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IS THE CONCEPT OF INDUSTRY 4.0 STILL INTERESTING FOR SCIENTISTS DUE TO THE EMERGENCE OF INDUSTRY 5.0? BIBLIOMETRIC ANALYSIS

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Abstract

Research purpose. Through Industry 4.0, also referred to as the fourth industrial revolution, new technologies or traditional production resources have been transformed into intelligent objects enhanced by the possibility of identification, scanning, and networking. In recent years, the concept of Industry 5.0 has already started to be discussed. However, is Industry 4.0 an uninteresting or sufficiently researched topic for scientists? The main aim of the scientific article is to perform a bibliometric analysis of the Industry 4.0 issue. The aim was supported by six research questions that reflect the publication trend in the years 2012–2022, the most publishing countries, the most used keywords, the Web of Science category, and authors and publishers.

Design / Methodology / Approach. The data was obtained from the renowned Web of Science database. The monitored period was 2012–2022 for Industry 4.0 and 2016-2022 for Industry 5.0. The year 2023 was excluded from the analysis, as the year 2023 is not finished. The total number of publications that were used in the bibliometric analysis was 20,151 (I4.0) and 293 (I5.0). VOSviewer and MS Excel were used for graphical data processing.

Findings. The oldest publication dedicated to Industry 4.0 in the Web of Science database dates back to 2012. The most scientific articles were seen in 2021, namely 4,326 (I4.0) and 201 in 2022 about I5.0. In 2022, 3848 publications were published. In addition, authors from Germany (2,450), Italy (2,318), China (1,515), and the USA (1,220) address the issue of Industry 4.0. All the countries of the Visegrad Group, Poland (859), the Czech Republic (859), Slovakia (539), and Hungary (282) are most concerned with this problem. If the publications are divided into categories according to the Web of Science database, most of them are included in the categories Engineering Industrial, Engineering Manufacturing, Engineering Electrical Electronic, Computer Science Theory Methods, or Computer Science Information Systems. Publications on Industry 4.0 are published mainly by publishers such as IEEE, Elsevier, Springer, and MDPI. The authors who are most devoted to the mentioned issue are Popkova, Martinek, Rauch, Bogoviz, Silva, and Xu.

Originality / Value / Practical implications. The added value of the scientific article is the summarisation of theoretical starting points from the field of Industry 4.0 and Industry 5.0. Likewise, the article is original from the point of view of conducting a bibliometric analysis, focused on the development of the number of publications, the authors who are most devoted to the given topic, the most commonly used keywords, or countries that focus on Industry 4.0 and Industry 5.0 issues the most. The originality of the article also lies in the mapping of the publications of the monitored issue for the entire previous year, 2022.

Keywords: Industry 4.0; Industry 5.0; Internet of Things; Artificial Intelligence; Bibliometric analysis.

JEL codes: O14; O33

Introduction

The digital, social, and economic needs of businesses are largely framed by the fourth industrial revolution. This idea enhances the cost-efficiency, quality, and effectiveness of enterprises, which has a significant impact on their results (Milosevic et al., 2022). Global manufacturing trends have evolved as a result of Industry 4.0 technologies. In order to meet mass customisation demands and compete with international industries, industries are implementing Industry 4.0 business models. Industry 4.0 is the

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name given to the current trend of automation and data interchange in manufacturing (Jamwal et al., 2021). The development in the past decade of Industry 4.0 technologies has brought many new opportunities to manufacturers (Francalanza et al., 2021). The phenomenon known as "Industry 4.0" is the coming together of the physical and digital worlds as "Cyber-Physical Systems" (CPS) (Soomro et al., 2021). Popkova and Giyazov's study from 2021 supports the importance of Industry 4.0's development in modern economic systems with varying degrees of knowledge of economic development. In 2011, during an economic discussion at Hannover Messe in Germany, the concept of Industry 4.0 was first conceived (Liebrecht et al., 2021). In order to fill a gap in the existing literature on the function of venture capital in Industry 4.0, Popkova et al. (2021) established a framework for how venture capital could contribute comprehensively to achieving sustainable development goals using Industry 4.0's digital entrepreneurship.

The main aim of the scientific article is to perform a bibliometric analysis of the Industry 4.0 issue. The aim was supported by six research questions:

1. What were the publication trends in the monitored issue of Industry 4.0 in the years 2012–2022 and Industry 5.0 in the years 2016-2022?
2. Which countries are most devoted to the field of Industry 4.0 and Industry 5.0?
3. Which keywords are used most often in scientific publications on Industry 4.0 and Industry 5.0?
4. According to the Web of Science, under which categories do publications on Industry 4.0 belong?
5. Which authors focus on the issue of Industry 4.0 the most?
6. Which publishers publish most often about the field of Industry 4.0?

The paper is divided as follows: The introduction is devoted to the concepts of Industry 4.0 and Industry 5.0. The methodology section portrays the use of bibliometric analysis. The result section is the part where we present our findings. The last part is the conclusion, which contains the summary of the findings.

Literature review

Industry 4.0 is "the digitalisation transition led by connected technologies to establish a cyber-physical entity," according to Soomro et al. (2021). Industry 4.0 is a manufacturing strategy built on integrating cutting-edge technologies like CC, CPS, and IoT into production processes in order to increase output (Freund & Al-Majeed, 2021). As Industry 4.0 relies heavily on radiofrequency technologies, some brief insight into this problem is provided by Martinek et al. (2021), including the Internet of Things (IoT) and 5G deployment.

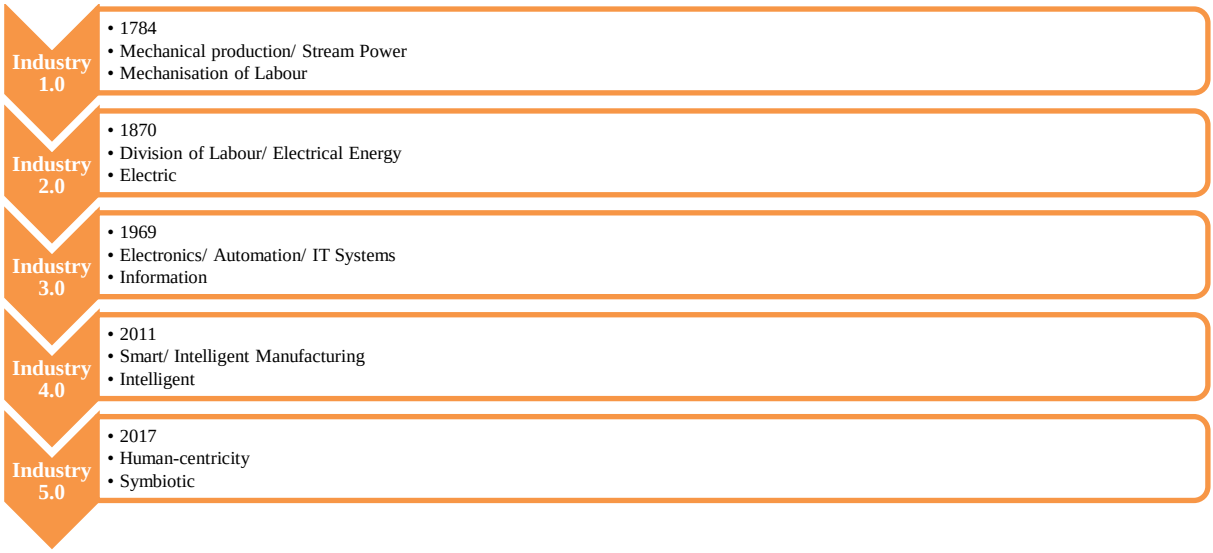


Fig. 1. The evolutionary history of industry X.0 (Source: Own processing according to Leng et al., 2022)

The progress of Industry X.0 is seen in Fig. 1. Water steam is used to power manufacturing machinery in Industry 1.0, ushering humanity into the "Steam Era." When the market (one of the pillars of the Industrial Revolution) explodes, humanity has access to early resources and the economy's primitive accumulation, which prompts social upheaval (Leng et al., 2022).

By harnessing energy as a conduit for electricity, Industry 2.0 ushers humanity into the "Electric Age." The division of labour in the manufacturing process is evident across the entire society, and the door is opened to the assembly-line mass production model. Information technology (IT)-based industry 3.0 offers mass customisation, whereas industry 4.0 combines IT and operational technology (OT) in a cyber-physical system to enable mass customisation/personalisation with intelligence. Industry 5.0 reflects the value of humanistic care and integrates human subjectivity and intellect with the effectiveness, artificial intelligence, and accuracy of robots in industrial production, accomplishing the progression toward the symbiotic ecosystem (Leng et al., 2022).

Industry 4.0 offers enormous advantages in terms of higher quality, quicker turnaround times, and general optimisation. Despite this, only 29% of organisations globally use Industry 4.0 technologies at scale, giving them a chance to realise paradigm-shifting effects (Soomro et al., 2021). A higher level of intelligence, and consequently a higher level of flexibility and performance, can be obtained in industrial manufacturing processes thanks to the technologies brought by Industry 4.0. So, it is expected that Industry 4.0 will enable the three key components of production digitisation, automation, and intelligent data exchange (Freund & Al-Majeed, 2021). Due to uncertainties on how Industry 4.0 technologies might collaborate to accomplish advantages, industries can be hesitant to deploy these new technologies (Dos Santos et al., 2021). The automotive, agricultural, apparel, paper, and other industries are among those being impacted by the digital transition. Companies must be aware of potential changes brought on by the digitalisation process and react swiftly and effectively (Zauskova et al., 2022).

The fourth industrial revolution, or Industry 4.0, is distinguished by connecting distributed artificial intelligence that has been multiplied and made accessible to the human operator. Cyber-Physical Systems (CPS), which are computers with networks of tiny sensors and actuators installed as embedded systems in materials, equipment, and machine parts and connected via the Internet, can describe the multiplied and dispersed artificial intelligence in greater depth (Rauch et al., 2020).

Boston Consulting Group (BCG) combines all technologies and concepts with the aim of identifying pillars of Industry 4.0. The nine pillars of Industry 4.0 are the industrial Internet, advanced manufacturing, additive manufacturing, simulation, horizontal/vertical integration, cloud, cyber-security, augmented reality, and big data analytics (Soomro et al., 2021).

The Industrial Internet of Things (IIoT) (Danys et al., 2022) and Cyber-Physical Production System (CPPS) (Coelho et al., 2022; Nikolakis et al., 2020) respectively, and their specialisation to industry, Digital Twin (DT) (Hassani et al. 2022; Jia et al., 2022), Internet of Things (IoT) (Twahirwa et al., 2022; Vitanova, 2021), and Cyber-Physical Systems (CPS) (Bellman et al., 2020; Radanliev et al., 2021), are thought to boost the efficacy of Facilities management (Nota et al., 2021). Based on the connection offered by the Industrial Internet of Things (IIoT) and the utilisation of many digital technologies, including cloud computing, big data, and artificial intelligence, Industry 4.0 has been proposed as a new stage of industrial development (Dos Santos et al., 2021).

With its innovative perspective, Industry 5.0 will assist in addressing the issue of the disconnect between societal requirements and manufacturing. The Industry 5.0 concept has a more human-centric focus than previous industrial revolutions, which focused more on the economic side of sustainability (Leng et al., 2022). The goal of Industry 5.0, which is thought of as the next stage in industrial evolution, is to combine the creativity of human specialists with effective, intelligent, and precise machinery to provide manufacturing solutions that are more user-friendly and resource-efficient than those of Industry 4.0 (Maddikunta et al., 2022).

In order to combat a resurgent strategic drift, Industry 5.0 is a crucial driving factor for industrial progress. This approach is the ideal instrument for fostering human-machine cooperation inside intelligent cyber-social systems and ensuring a sustainable, human-centred, and resilient enterprise. Only when industrial systems use digital strategy to advance digital development is a complete shift to

Industry 5.0 possible (Babkin et al., 2022). Industry 5.0 development concept points to significant advancements in the automation, robotisation, and digitisation of hypothetical processes that support economic growth, as well as in relation to sustainable development and climate strategies, particularly in the environmental field, with clear reserves and risks (Majernik et al., 2022).

Research Methodology

The usage of information and communication technology has led to a progressive increase in interest in bibliometric study. The topicality of the sphere is also demonstrated by the number of publications devoted to the bibliometric analysis of the concept of Industry 4.0. The bibliometric analysis was carried out by, to name a few, Muhuri et al. (2019); Nedjwa (2022); Rosario and Dias (2022); de Freitas Vilela and Filho (2022); Khoshroo and Talari (2022); Moiceanu and Paraschiv (2022); Kumar et al. (2022); Machado et al. (2022); Razmjooei et al. (2023); and another.

We shall conduct a bibliometric examination of Industry 4.0's and Industry 5.0's ideas in this academic article. The scientific database Web of Science, which is now the most well-known independent scientific database in the world, provided us with the data we required for the investigation. One of the main reasons why the Web of Science database was chosen is the fact, as already mentioned, that it is one of the most respected and world-famous scientific databases. In this database, we can find a number of publications in the world's most famous journals that deal with the investigated issues. The database contains several journals, conference proceedings, and book chapters that are recognised worldwide and written by renowned academics. In addition, data from the Google Scholar database cannot be processed through VOSviewer. We found the information by searching for "Industry 4.0" and "Industry 5.0." It suggests we were only concerned with establishing that link. We received a total of 20,151 articles for the phrase "Industry 4.0" from the WoS database between the years 2012 and 2022. 293 articles were identified for the phrase "Industry 5.0" between 2016 and 2022. In the case of the search for the term Industry 5.0, publications from earlier years were also found, but the connection was not with the current issue (it was just a mention of the term industry in the table, while the value five (5) was given in the adjacent column). All data obtained from the Web of Science database had to be rechecked or modified, as an error occurred with keywords that contained 4.0 or 5.0. In some scientific publications, keywords are separated by a period. In such cases, however, the term Industry 4.0 was divided into two keywords, namely *Industrie*s *4* and *0*. This had to be corrected so that the results of the bibliometric analysis of the keywords were correct.

We graphically processed individual graphic displays in MS Excel. The VOSviewer software was used to do a bibliometric analysis of keywords and co-authorship by country of origin. Clusters will be found for both analyses, and they will be separated by colour. There are two key parts to the bibliometric map. Links and bubbles are the subject. The size of the node represents how often the keyword occurs, and the more frequently it occurs, the larger the bubble. The connection between the bubbles depicts the co-occurrence of phrases (i.e., keywords that occur or occur together). The frequency of concurrent or consecutive occurrences of phrases, or the co-occurrences of keywords, is represented by link thickness. It is true that the denser the relationship between the bubbles, the more frequently common occurrences between keywords are likely to occur. Each colour represents a thematic cluster, and the nodes and connections within each cluster may be used to describe both the connections (links) between topics (bubbles) that occur inside a specific topic as well as the coverage of topics (bubbles) within that topic (cluster). Tab 1 provides an overview of the key phases of this study's production.

Table 1. An overview of the steps in the article (Source: on processing)

Searched Used Terms	Searched Used Terms	Searched Used Terms	Searched Used Terms	Searched Used Terms
Industry 4.0	2012 – 2022	Web of Science™	Bibliometric analysis	VOSviewer
Industry 5.0	2016 – 2022			

Research results

The data were obtained from the Web of Science database and subsequently processed using VOSviewer and MXS Excel. Based on the results, it was possible to obtain the detailed information necessary for bibliometric analysis.

From Figure 2, we can see how the publication trend dealing with Industry 4.0 has developed over the years. The first publication about Industry 4.0 published in the WoS database dates back to 2012. In total, only two publications were published that year. The trend continued to increase in the following years; the highest increase was recorded in 2019 when 4,252 publications were published. The year-on-year increase was 2,192 publications. There was a slight decline in 2020, while the number of publications increased again in 2021. In 2022, 3,848 scientific publications were published in the WoS database.

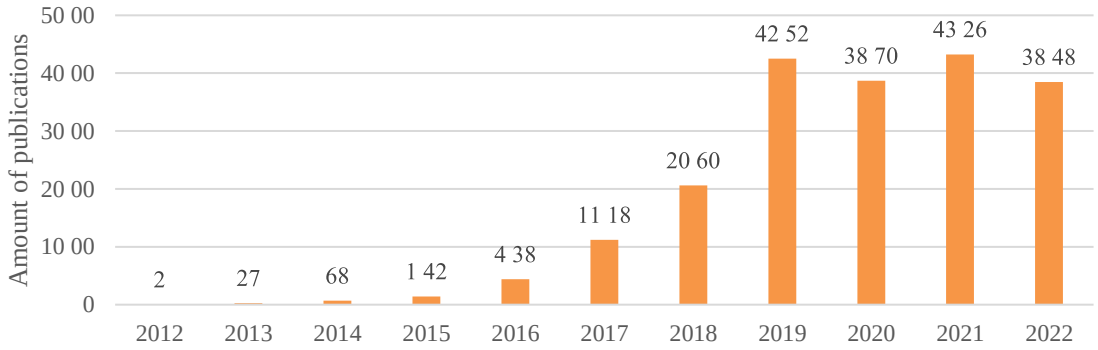


Fig. 2. Annual growth of documents' number related to Industry 4.0 in WoS during the period 2012-2022 **(**Source: Own processing)

If we follow the development trend of publications devoted to Industry 5.0, it is still growing. From 2016 to the present, the trend has been increasing. For the first time, the term "Industry 5.0" appeared in the WoS database in 2016, when one publication was published. The development trend gradually doubled in 2 years. In 2021, 58 publications were published. The following year, the number almost quadrupled to 201 publications.

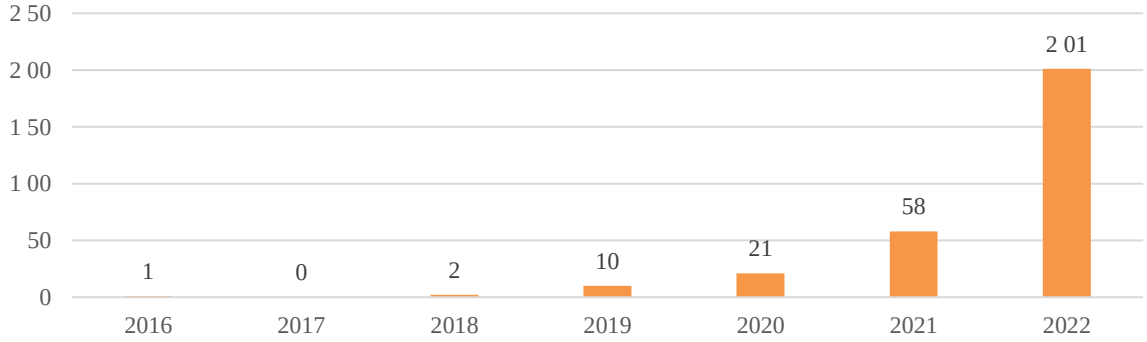


Fig. 3. Annual growth of documents' number related to Industry 5.0 in WoS during the period 2016-2022 **(**Source: Own processing)

From the point of view of the countries that are most devoted to the issue of Industry 4.0, it is necessary to mention Germany, with 2,450 publications and Italy, with 2,318 publications. China has the third-highest number of scientific articles (1,515), followed by the USA (1,220), India (1,198), and Great Britain with 1,277 publications. For Great Britain, we counted publications for England (1,064), Scotland (121), Wales (69), and Northern Ireland (23). Among the countries of the Visegrad Group, Poland (859) and the Czech Republic (842) are the most active in the field. In the third place, there is Slovakia, with a total of 539 publications, while in the overall ranking, it is in the 15th place. Hungary has the fewest publications from the Visegrad Group (V4), approximately 282. Of the neighbouring countries of the Slovak Republic, Austria has 509 publications, and Ukraine has 234 publications.

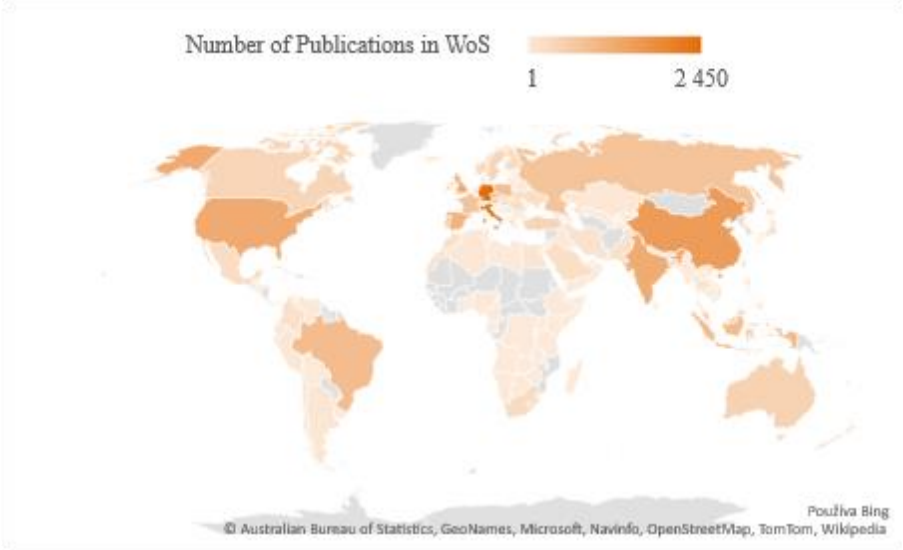


Fig. 4. Number of documents related to Industry 4.0 in WoS during the period 2012-2022 according to countries (Source: Own processing)

The term "Industry 5.0" is mostly covered by China, with 45 publications, followed by India with 42, the USA with 38, Italy with 37, and Great Britain with 27 publications. Great Britain's publications consisted of England (24) and Scotland (3). Poland (8) has the most publications from the V4 countries, followed by Slovakia (6), Hungary, and the Czech Republic (3). Austria has 8 publications, and Ukraine 2. Germany has the same number of articles as Australia (19), and they are ranked 6th overall.

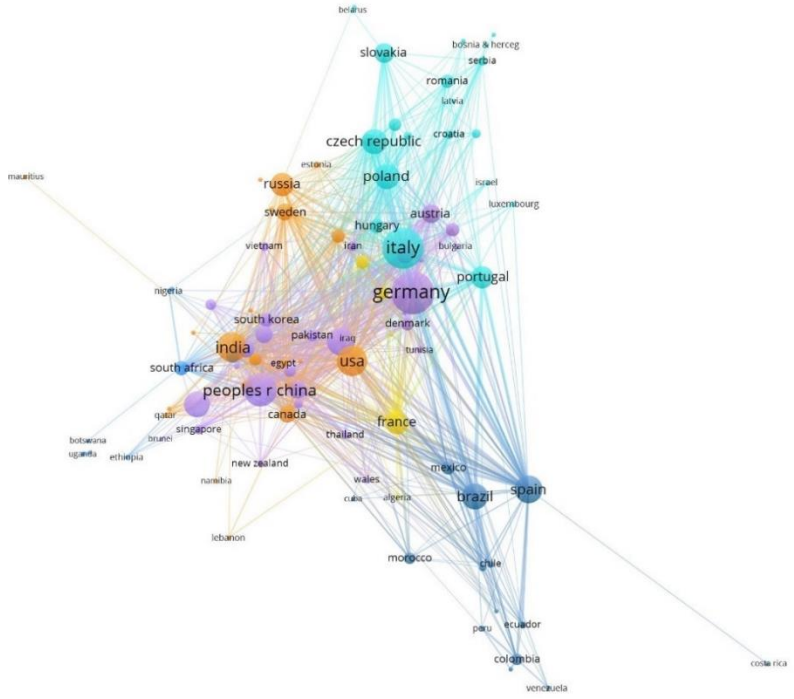


Fig. 5. Bibliometric map of the co-authorship countries for Industry 4.0 during the period 2012-2022 (Source: Own processing)

The largest cluster is shown in orange with 22 elements. These include countries such as India, the USA, Russia, and Sweden. The USA has the most occurrences, with 1,221 entries. The number of connections is 77, with a total strength of 1,341. Countries such as Italy, Poland, the Czech Republic, Slovakia, and Portugal are shown in turquoise. Italy has 73 connections with a total strength of 1,258 and 2,320 occurrences. China, Indonesia, and Australia are shown in purple; this cluster contains 19 countries. The most numerous country is China, with 1,515 occurrences, 76 links, and a total link strength of 1,275.

Spain, Brazil, Mexico, and Colombia are highlighted in dark blue, while a total of 14 countries are shown in this colour. Spain has a total of 70 connections with a total strength of 817. Germany, Austria, and Greece are shown in dark purple. This cluster contains 10 countries, the most numerous of which is Germany (2,541). Germany has 75 links altogether, with a total link strength of 2,541. The blue cluster contains nine countries, including, e.g., South Africa, Norway, etc. South Africa has the most connections (58), with a total strength of 265. The smallest cluster is yellow, which contains only six countries, such as France, Belgium, and the Netherlands. France has 65 links with a total strength of 821.

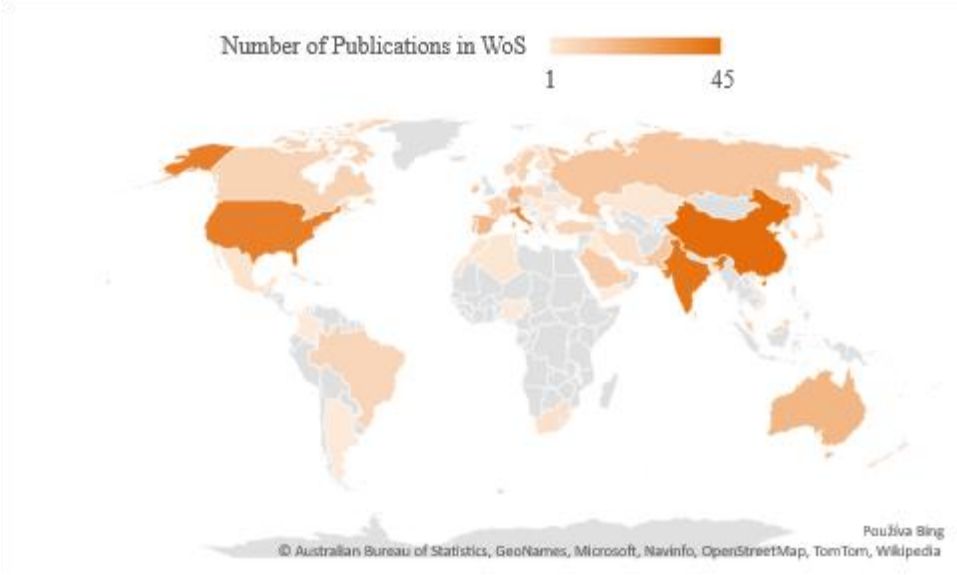


Fig. 6. Number of documents related to Industry 5.0 in WoS during the period 2016-2022 according to countries (Source: Own processing)

The minimum number of documents for one country was set at 5, which reduced the number from 68 countries to 30. The most numerous cluster is the orange one, which contains 12 items. In this cluster, the most numerous country is India, with the number of publications at 42, the number of links at 25 and a total strength of links at 68. Subsequently, this group also included Spain, Ireland, Portugal, etc. The remaining three clusters have six items each. In the turquoise cluster, the most numerous country is China, with 45 publications, a total of 17 links and a total link strength of 49. In addition to China, this category also includes Australia, South Korea, etc. The dark blue cluster contains the USA, Sweden, Slovenia, and Poland. The USA is the most numerous, with 38 publications, a total link strength of 61, and 25 links. The last cluster is purple, where Italy, Germany, and Greece are located. Italy has the most significant link strength (39), with 37 publications and 18 links.

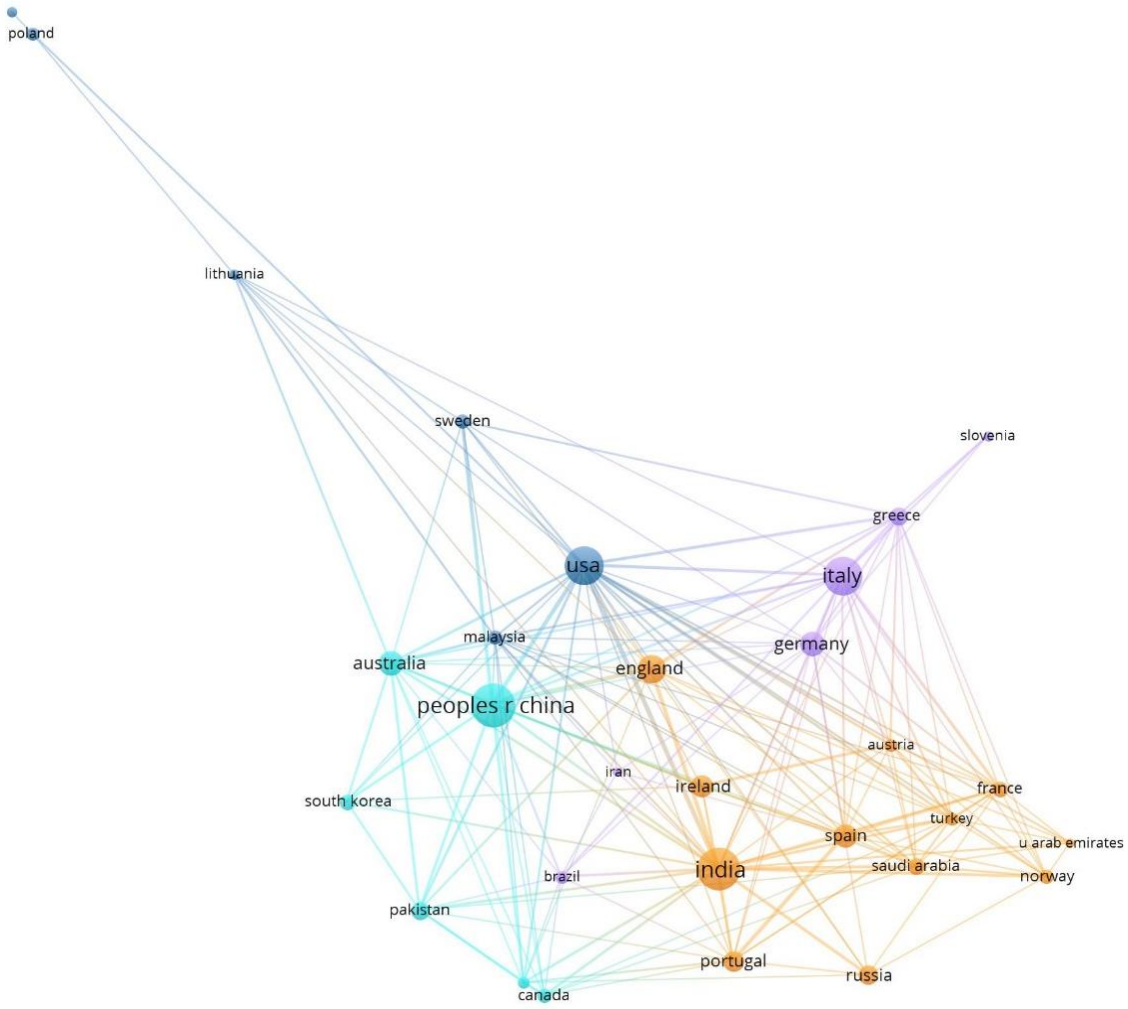


Fig. 7. Bibliometric map of the co-authorship countries for Industry 5.0 during the period 2016-2022 (Source: Own processing)

The minimum number of documents for one keyword was set at 5, which reduced the number from 42,288 keywords to 3,321. Six clusters were created, the largest of which contained 268 items and is shown in orange. The keyword with the highest occurrence in this cluster is 'Industry 4.0', with an occurrence of 8,649 words and a total link strength of 41,610 and 998 links. The 'Performance' had the second-highest occurrence (845), with 785 links and a total link strength of 6,238. A group with 224 elements is shown in turquoise. The most numerous word is 'Model' (851 occurrences), with a link strength of 6,222 and a total link strength of 851. The keyword 'System' has 772 links, with an occurrence of 792 and a total link strength of 4,949. The third cluster is shown in purple, with a total number of 215 elements. The cluster contains words such as 'Internet' or 'Internet of Things'. The 'Internet' has a total link strength of 9,218 with 832 links and a peak of 1,163. The dark blue cluster contains 176 elements. Terms such as 'management', 'future', 'framework', and 'sustainability' are included here. 'Management' appears 1,290 times, with a total link strength of 10,142 and 866 connections. The dark purple cluster contains 80 elements, with the most numerous word being 'design' (1,218), with 833 links and a total link strength of 7,508. The smallest cluster is shown with 37 elements. 'Big data' has a link strength of 8,247, with an occurrence of 1,093 and a total number of links of 838.

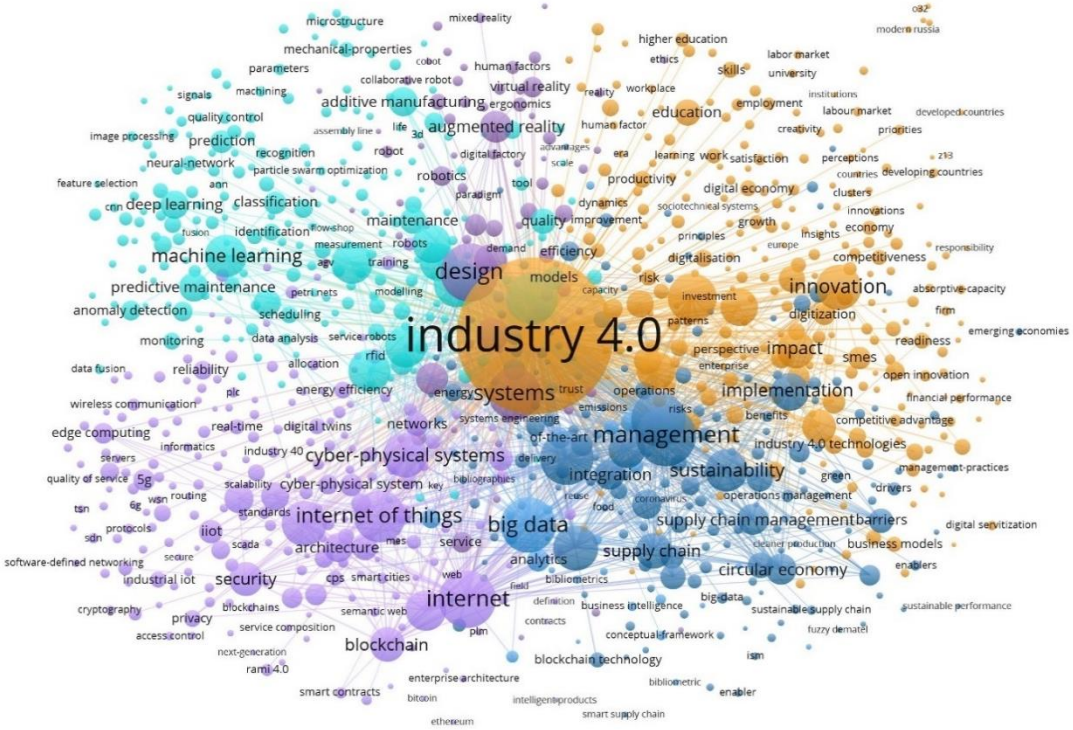


Fig. 8. Bibliometric map of the keywords Industry 4.0 during the period 2012-2022 (Source: Own processing)

The minimum number of documents for one keyword was set at 5, which reduced the number from 68 keywords to 30. The most numerous is the orange cluster, which contains 23 items. The most numerous keyword is ‘design’ with a frequency of 28 and a total link strength of 2,127 and 58 links. The second most numerous word is ‘framework’, with a frequency of 25, 64 links and a total link strength of 154.

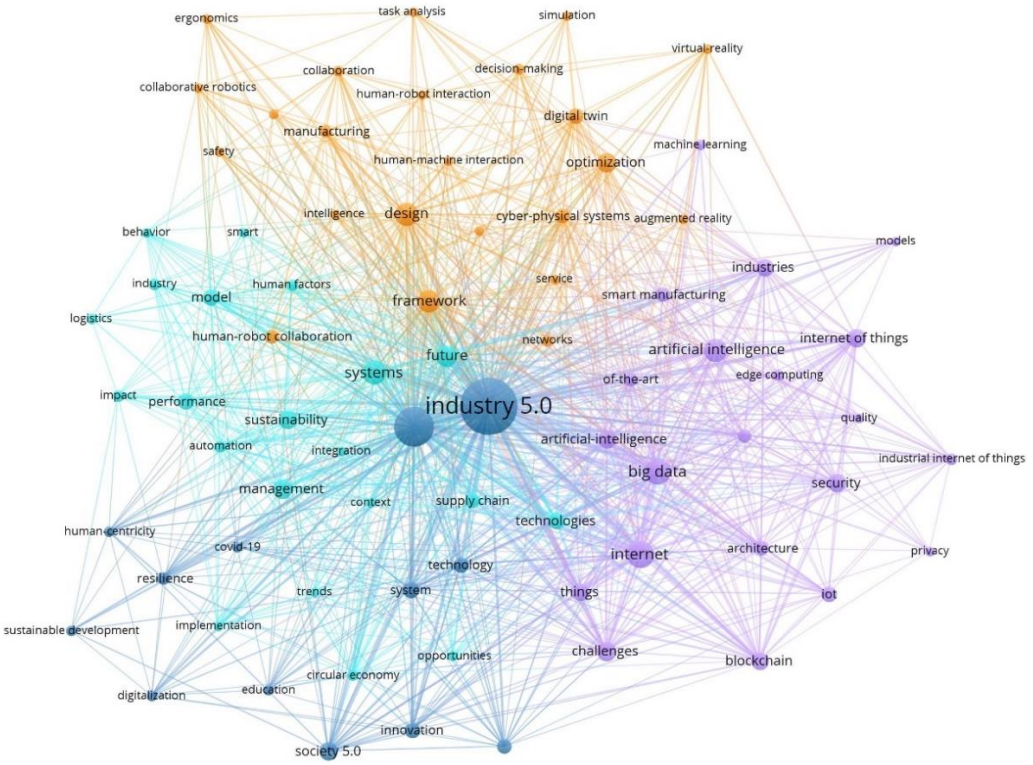


Fig. 9. Bibliometric map of the keywords Industry 5.0 during the period 2016-2022 (Source: Own processing)

It is followed by a turquoise and purple cluster with a frequency of 21. The most prominent word of the turquoise cluster is ‘system’ with link strength 139, frequency 30 and 56 links. Keywords such as future, management, or sustainability follow. The purple group contains words such as ‘big data’, ‘artificial intelligence’, and ‘Internet’. It is the internal one that has the most connections (37), with a connection strength of 59 and a total occurrence of 37. The smallest cluster is blue, containing 13 elements. The most prominent keyword is ‘Industry 5.0’, with a frequency of 153, a link strength of 558, and 76 links. It is followed by ‘Industry 4.0’ with 72 links, a frequency of 78, and a link strength of 392.

Figure 10 shows the most numerous WoS categories used for ‘Industry 4.0’. These are categories that contain more than 1,400 publications. Engineering Industrial is the most used category; it has been used up to 3,347 times. Next comes the Engineering Manufacturing category, to which 3,174 publications are assigned. Over 3,000 entries went to Engineering Electrical Electronic (3,115). Computer Science categories are also frequently used, namely CS Theory Methods (2,872), CS Information Systems (2,463), or CS Artificial Intelligence (2,157). They are followed by categories such as Automation Control Systems (1,942), CS Interdisciplinary Application (1,854), Telecommunication (1,585), and Management (1,463).

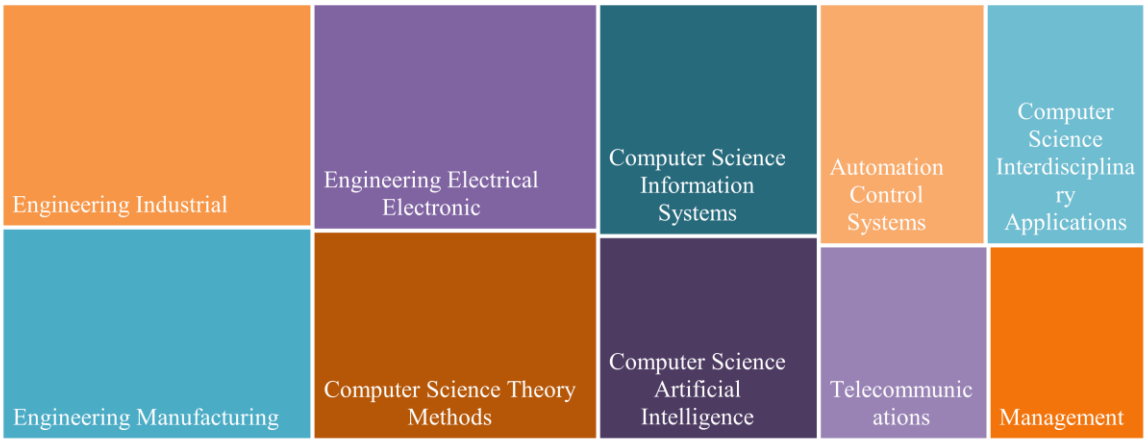


Fig. 10. WoS categories of documents related to Industry 4.0 during the period 2012-2022 (Source: Own processing)

Scientific worker Elena G. Popkova from the Moscow State Institute of International Relations currently has the most articles in the WoS database devoted to Industry 4.0. The author is listed 45 times as an author or co-author of publications that deal with the issue under investigation. Radek Martinek has 42 publications; he works at the Technical University of Ostrava.

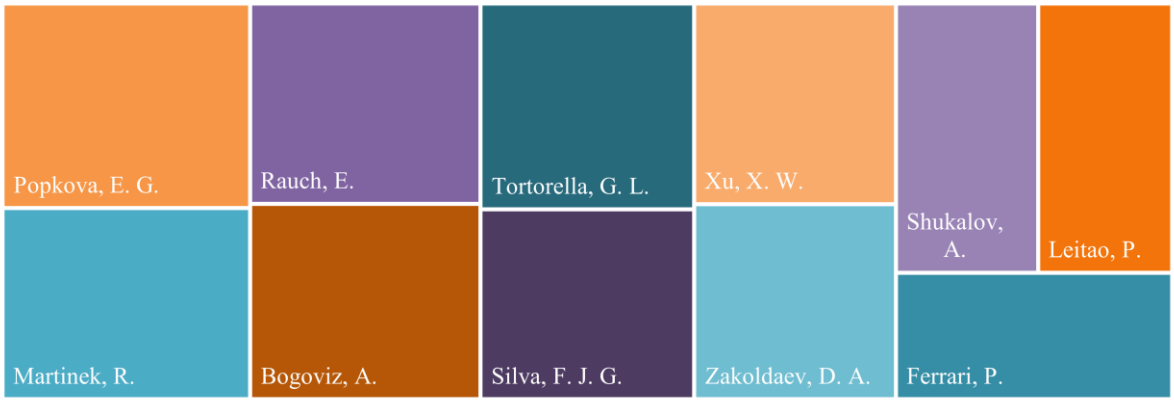


Fig. 11. The most published authors devoted to Industry 4.0 during the period 2012-2022 (Source: Own processing)

The third author is Erwin Rauch, who has written 41 publications and works at the Free University of Bozen-Bolzano. Other important authors include Bogoviz (40), Tortorella (39), Silva (36), Xu (36), Zakoldaev (35), Shukalov (34), Leitao (32), and Ferarri (31). From Slovakia, Maria Kozlovska, who works at the Technical University of Košice, has the most publications (21).

We also created a bibliometric map to identify scientific alliances. Due to the large amount of data and the fact that some of the more than 1000 items were not interconnected, we decided to display only the most extensive set of connected items of 513 items. The total number of clusters after adjustment was 9, while the minimum number of items in one cluster was 30, which eliminated the smallest clusters. The most numerous cluster contains 72 items. It is shown in turquoise. Brigit Vogel-Heure has the most documents from this cluster, namely 33, while the number of links is 14, and the total strength of the link is 18. This cluster also includes authors such as Christian Diedrich, Petr Novak, and Arndt Leuder. Authors such as Guido Guizzi, Silvestro Vespoli, Dmitry Ivanov, Maurizio Faccio, Marco Macchi, and Fernando Castano can be found in the pale purple cluster. 72 authors were also placed in this cluster.

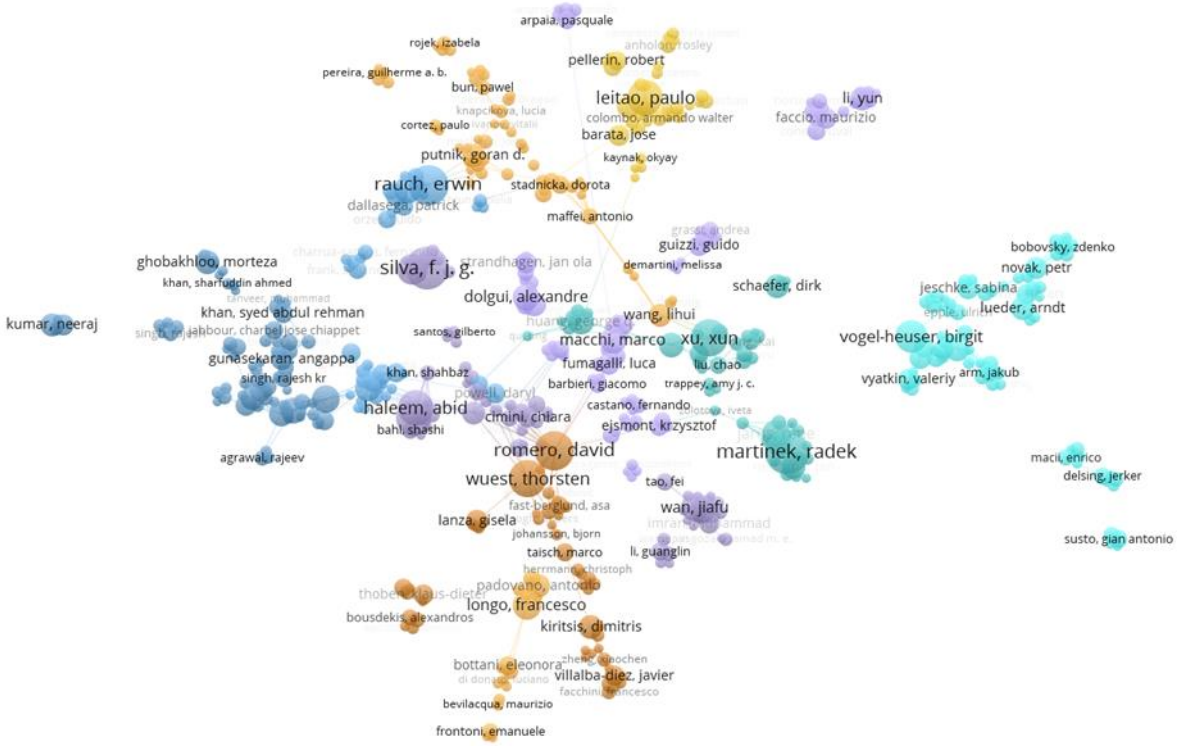


Fig. 12. Bibliometric map of the co-authorship for Industry 4.0 during the period 2012-2022 (Source: Own processing)

The orange group consists of 70 authors, such as Antonio Maffeim, Lihiu Wang, Gaultiero Fantoni, Francesco Longo, Antonio Padovano, Eleonora Bottani, and others. The dark blue cluster contains a total of 68 authors, such as Rajesh Singh, Jose Arturo Garza-Reyes, Sunil Luthra, Yigit Kazancoglu, Anil Kumar, etc. F. J. G. Silva, Jiafu Wan, Di Li, and Abid Haleem, Paolo Gaiardelli were included in the dark purple cluster. The dark turquoise cluster included authors such as Radek Martinek, Xun, Xu Ray R. Zhong, George Q. Huang, Dirk Schaefer, Rene Jaros, and others. The brown cluster grouped authors such as David Romero, Thorsten Wuest, Gisela Lanza, Dimitris Kiritsis, and many others. Erwin Rauch, Dominik T. Matt, Guilherme Luz Tortorella, and Patrick Dallasega were placed in the blue cluster. The smallest cluster is yellow, with authors like Paulo Leitao, Damien Trentesaux, etc. The creation of scientific alliances in the case of Industry 5.0 makes no sense, as this map has no informative value for the reader.



Fig. 13. The most published authors devoted to Industry 4.0 during the period 2012-2022 (Source: Own processing)

Additionally, articles devoted to Industry 4.0 were published by the professional association IEEE. A total number of 4,446 publications were published until 2022. Another publisher is the Dutch academic publisher Elsevier, with 4,321 publications. Publishers Springer Nature (2,418), MDPI (1,966), Emerald Group Publishing (687), Taylor & Francis (672) and IOP Publishing Ltd (628) follow.

Discussion and conclusions

The paper written by Grabowska et al. (2022) set out to find areas in which the idea of Industry 4.0 may be made more sustainable and humane. Additionally, the authors used Web of Science data that was transformed by utilising VOSviewer tools. The analysis of the dynamics of the rise in publications in the Industry 4.0 and Industry 5.0 segments is one of the most significant findings. For Industry 4.0, the research period for the authors was from 2012 to 2020, and for Industry 5.0, from 2020 to 2021.

Madsen and Berg's (2021) study provides an exploratory bibliometric analysis of the emerging literature on Industry 5.0, which is a new visionary concept for the future of the industry. The authors' aims were to map the field and provide a preliminary picture of the emergence and status of the scientific literature on Industry 5.0. Bibliometric data covering the period from 2015 to 2021 were extracted from the Scopus database. The majority of the publications belongs to engineering (45); computer science (40); business, management and accounting (17). The trend of publications about Industry 5.0 has a growing tendency. These growing trends support the findings of our research.

According to Cannavacciuolo et al. (2023), Industry 4.0 is a developing subject that is receiving more and more attention from the scientific community. The findings of this study are also valuable because they highlight the crucial role that governments and public agencies played in facilitating the socio-economic adjustments required to fully take advantage of Industry 4.0's technological advancement.

Kumar et al. (2022) gathered eight hundred and ninety-one articles from 2014 to 2020 from the Scopus database to carry out their research work. Researchers aimed to conduct a bibliometric investigation and visual evaluation of IoT in Industry 4.0 evolution to link the disparity in the available literature analysis and research directions. They used VOSviewer and Biblioshiny 2.0. Kumar et al. found out that, the paper "Intelligent Manufacturing in the Context of Industry 4.0: a review" by Zhong et al. (2017) was rated first with 754 citations, followed by "Industry 4.0: state of the art and future trends" by Xu et al., (2018). Industry 4.0 appeared first in 2014 with the application of IoT in Industry 4.0 with an overall appearance of 528.

The findings of the comparative bibliometric analysis Jafari et al. (2022) performed on the two collections of literature show that there is a growing trend in addressing the societal, human, and sustainability aspects, which are the key components of Smart Logistics in Industry 5.0 [6], in order to emphasise the coherence between technological advancement and human-centric socio-economic

transition. The analysis of the most often used phrases demonstrates that Industry 4.0's Smart Logistics focuses exclusively on the technological underpinnings. On the other hand, Industry 5.0 significantly promotes interaction between people, technology, and the environment through human-robot collaboration, collaborative robots, man-machine systems, etc. In addition to emphasising the adoption of new technologies in Smart Logistics operations. The authors agreed with our conclusions.

Authors researched Industry 4.0 in the context of shipping (Yang et al., 2023), the Internet of Things (Kumar et al., 2022), supply chains and circular economy (Hettiarachchi et al., 2022), artificial intelligence and machine learning (Mateo & Redchuk, 2022), Lean management tools (Nedjwa et al., 2022), operations management (Sordan et al. 2022), maritime industry (Razmjooei et al., 2023), digital twin and smart manufacturing (Moiceanu & Paraschiv, 2022).

Based on the results, it can be concluded that Industry 4.0 is a field of constant interest for scientists, on which they are constantly working. The rapidly growing trend of publications stopped in 2019 and subsequently decreased but increased again in 2021, only to decrease the following year. These trends are not caused by the emerging interest in Industry 5.0. Industry 5.0 is a constantly emerging term, and its significant growth can be expected in the coming years.

Countries such as Germany, Italy, China, the USA and India are among the most publishing countries about I4.0. China, India, the USA, Italy, and Great Britain mainly deal with the term 'I5.0'. As can be seen, the countries that are dedicated to Industry 4.0 are also dealing with the concept of Industry 5.0. From the point of view of keywords, the most frequently used for the term 'Industry 4.0' are 'design', 'management', 'Internet', 'big data', 'model', and 'Industry 4.0'. The term 'Industry 5.0' can be characterised by terms such as 'big data', 'system', 'design', or 'Industry 5.0'. Publications are most often included in categories such as Engineering Industrial, Engineering Manufacturing, Engineering Electrical and Electronic, Computer Science Theory and Methods, Computer Science Information Systems, etc. Authors such as Popkova, Martinek, Rauch, Bogoviz, and others have the most publications about Industry 4.0 in the WoS database. The most frequent publications on the researched issue are published by IEEE, Elsevier, Springer Nature, MDPI, and others.

The summary of theoretical launching points from the fields of Industry 4.0 and Industry 5.0 is the scientific article's additional value. This analysis is essential for authors dealing with Industry 4.0 and Industry 5.0 issues. Our study brings up-to-date information from the theoretical field, and at the same time, we inform scientific authors about the most published authors in the researched field. Using this, they can find their scientific articles, which will make their work easier for scientists when comparing research or expanding knowledge in the researched area. At the same time, we provide the authors with information about the most frequently used keywords that are used in the investigated issues of Industry 4.0 and Industry 5.0. If authors want to find out about publications from the country in which they are conducting their research, they can find in this scientific publication how many similar scientific contributions are in the Web of Science scientific database as of 2022.

A limitation of the research can be considered the fact that the bibliometric analysis was performed only from the data of the Web of Science scientific database. Data from this database is considered the most relevant. On the other hand, publications by authors that were not published in the most famous indexed journals were omitted from the research. A more extensive examination of the issue with a focus on other scientific databases such as SCOPUS or Google Scholar will be the intention of the authors in their further in-depth research on the examined issues of Industry 4.0 and Industry 5.0.

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