Society 5.0 Research: Performance Analysis and Science Mapping

Toplum 5.0 Araştırması: Performans Analizi ve Bilimsel Haritalama

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Abstract

The concept of Society 5.0 has become a new research phenomenon aimed at creating a better and super-intelligent human-centered society to help tackle long-term social changes. Today, Society 5.0 is a prominent and evolving field. While this area of research is still new, it is important to examine how much it has evolved. This study aims to examine the bibliometric features and trends of scientific research related to Society 5.0. To this end, the Bibliometrix library provided by the R software is used to analyze the scientific research on Society 5.0 in the Web of Science database. The analysis results provide valuable insights into the number of publications, citations, featured authors, institutions, countries, sources, and keywords in the Society 5.0 field. It is expected that the study results will guide researchers in the field of Society 5.0 to understand the field and identify research gaps.

Keywords: *Society 5.0, Super Smart Society, Bibliometric, Performance Analysis, Science Mapping*

Öz

Toplum 5.0 kavramı, uzun vadeli sosyal değişikliklerin üstesinden gelmeye yardımcı olmak için daha iyi ve süper akıllı insan merkezli bir toplum yaratmak için yeni bir araştırma olgusu haline geldi. Toplum 5.0 günümüzde öne çıkan ve gelişmeye devam eden bir alandır. Bu araştırma alanı aslında henüz oldukça yeni olsa da ne kadar geliştiğini incelemek önemlidir. Bu çalışma, Toplum 5.0 ile ilgili bilimsel araştırmaların bibliyometrik özellikleri ve eğilimlerini incelemeyi amaçlamaktadır. Bu doğrultuda Web of Science veri tabanında Toplum 5.0 ile ilgili elde edilen bilimsel araştırmaları analiz etmek için R yazılımı tarafından sunulan Bibliometrix kütüphanesi kullanılmaktadır. Analiz sonuçları Toplum 5.0 alanındaki yayın sayıları, atıf sayıları, öne çıkan yazarlar, kurumlar, ülkeler, kaynaklar ve anahtar kelimeler ile ilgili değerli iç görüler sağlamaktadır. Çalışma sonuçlarının Toplum 5.0 alanındaki araştırmacılara, alanı anlamak ve araştırma boşluklarını tespit etmek için kılavuz olacağı düşünülmektedir.

Anahtar Kelimeler: *Toplum 5.0, Süper Akıllı Toplum, Bibliyometrik, Performans Analizi, Bilimsel Haritalama*

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Introduction

Society 5.0 is a concept that was presented in Japan's 5th Science and Technology Master Plan covering the fiscal period between 2016 and 2021 and was approved by the Cabinet on January 22, 2016. The concept was introduced to the world by Japanese Prime Minister Shinzo Abe at the Information Technologies Fair-CeBIT held in Germany in 2017. Society 5.0 is "the philosophy of social transformation in which people's relationship with machines and robots is ensured most efficiently by evaluating the impact of digital transformation in the world from demographic, economic, ethical, and sociological aspects" (Develi, 2017). It is the name of the new society model that the literature refers to as "Digital Society", "Creative Society" or, most commonly, "Super Intelligent Society" (Arı, 2021). Figure 1 below illustrates the stages of human society and the industrial revolution.
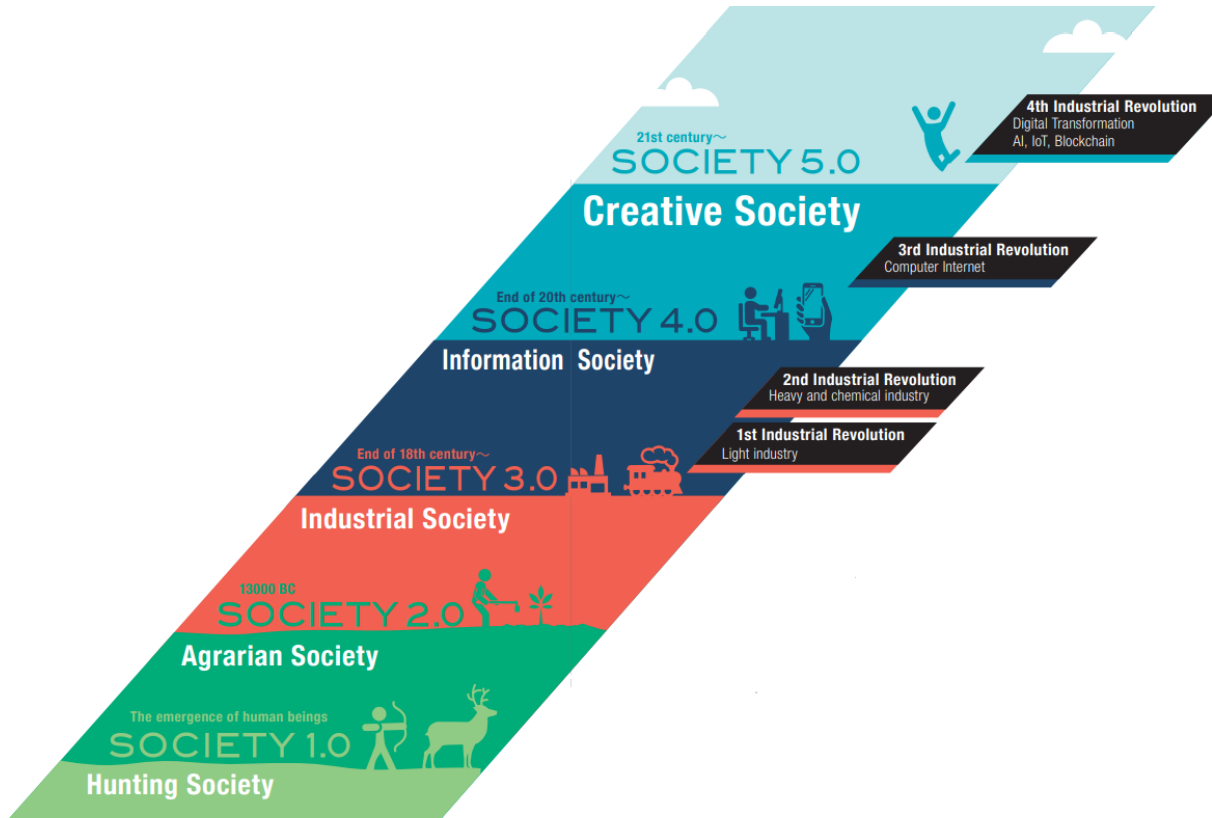

Figure 1. Development of Human Society

Source: Nakanishi & Kitano, 2018:5.

The 5th Science and Technology Basic Plan defined human societies in the past as the Hunting Society (Society 1.0), Agricultural Society (Society 2.0), Industrial Society (Society 3.0), and Information Society (Society 4.0). The concept of a Creative Society (Society 5.0) started to be discussed after the emergence of digital transformation. The concept of Society 5.0 has become a new research phenomenon aimed at creating a better and super-intelligent human-centered society to help tackle long-term social changes. The emergence of the concept of Society 5.0 highlights the importance of multidisciplinary research, which requires researchers from different specialties to study harmoniously together as a single research team. While this area of research is still new, it is important to examine how much it has evolved.

Researchers have adopted different qualitative and quantitative literature review approaches to understanding the available research. Unlike other techniques, bibliometrics offers a more objective and reliable review process based on the quantitative measurement of the relevant field or research (Broadus, 1987; Diodato, 1994; Pritchard, 1969). Bibliometric analysis is a rigorous and popular method of analyzing large volumes of research. This method allows one to examine the development of a particular field and to understand it more easily (Donthu et al. 2021). Although Society 5.0 is a developing concept in recent years, hundreds of scientific studies have been published in this field.

Purnomo et al. (2021) reviewed international research in the field of Society 5.0 using bibliometric analysis. Data from 57 studies covering the period between 2017 and December 2019 from the Scopus database were analyzed with the VOSviewer software. According to the analysis results, there is an increase in the number of Society 5.0 studies. In addition, the country with the most publications in research is Japan, the document type is article and the subject area is

computer science. However, no institution or researcher that stands out in terms of productivity was identified in the Society 5.0 studies. Similarly, Shahidan et al. (2021) applied bibliometric analysis on 142 studies obtained from the Scopus database for the period between 2017 and February 2021 to search the Society 5.0 literature. They provided a holistic perspective to Society 5.0 research by identifying the publications' bibliometric features, keywords, and topics. The analysis showed that Society 5.0 research has been influenced by the Industry 4.0 trend, and the Internet of Things (IoT) and artificial intelligence (AI) fields are prominent in Society 5.0 research. Roblek et al. (2021), on the other hand, used bibliometric analysis to examine Society 5.0 studies and identify future research trends. They reviewed 36 articles published in the Web of Science database between 2017 and March 2021. According to the results of the analysis, the most used keywords in the research in the last three years are cyber-physical systems, artificial intelligence, Society 5.0, super smart society, Industry 4.0, Industry 5.0, big data, and open innovation.

As seen in the literature, Society 5.0 is still a developing field. Although various studies tried to reveal the trends of research in the field of Society 5.0, the datasets used in these studies were limited, so their contributions were insufficient. Therefore, this study considers the bibliometric features and keywords of the studies to provide a broader framework about the Society 5.0 literature and trends and aims to apply bibliometric analysis to contribute to the literature. To this end, this study aims to answer the following research questions:

RQ1. What is the general information about the Society 5.0 studies?

RQ2. What is the distribution of Society 5.0 studies by year and the number of citations?

RQ3. Which countries stand out in Society 5.0 studies?

RQ4. Which higher education institutions contribute the most to Society 5.0 studies?

RQ5. Who are the prominent researchers in Society 5.0 studies?

RQ6. Which resources are most preferred in Society 5.0 studies?

RQ7. What are the titles, citation numbers and other citation information of the most cited studies in the field of Society 5.0?

RQ8. What are the frequently used keywords and trends in Society 5.0 studies?

1. Method

This study adopts bibliometric techniques that include both quantitative and statistical analysis to report scientific studies published on specific topics and in specific periods (Donthu et al. 2021). Analysis of bibliometric data is a systematic and repeatable process that includes quantitative measurements to review scientific publications, evaluate research articles, and identify trends and patterns over a given period (Broadus, 1987). This analysis allows researchers to understand the literature and facilitate knowledge creation by establishing multiple types of associations between bibliometric features of studies. This study followed the bibliometric analysis procedure proposed by Donthu et al (2021):

1. Defining the aims and scope of the bibliometric study,

2. Selecting techniques for bibliometric analysis,

3. Collecting data for bibliometric analysis,

4. Applying bibliometric analysis and presentation of findings.

1.1. Purpose and scope of the study

The first step is to define the purpose and scope of the bibliometric study, before choosing bibliometric analysis techniques and collecting bibliometric data.

This study aims to examine Society 5.0 studies. The study has two objectives. The first is identifying productive authors, institutions, countries, and journals in Society 5.0 research in terms of performance. The second is to uncover the bibliometric structure that encompasses networks between research components that contribute to the intellectual structure built on clusters of related themes in Society 5.0 research from a scientific perspective.

Because the analysis is designed to handle large volumes of bibliometric data, the field should generally be broad enough to perform bibliometric analysis (Ramos-Rodrígue & Ruíz-Navarro, 2004). If there are hundreds (for example, 500 or more) or thousands of articles, this area of research can be considered broad enough to warrant bibliometric analysis. Therefore, the data set of this study is suitable for use of bibliometric analysis as it includes 456 studies.

1.2. Bibliometric analysis techniques

The second step is to design bibliometric work. In this step, bibliometric analysis techniques are selected in accordance with the purpose and scope of the study determined in the first step. Donthu et al (2021) stated that a technique should be selected before the bibliometric analysis and then bibliometric data should be prepared in accordance with the selected technique. In this study, performance analysis and scientific mapping bibliometric techniques will be used. While performance analysis takes into account the contributions of research components, science mapping focuses on the relationships between research components (Donthu et al. 2021).

1.3. Data collection for bibliometric analysis

The third step is to collect the relevant data for bibliometric analysis techniques selected in the second step. Web of Science (WOS) database was used to obtain studies on Society 5.0. Thomas ISI Web of Science (WoS) database was selected for data collection. Unlike Scopus database, WOS has a wide scope since 1990. Although Scopus includes many journals, its impact is limited to articles published in recent years (Chadegani et al., 2013). This study adopted the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guideline for the data collection process (Page et al., 2021). Figure 2 contains the PRISMA Guide.
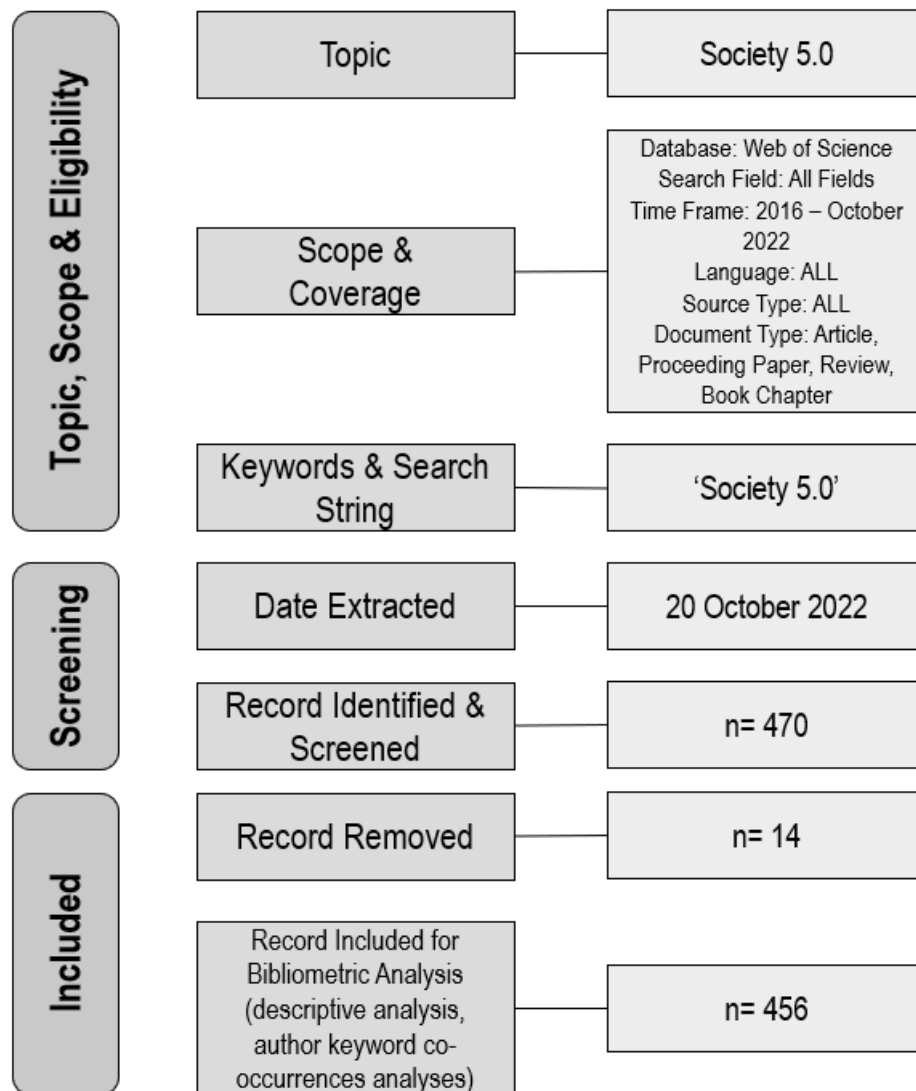
Topic, Scope & Eligibility		
	Topic	Society 5.0
	Scope & Coverage	Database: Web of Science Search Field: All Fields Time Frame: 2016 – October 2022 Language: ALL Source Type: ALL Document Type: Article, Proceeding Paper, Review, Book Chapter
	Keywords & Search String	'Society 5.0'
Screening	Date Extracted	20 October 2022
	Record Identified & Screened	n= 470
Included	Record Removed	n= 14
	Record Included for Bibliometric Analysis (descriptive analysis, author keyword co-occurrences analyses)	n= 456

Figure 2. PRISMA

The search was carried out on October 20, 2022. For the first step, the query "Society 5.0" was used in all fields in the WoS database. As a result of the search, 470 studies were obtained. Studies with document type Early access and Editorial were excluded. As a result, 456 studies directly related to Society 5.0 were identified. Two researchers performed the filtering process to ensure the reliability of the findings. The two researchers reached a consensus by negotiating the

studies to be included. As the studies were retrieved from the WoS database, their metadata was obtained in a plain text file format.

1.4. Bibliometric analysis

Bibliometrix library provided by R software was used for bibliometric analysis and synthesis. The Bibliometrix R-package (http://www.bibliometrix.org) provides a set of tools for bibliometrics and quantitative research. It is written in R, an open-source environment and ecosystem (Aria & Cuccurullo, 2017).

2. Results and Discussion

2.1. What is the general information about the Society 5.0 studies?

This section contains general information about the study. Figure 3 summarizes this general information.

Figure 3. General Information on Society 5.0 Studies

This study includes 456 documents about "Society 5.0" in the Web of Science database between 2016 and 2022. These documents were published in 245 different sources, and 1,221 authors contributed to these studies. 46 of them have a single author. The rate of international cooperation between the authors is 20.18%. The average number of authors per document is 3.62. Authors in 456 studies defined 1528 keywords and cited 14246 sources. The average life span of the documents is 1.61 years. The average number of citations of these documents was determined as 2,724.

Table 1 shows the distribution of publications by document type. Out of the 456 studies, 186 were articles, 1 was a book chapter, 256 were proceedings, and 13 were article reviews. A large part of the data repository consists of articles and proceedings papers.

Table 1. Distribution of Publications by Document Types

Document Types	Results
Article	186
Book chapter	1
Proceedings paper	256
Review	13
Total	456

2.2. What is the distribution of Society 5.0 studies by year and the number of citations?

Table 2 gives information about the number of publications by year, the average number of citations, the average number of citations per year, and the citation years.

Table 2. Distribution of Publications by Year, Average Number of Citations of These Publications and Average Number of Citations on Annual Basis

Year	N	MeanTCperArticle	MeanTCperYear	CitableYears
2016	1	0,00	0,00	6
2017	5	2,80	0,56	5

2018	40	2,40	0,60	4
2019	42	3,50	1,17	3
2020	133	3,13	1,56	2
2021	150	3,03	3,03	1
2022	85	1,35	-	0

Only one study was published in 2016. This publication has not been cited for 6 years. Five studies were published in 2017. These publications were cited 2.80 times on average. These studies were cited 0.56 times per year. 40 studies on Society 5.0 were published in 2018. While these studies were cited 2.40 times on average, the average annual citation is 0.60. While 42 studies in 2019 were cited 3.50 times on average, they were cited 1.17 times on an annual basis. The highest average citation amount belongs to 2019. In 2020, 133 studies on Society 5.0 were published and these studies were cited 3.13 times on average. These studies were cited 1.56 times on an annual basis. In 2021, the highest number of publications was reached. In 2021, 150 studies were published, and these studies were cited 3.03 times on average in 1 year. In 2022, the number of publications decreased. This is because 2022 is not over yet. Studies published so far in 2022 were cited 1.35 times on average in a short time, which can be considered a high number.

2.3. Which countries stand out in Society 5.0 studies?

Table 3 contains information on the 20 countries with the highest number of publications on Society 5.0. This information includes the number of publications, the number of single-country publications (SCP), the number of multiple-country publications (MCP), the ratio of the total number of publications of the country to the total number of publications, and the ratio of the number of multiple-country publications to the total number of publications. Considering these data, Japan is the most productive country with 155 publications. This value corresponds to 0.34 of the total number of publications. In short, Japanese authors contributed to 1 out of 3 studies. While Japanese authors made 137 of these studies with authors in their own countries, they collaborated with authors from other countries in 18 of them. They collaborated with other countries in almost 1 out of 9 studies. In terms of efficiency, Japan is followed by "Indonesia", "Czech Republic", "Italy" and "Russia", respectively. The most effective countries in terms of cooperation with other countries are "China" and "Malaysia" with a value of 0.556. These countries collaborated with other countries in more than half of their publications. Türkiye is in the last row of the table. All 5 studies originating in Türkiye were conducted within the country. Studies in Türkiye have not established cooperation with authors in other countries. Other countries that do not have author cooperation with other countries are "South Africa", "Indıa" and "Philippines".

Table 3. Most Productive Countries and Data Related to These Countries

No	Country	Articles	SCP	MCP	Freq	MCP_Ratio
1	Japan	155	137	18	0,34	0,116
2	Indonesia	101	89	12	0,221	0,119
3	Czech Republic	16	10	6	0,035	0,375
4	Italy	13	10	3	0,029	0,231
5	Russia	13	10	3	0,029	0,231
6	China	9	4	5	0,02	0,556
7	Malaysia	9	4	5	0,02	0,556
8	Poland	9	5	4	0,02	0,444
9	South Africa	9	9	0	0,02	0
10	Switzerland	9	7	2	0,02	0,222
11	Brazil	8	6	2	0,018	0,25
12	Canada	8	5	3	0,018	0,375
13	USA	8	4	4	0,018	0,5
14	India	7	7	0	0,015	0
15	Slovenia	7	5	2	0,015	0,286
16	Colombia	5	4	1	0,011	0,2
17	Philippines	5	5	0	0,011	0
18	Portugal	5	4	1	0,011	0,2

| 19 | Singapore | 5 | 1 | 4 | 0,011 | 0,8 |
| 20 | Türkiye | 5 | 5 | 0 | 0,011 | 0 |

Table 4 gives data on the effective countries in the Society 5.0 domain. The evaluation of the effective countries is based on citation numbers and average citation numbers. Japan has the highest number of citations. Japan is followed by "Indonesia", "USA", "Italy" and "Slovenia" in terms of the number of citations. It is noteworthy that "Czech Republic", which is in the 4th place in terms of the number of publications, could not be among the top 20 countries in terms of the number of citations. In terms of the average number of citations, "Morocco", which has only one publication, ranked 12th with 24 citations. Another country that draws attention with an average citation rate of 11.38 is the "USA". Ranking 2nd in terms of total citations and publications, "Indonesia" is the country with the lowest average number of citations. Therefore, the average number of citations is also an important indicator of effectiveness.

Table 4. Effective Countries, Number of Citations and Average Number of Citations

No	Country	TC	Average Article Citations
1	Japan	391	2,52
2	Indonesia	109	1,08
3	USA	91	11,38
4	Italy	89	6,85
5	Slovenia	64	9,14
6	Poland	59	6,56
7	Russia	45	3,46
8	Australia	35	8,75
9	Brazil	34	4,25
10	United Kingdom	30	6,00
11	Canada	26	3,25
12	Morocco	24	24,00
13	Portugal	24	4,80
14	Colombia	21	4,20
15	Croatia	18	9,00
16	Germany	18	6,00
17	China	17	1,89
18	Mexico	17	4,25
19	Türkiye	16	3,20
20	India	15	2,14

2.4. Which higher education institutions contribute the most to Society 5.0 studies?

Figure 4 shows the publication information of the 10 most productive institutions in the field of Society 5.0.
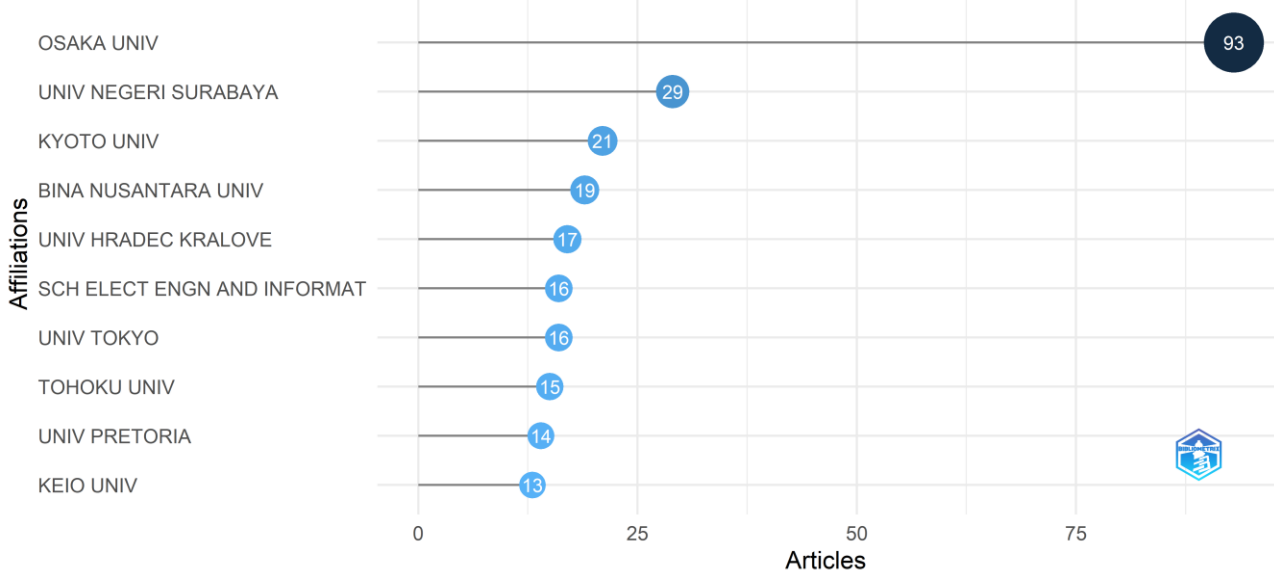

Figure 4. Most Productive Institutions

"Osaka Univ" is the institution that publishes the most in the field of society 5.0. Located in Japan, this university has contributed to a total of 93 publications. This university contributed to 1 of every 5 publications published in the field of Society 5.0. Located in Indonesia, "Univ Negeri Surabaya" is the second institution that contributes the most to the field with 29 publications. However, there are great differences in the number of publications between "Osaka Univ" and "Univ Negeri Surabaya". "Osaka Univ" has contributed more than three times as much work as "Univ Negeri Surabaya", making it the most productive institution in the field. The number of publications of institutions after "Univ Negeri Surabaya" is close to each other. "Kyoto Univ" in Japan, "Bina Nusantara Univ" in Indonesia, and "Univ Hradec Kralove" in the Czech Republic follow "Osaka Univ" and "Univ Negeri Surabaya" in the number of publications. In terms of the origin of the institutions, the superiority of Japan, Indonesia, and the Czech Republic draw attention.

Figure 5 shows the change in the number of publications of the institutions in Figure 4 over time. This change is given cumulatively. The color of each institution is explained at the bottom of the figure.
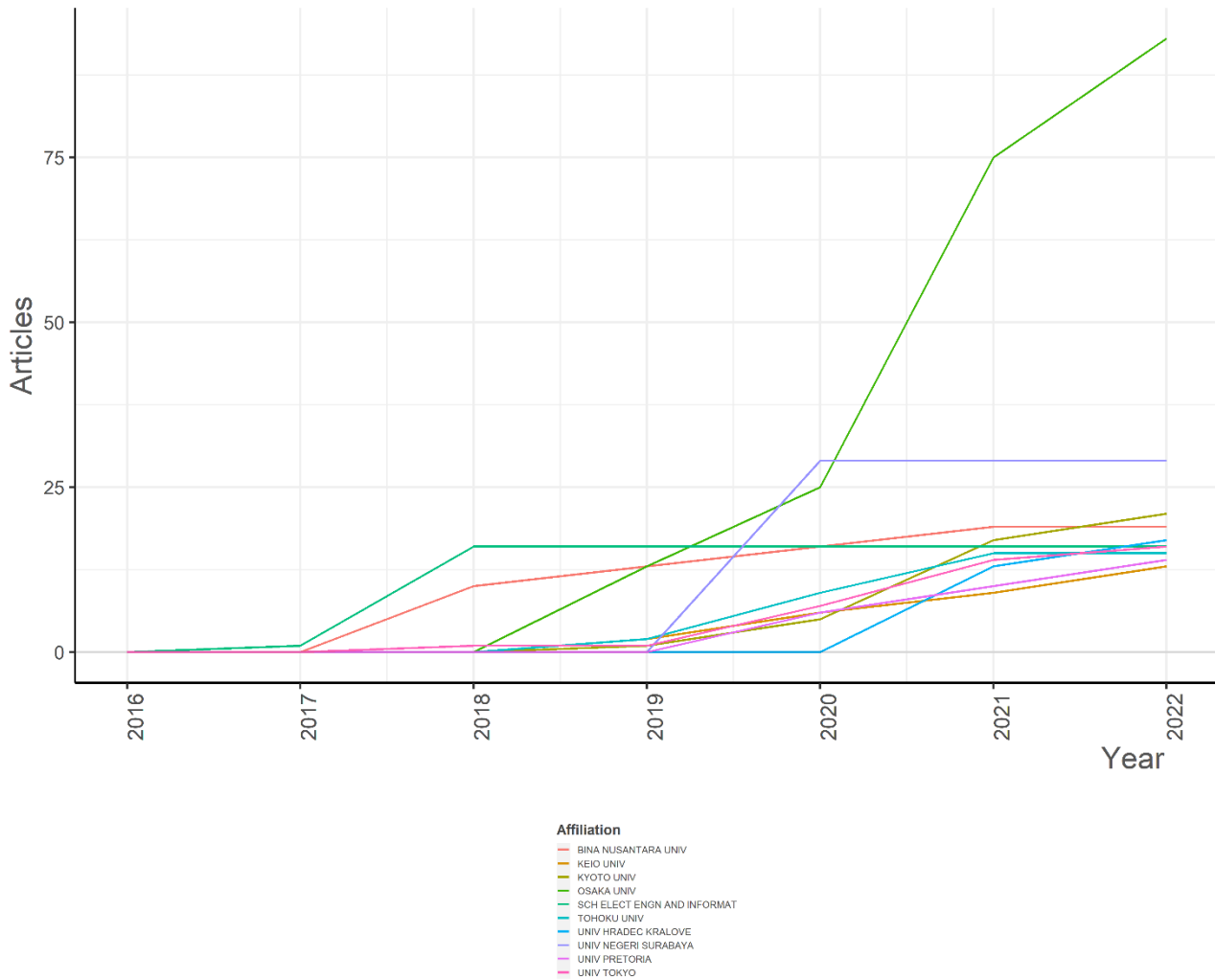
Affiliation Production over Time

Figure 5. Cumulative Representation of Publications by the Most Efficient Institutions by Time

According to this Figure 5, "Sch Elect Engn And Informat" ranked first in terms of the number of publications in 2017. While "Sch Elect Engn And Informat" maintained its first rank in 2018, "Bina Nusantra Univ" attracted attention and placed in the 2nd rank. After 2018, the number of publications of "Sch Elect Engn And Informat" has not increased. In 2019, "Osaka Univ" shares second place with "Bina Nusantra Univ", although the ranking remains the same as in 2018. In 2020, "Osaka Univ" remains in second place, while "Univ Negeri Surabaya" is in the first place. In 2021, "Osaka Univ" took over the leadership from "Univ Negeri Surabaya", increasing the difference over time. "Kyoto University", which rose to third place in 2022, continued its rise by making a rapid entry into the field as of 2020.

2.5. Who are the prominent researchers in Society 5.0 studies?

Figure 6 gives information about the 10 most productive authors in terms of the number of publications in the field of Society 5.0. In light of this information, the author who published the most in the field of Society 5.0 is Miyaji A with a total of 22 publications. Miyaji A is followed by Supangkat SH with 12 publications, Ishiguro H with 11 publications, and Noda S with 10 publications, respectively. Miyaji A has almost twice as many publications as his successors Supangkat SH and Ishiguro H.
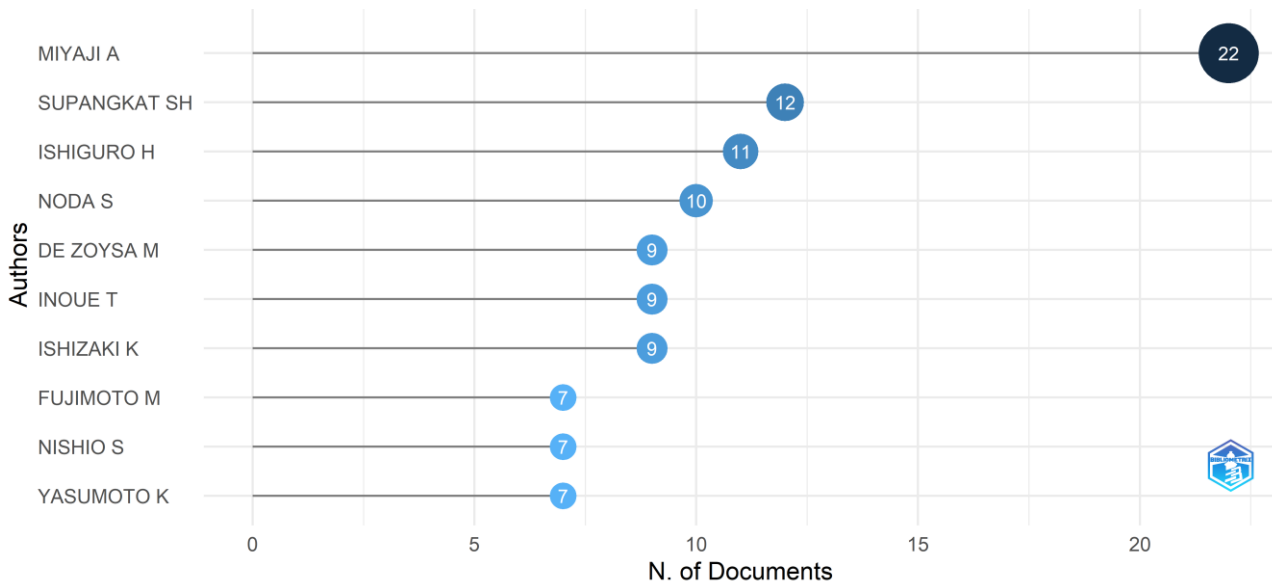
Figure 6. The Most Productive Researchers in the Field of Society 5.0

Table 5 gives information about the effectiveness of the researchers. The table was created based on the h-index value. The H-index is one of the indexes that indicates the effectiveness of the researchers. The table also gives information about the g-index and m-index values of the respective researchers, the number of citations (TC), the number of publications (NP), and the first year of their publication in the field (PY_Start).

Table 5. Effective Authors in the Field of Society 5.0

Authors	H_index	G_index	M_index	TC	NP	PY_Start
Carayannis EG	4	5	2	76	5	2021
De Zoysa M	4	8	1,333	64	9	2020
Inoue T	4	8	1,333	64	9	2020
Ishizaki K	4	8	1,333	64	9	2020
Noda S	4	8	1	67	10	2019
Gelleta J	3	5	0,75	31	6	2019
Guskova N	3	3	0,75	27	3	2019
Hatsuda R	3	4	1	38	4	2020
Ishiguro H	3	3	0,75	17	11	2019
Nishio S	3	3	0,75	14	7	2019

G-index refers to the maximum value that the h-index can reach. It is considered an improved version of the H-index. In short, the g-index value is the square root of the number of citations and then rounding to the obtained value. However, the g-index value cannot be greater than the total number of publications, as in the h-index value. For example, if Noda S has 67 citations, its square root is 8.18. This value is rounded down to 8. If the number of publications is over 8, the g-index value is accepted as 8. According to the Table, the g-index value of Noda S is 8.

The m-index is another variant of the h-index. It gives the average h-index value since the first publication. For example, the h index value of Carayannis EG is 4 according to Table 5. He made its first publication in 2021. Citations in Carayannis' publications cover the years 2021 and 2022. Therefore, this data covers two years. The m-index value is obtained by dividing the h-index value of 4 by these two years. As seen in the Table, the m-index value of Carayannis EG is 2.

According to Table 5, the authors most effective in terms of h-index are Carayannis EG, De Zoysa M, Inoue T, and Ishizaki K. Although Carayannis EG has the least publication among these four authors. It is noteworthy that he is the author with the highest m-index value in the Table. Carayannis EG can be accepted as a rising value in this field. In terms of the G-index, De Zoysa M, Inoue T, Ishizaki K, and Noda S are the leading authors. The reason why Carayannis EG falls behind here is that he has a total of 5 publications. Naturally, the m-index value cannot be above five. But when he publishes a new study, the m-index value will increase directly, even if it is not cited. With the current number of citations, the m-index

value will increase to 8 when the total number of publications in the field is 8. This highlights the importance of the number of citations.

2.6. Which journals and conferences are preferred most in Society 5.0 studies?

Table 6 gives information about the number of studies of the 10 most preferred journals and conferences in the field of Society 5.0.

Table 6. Preferred Journals and Conferences in the Field of Society 5.0

Sources	Articles
2020 Third International Conference on Vocational Education and Electrical Engineering (ICVEE): Strengthening the Framework of Society 5.0 Through Innovations in Education, Electrical, Engineering and Informatics Engineering	71
2018 International Conference on Ict for Smart Society (ICISS)	34
Sustainability	17
Society 5.0	15
Hradec Economic Days	10
IEEE Access	8
Sensors	6
Physical Review Research	5
IEEE Revista Iberoamericana De Tecnologias Del Aprendizaje-IEEE RITA	4
IEICE Transactions on Information and Systems	4

The most productive journal is Sustaınabılıty, an open-access journal with 17 publications. "IEEE Access", "Sensors", "Physical Review Research", "IEEE Revista Iberoamericana De Tecnologias Del Aprendizaje-IEEE RITA", and "IEICE Transactions on Information and Systems" also follow this journal, respectively. However, the superiority of "Sustainability" journal in the field is quite remarkable.

The most productive conference is the "2020 Third International Conference on Vocational Education and Electrical Engineerıng (ICVEE): Strengthening the Framework of Society 5.0 Through Innovations in Education, Electrical, Engineering And Informatics Engineering", with 71 publications. This conference is followed by the "2018 International Conference on Ict for Smart Society (ICISS)", "Society 5.0", and "Hradec Economic Days", respectively. "2020 Third International Conference on Vocational Education and Electrical Engineerıng (ICVEE): Strengthening the Framework of Society 5.0 Through Innovations in Education, Electrical, Engineering And Informatics Engineering" contains more research than the total number of publications of other congresses in the table. Table 7 gives information about effective journals in the field of Society 5.0.

Table 7. Effective Journals and Conferences in the Field of Society 5.0

Source	h_index	g_index	m_index	TC	NP	PY_Start
Sustainability	8	12	2,667	160	17	2020
2018 International Conference on Ict for Smart Society (ICISS)	4	7	0,8	76	34	2018
Journal of the Knowledge Economy	4	4	2	73	4	2021
Sensors	4	5	1	32	6	2019
2020 Third International Conference on Vocational Education and Electrical Engineerıng (ICVEE): Strengthening the Framework of Society 5.0 Through Innovations in Education, Electrical, Engineering And Informatics Engineering	3	4	1	24	71	2020
CMC-Computers Materials & Continua	2	2	1	6	2	2021
Hradec Economic Days	2	2	1	6	10	2021
IEEE Access	2	3	0,667	14	8	2020
IEEE Internet of Things Journal	2	2	2	22	2	2022
IFAC Papersonline	2	2	0,5	7	4	2019

"Sustainability" journal, in the first row of the table, is ahead in terms of h-index, g-index, m-index, and the number of citations. There is no harm in saying that it is the most effective journal in this field. In terms of h-index and g-index values, the "2018 International Conference On Ict For Smart Society (ICISS)", "Journal Of The Knowledge Economy And Sensors" follow the "Sustainability" journal. As can be seen here, publications in journals are ahead of conference publications in terms of effectiveness. One of the biggest proofs of this is that the congress, which was in first place in the number of publications, has regressed to fifth place in terms of effectiveness.

2.7. What are the titles, citation numbers and other citation information of the most cited studies in the field of Society 5.0?

Table 8 gives information about the most cited studies in the field of Society 5.0. Readers can review the articles by using the relevant DOI numbers. These studies can be considered pioneers of the field. Examining these studies will contribute to the development of people who are interested in the field.

Table 8. Most Cited Studies in the Field of Society 5.0

Paper	DOI	Total Citations	TC Per Year
Fukuda K, 2020, Int J Prod Econ	10.1016/j.ijpe.2019.07.033	62	20,67
Potocan V, 2021, Kybernetes	10.1108/K-12-2019-0858	39	19,50
Foresti R, 2020, Engineering-Prc	10.1016/j.eng.2019.11.014	36	12,00
Cvitic I, 2021, Int J Mach Learn Cyb	10.1007/s13042-020-01241-0	34	17,00
Acioli C, 2021, Int J Product Perfor	10.1108/IJPPM-03-2020-0137	30	15,00
Aquilani B, 2020, Sustainability-Basel	10.3390/su12218943	28	9,33
Gladden ME, 2019, Soc Sci-Basel	10.3390/socsci8050148	28	7,00
Carayannis EG, 2022, J Knowl Econ	10.1007/s13132-021-00763-4	25	25,00
Tabaa M, 2020, Energy Rep	10.1016/j.egyr.2020.09.022	24	8,00
Rahmandita A, 2018, Int Conf Ict Smart S	10.1109/ICTSS.2018.8549942	23	4,60

Kayano Fukuda's (2020) study titled "Science, technology, and innovation ecosystem transformation toward society 5.0" is the most popular publication in the field with 62 citations. The average annual citation for this publication is 20.67, placing it in second place. The study titled "Society 5.0: balancing of Industry 4.0, economic advancement and social problems" by Potočan V. et al. (2021) was ranked second with 39 citations, with an average annual citation of 19.50. The publication with the highest number of citations with 25.00 belongs to one of the most active authors, Carayannis EG. The study "Smart Environments and Techno-centric and Human-Centric Innovations for Industry and Society 5.0: A Quintuple Helix Innovation System View Towards Smart, Sustainable, and Inclusive Solutions" by Carayannis EG et al. was published in 2022 and received 25 citations.

2.8. What are the frequently used keywords and trends in Society 5.0 studies?

Under this heading, important terms in society 5.0 have been identified. The terms were first listed under the themes and a strategic diagram of these themes was created. In the second stage, the development of the 10 strongest terms in these themes according to years was examined. In the third stage, two-year evolution maps of terms were created and how they affected each other over time was examined. Then, a Conceptual Structure Map of the terms was created using the MCA method. Finally, the dendrogram map of the clusters obtained regarding the terms is given.

Figure 7 shows the resulting strategic diagram. Strategic diagrams consist of 4 parts. Motor themes are concerned with the strengthening and development of the research field. While niche themes express strong relationships, they lack a significant background in the field. Emerging or declining themes refer to themes that appear and disappear over time. Basic themes are known as general themes in the field (Viedma, 2020).

The figure shows 11 different themes. Of these themes, 1 was accepted as the motor theme, 5 as the niche theme, 1 as the emerging and disappearing theme, and 4 as the main theme. The Components of Industry 4.0 theme included in the motor theme refers to the components of industry 4.0. The terms that stand out under this theme are "internet of things", "artificial intelligence", "blockchain", "machine learning", "cyber-physical systems", "big data", "cloud computing", "data mining", "edge computing" and "feature extraction". The most striking niche theme is the "Smart City" theme. The notable terms under this theme are "smart cities", "privacy", "cyber security", "data protection" and "data visualization". This theme is about the security and privacy of smart cities. Another striking theme among niche themes is "Security". The terms that draw attention under this theme are "neural network", "security", "authentication", "cryptography", "femtosecond laser

processing", "hardware" and "hardware security". This theme emphasizes network and hardware security in general. Other niche themes are "Communication Support", "Digital economy" and "Enterprise architecture". "Communication Support" is interested in reducing employee anxiety through effective communication using android robots. "Digital economy" means taking precautions against the dangers brought by the digital economy with the development of the digital economy. "Enterprise architecture", on the other hand, emphasizes the importance of corporate architecture in e-government. DSS (Decision Support System), which is included in the "Emerging or Declining" theme, stands out in eliminating the deficiencies in health services that have emerged with covid-19 and in providing more effective decision-making. "The Development of Industry 5.0" included in "Basic Themes" is the theme with the highest density. The prominent terms in this theme are "industry 4.0", "sustainability", "industry 5.0", "covid-19", "deep learning", "digitalization", "smart society", "digital transformation", "sustainable development", and "sustainable development goals". The foundations of "Industry 5.0" are based on industry 4.0, digitalization, and sustainability. Another important theme in "Basic Themes" is "E-learning". Important terms for this theme are "e-learning", "education" and "Google classroom". Especially during the covid-19 period, the transition of many government institutions to online education paved the way for the emergence of this theme. "Virtual Try-On" is another prominent theme. The prominent terms in this theme are "augmented reality", "eyewear computing" and "gamification". With "Virtual Try-On", which is based on "augmented reality", many services, including games, can be experienced virtually. The last theme is HRI "Human-robot interaction" in "Basic Theme". It refers to the study of the relationship between humans and robots. In this context, it benefits from many different fields such as artificial intelligence, robotics, and natural language processing.
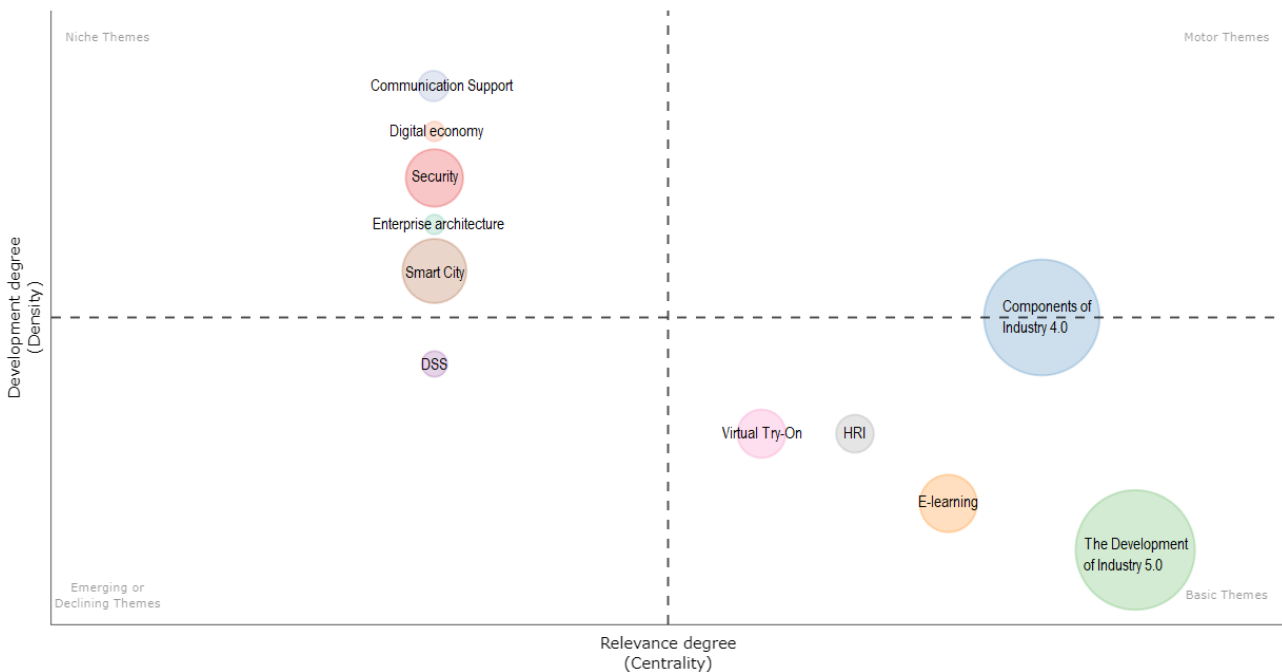

Figure 7. Strategic Diagram

Figure 8 is an illustration of the cumulative evolution of the 10 most striking terms in the field of society 5.0. These terms that draw the most attention in the field of society 5.0 are artificial intelligence, augmented reality, blockchain, covid-19, e-learning, industry 4.0, industry 5.0, internet of things, smart city, and sustainability. If the strengths of these terms are examined on an annual basis, smart city studies have gained intensity in 2018. But then there was a recession until 2020 and it lost its first place in 2018. In 2022, it dropped to eighth place. Industry 4.0 studies, which started to rise in 2018, took over the leadership in 2019 and came to the forefront in 2022. The Internet of things came to the fore in 2019 and took second place and managed to maintain its ranking until 2022. Artificial intelligence, which started to rise in 2020, is the third term with the highest interest in 2022. Another term that started to rise in 2020 is sustainability. "Sustainability", which has become one of the important terms in the field, rose to fourth place in 2022. "Industry 5.0" is one of the important terms that managed to stand out as of 2021. "Industry 5.0", which managed to become one of the most important terms in the field in a short time, found itself in fifth place in 2022.
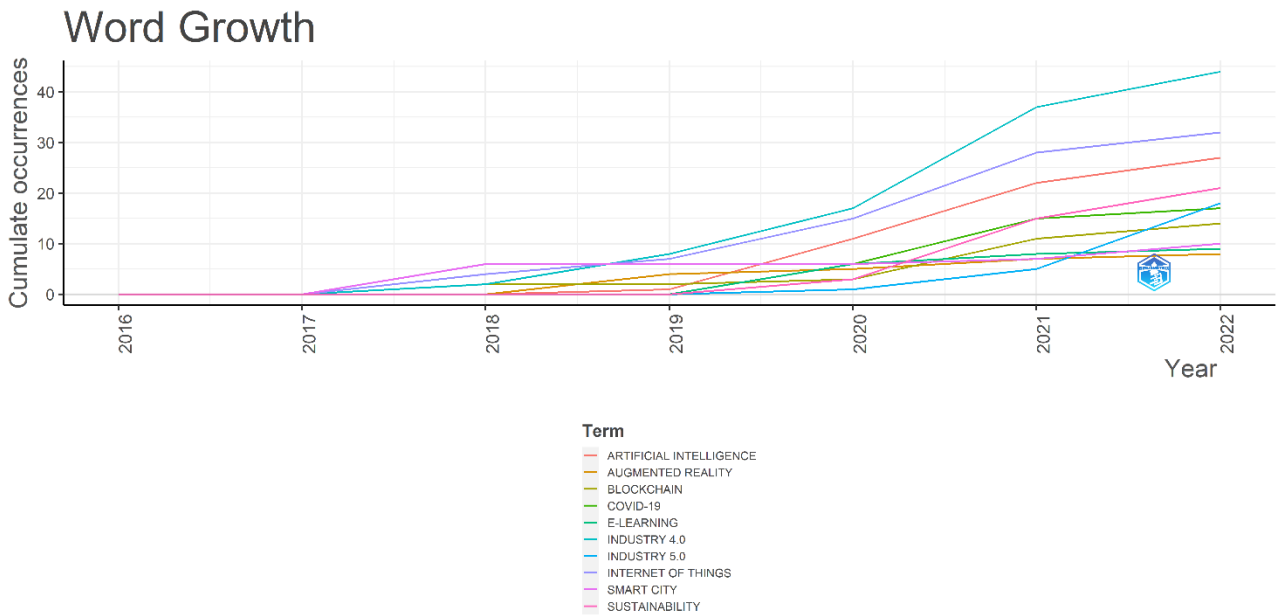
Figure 8. Temporal Development of the 10 Most Powerful Terms in the Field

Figure 9 shows how the most important terms in the field interact and evolve over 3 periods (2016-2018, 2019-2020, 2021-2022). The 3 terms that stood out in the period between 2016 and 2018 are "industry 4.0", "internet of things", and "data mining". The length of the bars indicates the strength of the terms. 7 terms stand out in the period between 2019 and 2020: "industry 4.0", "covid-19", "digitalization", "machine learning", "sustainable development", "augmented reality", and "e-learning". Of these terms, only "industry 4.0" and "machine learning" are related to previous periods. Other terms have no connection with the previous period. "Industry 4.0" in the period between 2019 and 2020 has a connection with "industry 4.0" and "internet of things" in the period between 2016 and 2018. "Industry 4.0" continued on its way by increasing its power with the contributions of the "internet of things" in the period between 2019 and 2020. "Data mining", which was one of the main terms in the period between 2016 and 2018, was associated with "machine learning" in the period between 2019 and 2020. Considering the strength of "covid-19" in the period between 2019 and 2020, it can be considered that it plays an important role. Research in this area became more frequent during this period but continued as a contribution to other areas in the next period between 2021 and 2022. In the period between 2021 and 2022, 9 different terms came to the fore: "industry 4.0", "neural network", "augmented reality", "big data", "e-learning", "machine learning", "deep learning", "sustainable" development goals", and "blockchain". The strongest among these terms is "industry 4.0", which is also the leader of previous periods. "Industry 4.0" in the period between 2019 and 2020 also enabled new research areas to emerge in the period between 2021 and 2022. The term "industry 4.0" contributed to the emergence of the terms "neural network", "big data", "sustainable development goals", and "blockchain". The terms "e-learning", "augmented reality" and "machine learning", which were prominent terms in the period between 2019 and 2020, managed to become one of the prominent terms in the period between 2021 and 2022. "Industry 4.0", which was the most important term in the period between 2021 and 2022, had an even stronger place in the field with the contributions of "covid-19", "digitilization" and "sustainable development".
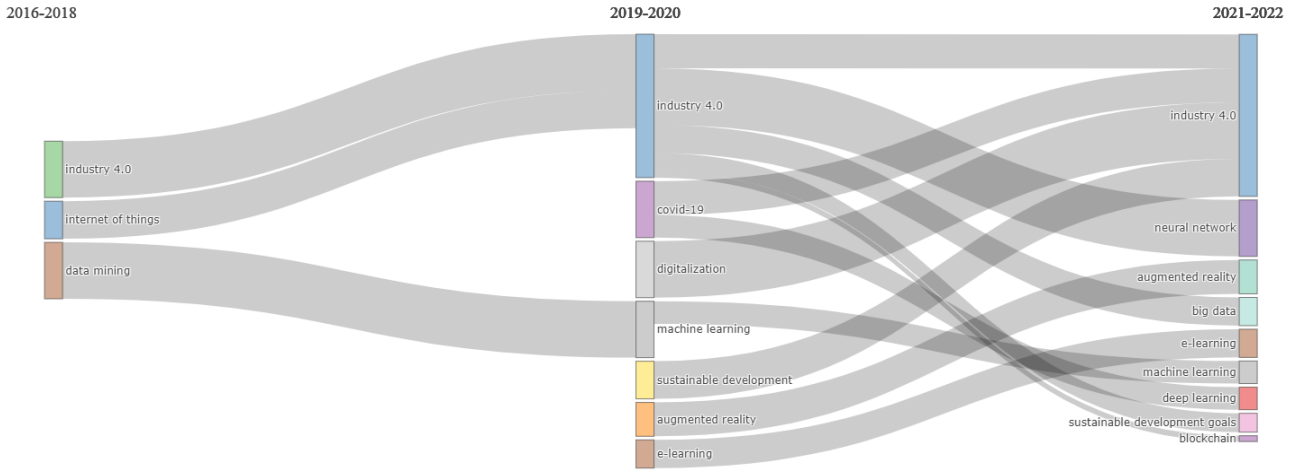
Figure 9. The Development of the Most Important Terms in the Field and Their Impact on Each Other

Figure 10 is a two-dimensional "Conceptual Structure Map". This map was produced using the "conceptualStructure function" in bibliometrix. In this context, the function first performs "Multiple Correspondence Analysis". "Multiple Correspondence Analysis" is an exploratory analysis method that can show the relationship between variables in two-dimensional space and helps to detect the spatial distribution of terms. Then, these terms are divided into clusters with the k-means algorithm (Aria and Cuccurullo 2017; Shi, 2020). Terms that approach the center point are those that have received more attention in recent years (Xie, 2020).
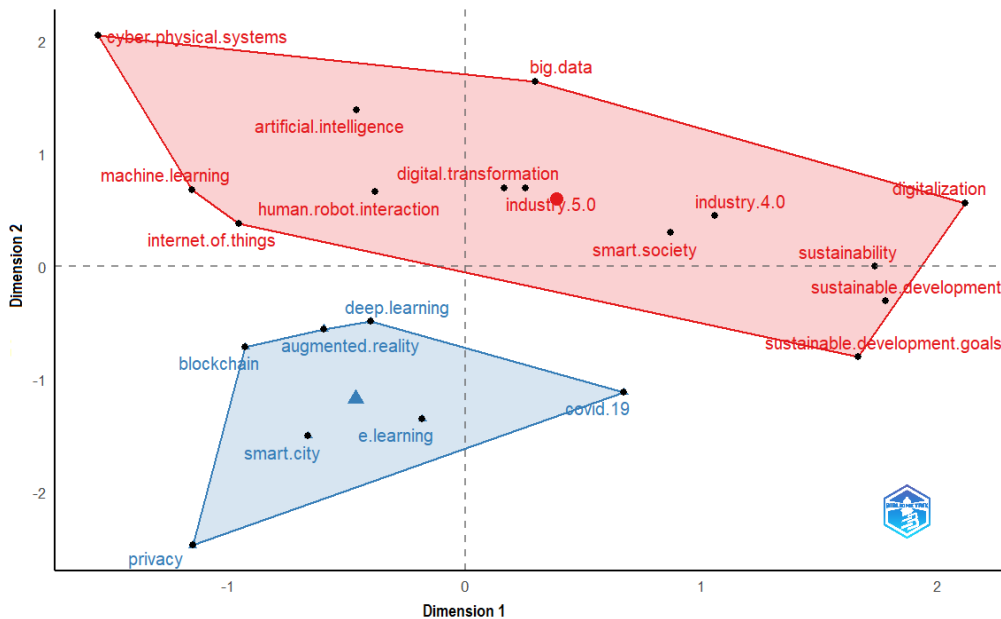

Figure 10. Conceptual Structure Map of Society 5.0

According to Figure 10, there are 13 terms in the red cluster. The big red dot inside the cluster indicates the center of the cluster. At the center of the cluster are "industry 5.0" and "digital transformation". Other elements of the cluster are "cyber-physical systems", "machine learning", "internet of things", human-robot interaction", "artificial intelligence", "big-data", "smart society", "industry 4.0" , "sustainability", "sustainable development", "sustainable development goals", and "digitalization"'. This cluster generally concentrates on the main elements of "Industry 4.0" and "industry 5.0". The main elements of "Industry 4.0" are "cyber-physical systems", "internet of things", "artificial intelligence" and "big-data" (Kamber, 2019). The main elements of "Industry 5.0" can be considered as "sustainability", "sustainable development", "sustainable development goals", human-robot interaction", and "digitalization" (Huang, 2022).

There are 7 terms in the blue set. At the center of the cluster are "e-learning" and "smart cities". Other terms include "privacy", "blockchain", "augmented reality", "deep learning", and "covid-19". The center of this cluster is "e-learning" and "smart city". The terms "privacy" and "blockchain" were observed to be more compatible with "smart city", while "augmented

reality", "deep learning" and "covid-19" were considered to be more compatible with "e-learning". "Blockchain" technologies used to improve network structures in "smart cities" draw attention (Nam, 2021; Sharma, 2018; Singh, 2020). In addition, studies on the "security" and "privacy" of "smart cities" are very important in the field (Zhang, 2017; Eckhoff, 2017). Interest in "augmented reality" and "deep learning" studies in the field of "e-learning" with "Covid-19" increased (Saleem, 2021; Mladenovic, 2021).

Figure 11 is the dendrogram of the terms in the "Conceptual Structure Map". The dendrogram shows the order of the obtained clusters and the points to which the terms are associated in hierarchical clustering (CaliŃski, 2014). In this context, the two clusters will create the connection point last. "Height" indicates the distance between joints. As the distance increases, the closeness between the junctions will decrease and the relationship strength will be low. As the distance decreases, the strength of the relationship will increase. The relation strength of the elements in a cluster will always be higher than the relation strength of the elements in another cluster.
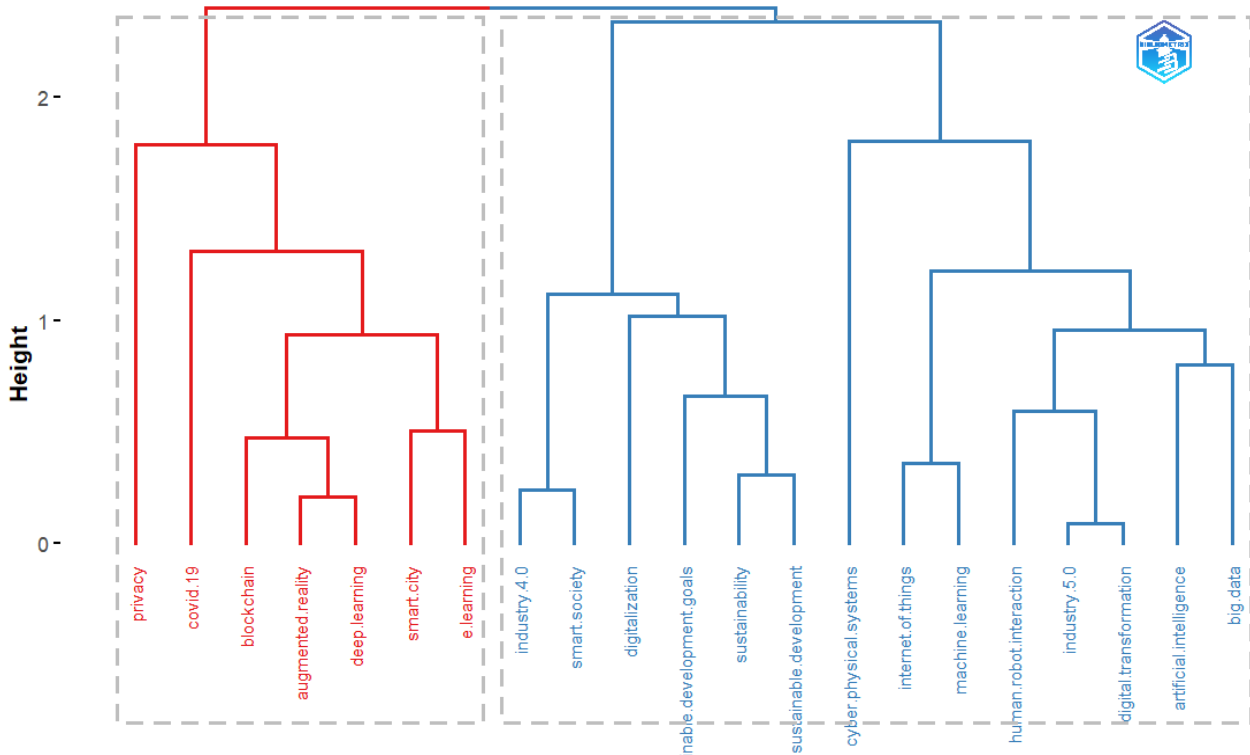

Figure 11. Topic Dendrogram of Society 5.0

According to Figure 11, "augmented reality" and "deep learning" merged first in the red cluster. This mergence is named K1. Then, K1 and "blockchain" were merged and K2 merged was obtained. "Smart city" and "e-learning" formed K3 mergence. K2 and K3 merged into K4. K4 and "covid-19" merged into K5 and finally, K5 and "privacy" merged to form the red cluster.

In the blue cluster, "digital transformation" and "industry 5.0" are the first mergence (M1). "Industry 4.0" and "smart society" mergence (M2) draw attention as the second proximity of the blue cluster. "Sustainability" and "Sustainable development", respectively, merged to form M3. "Internet of things" and "machine learning" merged into M4, "Human-robot interaction" and M1 into M5, "sustainable development goals" and M3 into M6, "artificial intelligence" and "big data" into M7, M5 and M7 into M8, "digitalization" and M6 into M9, M9 and M2 into M10, M4 and M8 into M11, "cyber-physical systems" and M11 into M12, and finally M10 and M12 merged to form the blue cluster. Merging points are one of the best ways to understand how strongly the terms are related to each other.

In addition, this study conducted various analyzes focusing on keywords to explore the Society 5.0 research trend. Figure 12 shows 50 keywords that stand out in scientific research according to research results. Therefore, the keywords in the figure give an idea of the general focus of Society 5.0 research.
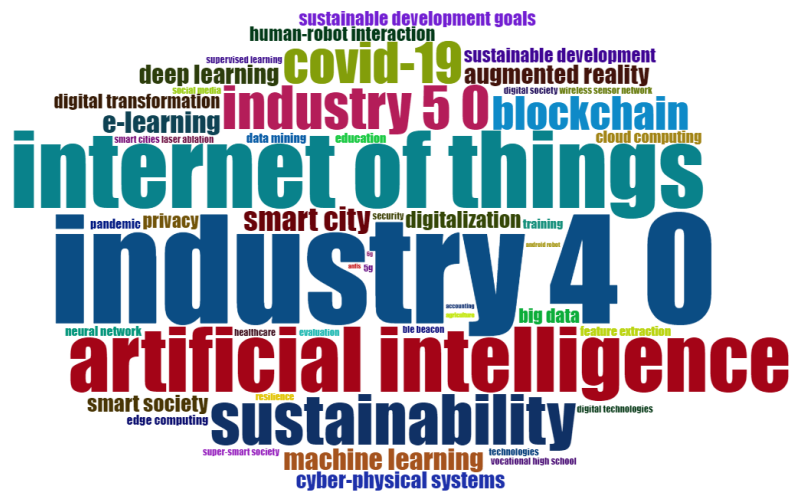
Figure 12. Word Cloud

Conclusion

This study examined the bibliometric features and trends of scientific research in the field of Society 5.0. According to the analyzes carried out in the study, Japan is the country that contributes the most to scientific research. Additionally, attention should be paid to Indonesia's contribution to recent publications. In addition, Japan's superiority over other countries in terms of prominent writers and institutions is striking. Given the fact that Society 5.0 is still a new concept, it is usual for Japan to be at the forefront and leading position.

Both journals and conferences stand out in terms of the sources of scientific research. As Society 5.0 is a new field, it is normal for conferences to publish a large number of conference papers. As time goes on, scientific research in this field will likely appear more in prestigious journals with high-impact factors.

The most researched themes also illustrate the contribution of Society 5.0 to society and technology practice. It is important to examine the evolution of scientific publications to identify trends and identify research gaps in the field of Society 5.0. Therefore, new studies can be carried out to fill the research gap in the field of Society 5.0 and to improve knowledge. This study is limited to only the Web of Science database for bibliometric review. It also covers only 456 research descriptions and subject trends. It is recommended that future studies include other databases such as Scopus. It is also recommended to perform other bibliometric indicator analyzes such as bibliographic matches and co-citation analysis in larger studies.

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