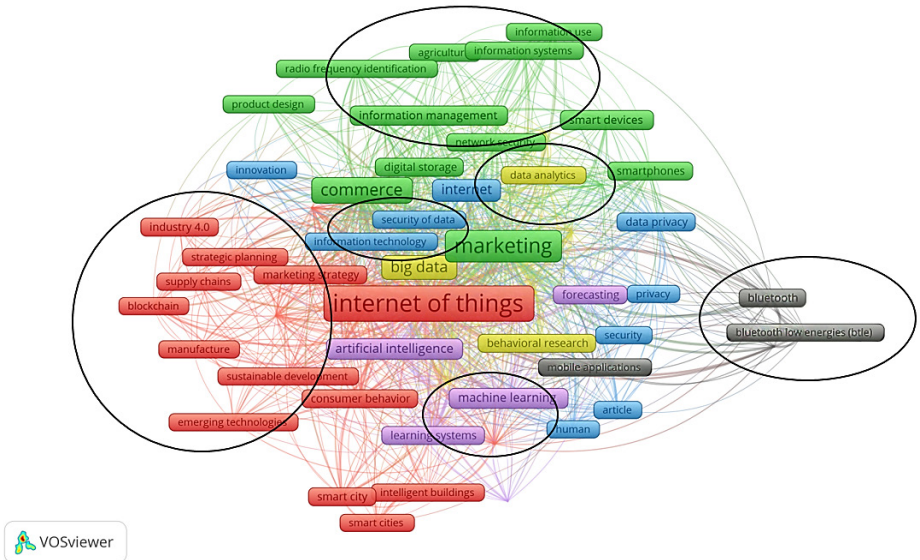
FIGURE 4. Interconnections of the term Internet of Things – Scopus



Source: Authors

The following section shows the cluster analysis results for WoS and Scopus keywords. Four clusters were identified for the WoS database, while six clusters were identified for Scopus:

FIGURE 5. Cluster analysis of keywords – Scopus



Source: Authors.

TABLE 4. Keywords by clusters – Scopus

SCOPUS	
Cluster	**Keywords**
Cluster no. 1 (18) Red color	automation, blockchain, competition, customer behavior, e-commerce, emerging technology, industry 4.0, smart buildings, IoT, production, marketing strategy, sales, smart cities, strategic planning, supply chains, sustainable development Word with the largest number of occurrences: ***Internet of Things* (353)**
Cluster no. 2 (14) Green color	agriculture, commerce, costs, digital storage, information management, information use, marketing, mobile telecommunications, network security, product design, RFID, smart devices, smartphones. Word with the largest number of occurrences: ***marketing* (238)**
Cluster no. 3 (12) Blue color	article, cloud computing, data privacy, digital marketing, digital transformation, the man, information technology, innovation, Internet, privacy, security, data. Word with the largest number of occurrences: I***nternet* (60)**
Cluster no. 4 (8) Yellow color	advanced analytics, behavior research, big data, data analytics, data mining, decision-making, social media, social networks. Word with the largest number of occurrences: ***big data* (96)**
Cluster no. 5 (5) Violet color	Artificial Intelligence, deep learning, forecasting, learning systems, machine learning. Word with the largest number of occurrences: ***Artificial Intelligence* (49)**
Cluster no. 6 (4) Grey color	Bluetooth, Bluetooth low energy, mobile applications Word with the largest number of occurrences: ***Bluetooth* (22)**

Source: Authors

- The first cluster, marked red, shows that research focuses on using IoT technology for process automation through the design of smart cities, smart buildings, smart supply chains, and the improvement of sustainable development. In addition, research is looking at the use of IoT to gain a marketing advantage over the competition by selecting an appropriate marketing strategy and developing a strategic plan that will ultimately lead to an improvement in the service offered and an increase in sales.
- The second cluster, marked green, contains contributions that deal with the use of IoT in marketing through the appropriate management and utilization of information and the use of RFID technology in combination with smart devices to reduce costs.
- The third cluster, marked blue, contains articles that deal with security issues and challenges, such as network attacks and data protection.
- The fourth cluster, marked yellow, focuses on studying the use of big data generated through IoT channels to study customer behavior, data analytics, and data mining.
- The fifth cluster, marked violet, explores the relationship between IoT, Artificial Intelligence, and machine learning technology to forecast future activities and decisions.
- The sixth cluster, marked grey, comprises contributions that use Bluetooth and BLE technology to improve marketing in combination with mobile applications.

Table 5. *Keywords by clusters – WoS*

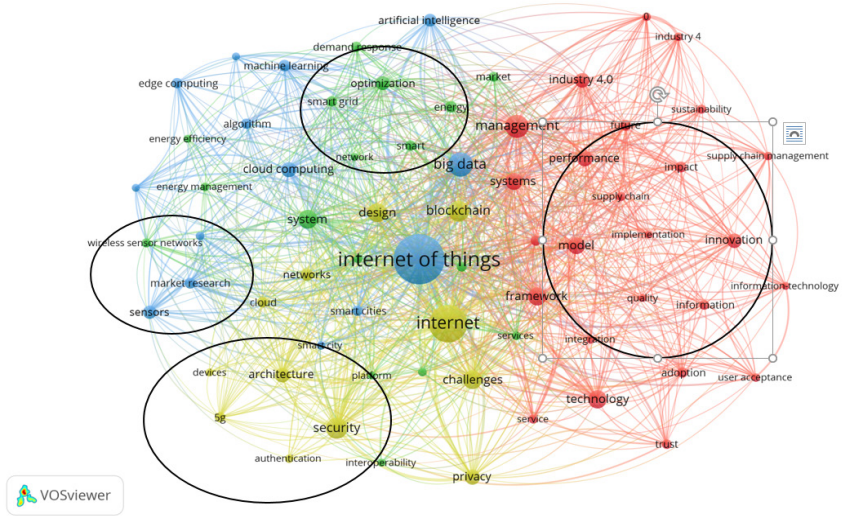
WoS	
Cluster WoS	**Keywords**
Cluster no. 1 (25) Red color	Acceptance, cyber-physical systems, framework, future, impact, implementation, industry 4.0, information, information technology, innovation, integration, management, model, performance, quality, service, supply chain, supply chain management, sustainability, systems, technology, trust, users' acceptance Word with the largest number of occurrences: ***management* (122)**
Cluster no. 2 (17) Green color	Communication, response to demand, energy efficiency, energy management, interoperability, market, network, optimization, platform, services, smart network, smart home, system, technologies, wireless sensor networks. Word with the largest number of occurrences: ***system* (86)**
Cluster no.3 (14) Blue color	Algorithms, Artificial Intelligence, big data, cloud computing, computer architecture, deep learning, machine learning, market research, monitoring, sensors, smart cities. Word with the largest number of occurrences: **IoT** (439)
Cluster no. 4 (12) Yellow color	5G, architecture, authentication, blockchain, challenges, cloud, design, devices, Internet, network, privacy, security. Word with the largest number of occurrences: ***Internet* (268)**

Source: Authors

Four clusters for keywords were identified in the WoS database (see Table 5):

- The first cluster, marked red, includes contributions that deal with systems, models, and innovative IoT technology that is part of Industry 4.0 and its acceptance by new users.
- The second cluster, marked green, comprises work that deals with the use of IoT for energy efficiency system optimization through the creation of smart networks and smart homes.
- The third cluster explores the use of artificial Intelligence and machine learning in combination with IoT technology for advanced market research through the generation of big data and the design of smart cities.
- The fourth cluster, marked red, deals with the IoT architecture and the challenges for the security and data protection of users of IoT technology.

FIGURE 6. Cluster analysis of keywords – WoS



Source: Authors

Let us compare the results of the cluster analysis of both databases. We can see that the articles in the WoS database mainly focus on the study of IoT technology itself, its architecture, and the use of big data to improve quality of life comprehensively. In contrast, the articles in the Scopus database examine the direct impact of IoT on marketing, the way it is used, and the effects on users.

RQ2: Who are the most significant authors in the observed field?

We find the answer to this question by analyzing bibliographic pairs and co-citation analyses of authors in the Scopus and WoS databases. We find considerable differences in the results for the most important authors, so no single author appears among the top ten most important authors in both databases. As noted in the results of the keyword cluster analysis, the results of the two analyses differ significantly, leading to the interpretation that the top authors in the two databases differ due to different research areas. The most important authors of the Scopus database in the field of research are Chih-Yuan Huang and Yu-Sheng Kao, who have three published articles and a total of 360 strengths of interconnection. Their most cited paper is *"UTAUT2 Based Predictions of Factors Influencing the Technology Acceptance of Phablets by DNP"* in the given field. The most significant author of the WoS database is An Dou, who has four published papers in the given field and has the strength of interconnections of 902 units, together with authors Yang Qingyu and Yu Wei. The most cited paper by An Dou is *"A Survey on Big Data Market: Pricing, Trading, and Protection."*

Co-citation analysis revealed that in bibliographies of papers in the Scopus database, the most significant author is Cambria Erik, with 5615 units of interconnection strengths. In contrast, the most significant author for the WoS database is Li Da Xu, with 114 co-citations and a strong connection of 3207 units.

RQ3: What is the strength of the interconnection of the most cited papers?

The paper that stands out among the most frequently cited works in the Scopus database is "*Opportunistic IoT: Exploring the harmonious interaction between human and the Internet of Things*" by Bin Guo, Daqing Zhang, Zhu Wang, Zhiwen Yu, and Xingshe Zhou, published in 2013, with 237 citations. However, this paper does not have the greatest strength of interconnection with other papers. We found the greatest strength of interconnection for the paper "*Adoption of Internet of Things (IoT) based wearables for healthcare of older adults – a behavioural reasoning theory (BRT) approach*" with a total of 133 units of strength, by Brijesh Sivathanu, published in 2018. By the strength of interconnection, the second best is the paper "*Adoption of Internet of Things (IoT) in the*

TABLE 6. Comparison of the most significant authors in Scopus and WoS

Scopus			WoS		
Author	**Number of papers**	**Strength of interconnection**	**Author**	**Number of papers**	**Strength of interconnection**
Huang C.-Y.	3	360	An D.	4	902
Kao Y.-S.	3	360	Yang Q.	4	902
Guo B.	2	322	Yu W.	4	902
Zhang D.	2	322	Niyato D.	9	758
Yu Z.	2	322	Wang P.	8	753
Li X.	5	304	Guijarro L.	5	550
Wang Z.	3	261	Naldi M.	5	550
Liu Q.	2	255	Pla V.	5	550
Zhou X.	4	255	Han Z.	5	463
Jara A.J.	3	244	Vidal, Jose R.	4	443

Source: Authors.

agriculture industry deploying the BRT framework" by Rajasshrie Pillai and Brijesh Sivathanu, published in 2020. By the strength of interconnection, they are followed by the papers: "*An Exploration and Confirmation of the Factors Influencing Adoption of IoT-Based Wearable Fitness Trackers*" by Yu-Sheng Kao, Kazumitsu Nawata, and Chi-Yo Huang, published in 2019, then paper "*Internet of Things support for marketing activities"* by Mark Taylor, Denis Reilly and Chris Wren, which was published in 2020.

Regarding results for the WoS database, the most cited paper is "*Context Aware Computing for The Internet of Things: A Survey*" by Charith Perera et al., published in 2014, with 1293 citations and a strength of interconnection of 78. However, as with the Scopus database, this paper does not have the greatest strength of interconnection with other papers. The paper that stands out by the greatest strength of interconnection is paper "*A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements"* by Manavalan Ethirajan and Jayakrishna Kandasamy, with a strength of interconnection of 326 units. The second largest strength of interconnection can be identified in the paper "*Development capabilities for smart products*" by Tetsuo Tomiyama, Eric Lutters, Rainer Stark, and Michael Abramovic published in 2019, with 235 units of strength, and it is followed by paper "*Intelligent Manufacturing in the Context of Industry 4.0: A Review*" by Ray Y. Zhong, Xun Xu, Eberhard Klotz and Stephen T. Newman, published in 2017, with a strength of 181 units. The paper "*Machine-to-machine wireless communication technologies for the Internet of Things: Taxonomy, comparison and open issues*" by Federico Montori, Luca Bedogni, Marco Di Felice, and Luciano Bononi, published in 2018, with a strength of 171 units ranks third. The first three papers on the strength of interconnection are also found in the same cluster.

A review of the tabular presentation of ten papers with the greatest strength of interconnection in Table 7 reveals that both databases include the following papers, though with different positions in the table: "*Adoption of Internet of Things (IoT) based wearables for healthcare of older adults – a behavioural reasoning theory (BRT) approach*" by Brijesh Sivathanu, "*Modeling the Internet of Things adoption barriers in food retail supply chains*" by Sachin S. Kamble, Angappa Gunasekaran, Harsh Parekh and Sudhanshu Joshi, and paper "*The Internet-of-Things: Review and research directions*" by Irene C.L.Ng, and Susan Y.L.Wakenshaw.

TABLE 7. Comparison of papers with the greatest strength of interconnection – Scopus and WoS

Title of the paper (Scopus)	Author	Strength	Title of the paper (WoS)	Author	Strength
Adoption of Internet of Things (IoT) based wearables for healthcare of older adults – a behavioural reasoning theory (BRT) approach (2018)	Brijesh Sivathanu	133	A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements (2019)	Manavalan Ethirajan and Jayakrishna Kandasamy	326
Adoption of Internet of Things (IoT) in the agriculture industry deploying the BRT framework (2020)	Rajasshrie Pillai, Brijesh Sivathanu	119	Development capabilities for smart products (2019)	Tetsuo Tomiyama, Eric Lutters, Rainer Stark, Michael Abramovic	235
An Exploration and Confirmation of the Factors Influencing Adoption of IoT-Based Wearable Fitness Trackers (2019)	Yu-Sheng Kao, Kazumitsu Nawata and Chi-Yo Huang	113	Intelligent Manufacturing in the Context of Industry 4.0: A Review (2017)	Ray Y. Zhong, Xun Xu , Eberhard Klotz, Stephen T.Newman	191
Internet of Things support for marketing activities (2020)	Mark Taylor, Denis Reilly, Chris Wren	109	Machine-to-machine wireless communication technologies for the Internet of Things: Taxonomy, comparison and open issues (2018)	Federico Montori, Luca Bedogni, Marco Di Felice, Luciano Bononi	171

Title of the paper (Scopus)	Author	Strength	Title of the paper (WoS)	Author	Strength
Generating Marketing Outcomes through Internet of Things (IoT) Technologies (2020)	Beenish Tariq et al.	99	Adoption of Internet of Things (IoT) based wearables for healthcare of older adults – a behavioural reasoning theory (BRT) approach (2018)	Brijesh Sivathanu	162
Internet of Things Utilization in Marketing for Competitive Advantage: An Organizational Capability Perspective (2020)	Wei-Hsiu Weng	95	Modeling the Internet of Things adoption barriers in food retail supply chains (2019)	Sachin S.Kamble, Angappa Gunasekaran, HarshParekh, Sudhanshu Joshi	152
Modeling the Internet of Things adoption barriers in food retail supply chains (2019)	Sachin S.Kamble et al.	75	The future of the Internet of Things: toward heterarchical ecosystems and service business models (2018)	Seppo Leminen, Mervi Rajahonka, Mika Westerlund, Robert Wendelin	148
The Internet of Things - new value streams for customers (2017)	Ashok Kumar Wahi, Vandana Ahuja	71	The Emerging Internet of Things Marketplace From an Industrial Perspective: A Survey (2015)	Charith Perera; Chi Harold Liu; Srimal Jayawardena	141
The Internet-of-Things: Review and research directions (2017)	Irene C.L.Ng, Susan Y.L.Wakenshaw	68	The Role and Impact of Industry 4.0 and the Internet of Things on the Business Strategy of the Value Chain—The Case of Hungary (2018)	J. Nagy, Judit Oláh, Edina Erdei, Domicián Máté, József Popp	133
The Early Bird Catches the Worm - First Mover Advantage through IoT Adoption for Indian Public Sector Retail Oil Outlet (2019)	Sudip Das	67	The Internet-of-Things: Review and research directions (2017)	Irene C.L.Ng, Susan Y.L.Wakenshaw	127

Source: Authors.

5. CONCLUSION

The fourth industrial revolution has changed lifestyles in the 21st century. The large amount of data generated daily through digital devices enables the use of new technologies, such as IoT, in various fields such as agriculture, healthcare, education, marketing, etc. The most important application of IoT in marketing is using various sensors that collect a large amount of user data. With the help of this data, marketers can analyze customer purchasing behavior and respond quickly to customer requests, facilitate communication, and increase customer loyalty. IoT in marketing helps companies make smart decisions in real time, reduce costs, increase profits, and improve customer experience and satisfaction with the company. Undoubtedly, the implementation of IoT in marketing is becoming a universal necessity for marketers and management to keep up with technological advancements and ensure the quality of business and competitive advantage of the products and services they offer to customers.

The systematic mapping method was used to obtain an overview of the current state of research on IoT in marketing. Six hundred seventy-nine articles met the specified criteria were extracted from the Scopus database and 1640 from WoS. In addition to a clear disparity in the number of articles extracted, the results of the bibliometric analysis show discrepancies when analyzing the most important journals, the most important authors, and the keywords associated with the term IoT.

WoS-indexed studies focus on IoT technology, its foundations, architecture, and the challenges of applying innovative technology in different areas, such as optimizing resources and automating different processes, especially in constructing smart cities. Scopus-indexed studies mostly deal with IoT in marketing to increase sales, retain customers, and enrich the buying experience. In addition, many articles in the Scopus database analyze the use of IoT in marketing with the help of big data in combination with artificial Intelligence. The trend of exploring the analyzed topic is most pronounced in both citation databases in China, the US, India and South Korea. Since only a few papers use systematic mapping in the study of IoT in marketing, this paper can serve as a reference for future research on similar topics.

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PRIMJENA "INTERNETA STVARI" U MARKETINGU

SAŽETAK

"Internet stvari" (Internet of Things - IoT) jedna je od ključnih tehnologija digitalne transformacije poslovanja i društva. Rad je prvenstveno usmjeren na proučavanje strukture i dinamike akademskih publikacija, pisanih na engleskom jeziku, koje se bave pitanjima razvoja IoT. Rad promatra ovu problematiku sa stanovišta marketinga, korištenjem metoda sistematskog mapiranja - kocitatne analize, bibliografskog povezivanja i analiza zajedničkog pojavljivanja ključnih riječi na podacima u bazama podataka Scopus i Web of Science (WoS). Analiza istraživačkih radova omogućuje izdvajanje najutjecajnijih članaka, radova i časopisa, kao i vizualizaciju zajedničkog pojavljivanja ključnih riječi u radovima i koautorstva između zemalja. Rezultati analize pokazuju da postoji eksponencijalan porast istraživanja o upotrebi IoT u marketingu, indeksiranih u citatnim bazama podataka Scopus i WoS. Uvid u analizirane radove govori da se koriste ogromne količine podataka, koje generira IoT, da bi se stekao uvid u ponudu i stvaranje vrijednosti za kupce, što pomaže u jačanju veze s kupcima i usvajanju efikasnije marketinške politike i prakse, što u konačnici rezultira postizanjem konkurentske prednosti. Očekuje se da će IoT postati ogromna mreža, koja neće samo obuhvatiti pametne uređaje, već će i značajno utjecati na ponašanje ljudi, posebno na donošenje odluka u različitim fazama procesa kupovine.

KLJUČNE RIJEČI: *"Internet stvari", marketing, bibliometrijska analiza*