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METAVERSE AND THE GLOBAL ECONOMY. METAVERSE AND AGRICULTURE - A BIBLIOMETRIC ANALYSIS

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Abstract

The purpose of this work is to examine the publications in the field of Metaverse with the method of bibliometric analysis. Starting from the Metaverse keyword, the WOS and Scopus databases were searched, identifying a total of 788 publications in WOS and 1,385 publications in Scopus that met the study criteria. The VOSviewer software and the Scopus database were used for the analysis. We used several types of analysis: co-author analysis to identify the descriptive characteristics of the publications. It was found that the largest number was that of scientific works. The number of publications started to increase from 2007, but exploded in 2022. The countries that had the most publications were China, USA, United Kingdom, South Korea and Germany. The University of Zilina, Slovakia, Dimitrie Cantemir University Bucharest, Romania, University of Bucharest, The Institute of Technology and Business in Ceske Budejovice, Czech Republic, University of Craiova, etc. had the most publications among organizations. The analysis of the citations led to the identification of the authors and publications that were the most cited, resulting in the following: Sang-Ming, P.; Young-Gab, K. (2022); Sang-Ming, P.; Young-Gab, K. (2022); Haihan, D; Jiaye, L.; Sizheng, F. (2021), etc. Although the metaverse is not a new concept, it has become a new extension of virtual worlds, starting to be applied more and more in more and more fields (commerce, medicine, tourism, agriculture, etc.). The conclusions of the study will be able to constitute a road map regarding future research that will be more and more complex with the complexity of the Metaverse concept.

Key words: *metaverse, globalization, virtual reality, augmented reality, virtual economy*

INTRODUCTION

The Metaverse has become an increasingly frequently used concept not only in professional fields, but also in domestic ones, which seems to gain more and more importance with the emergence of new generations of consumers, even more so in a world global, inter-connected, in which we can no longer conceive of our existence or in which it is increasingly difficult for us to survive without the existence of this connection that began with the advent of computers, the Internet and continued with the existence of personal devices, immersive space technologies and artificial intelligence [28, 34, 67]. Along with these technological advances, the world we live in has changed and will continue to change, which has led to the emergence of a new paradigm, a new concept called Metaverse, which is starting to be more and more present in everyday life.

The concept is not a new one, IT specialists have been flirting with it for some time and referring to a 3D reality. The phenomenon began to come to the attention of the general public in 2021-2022, when Mark Zuckerberg changed the name of his company Facebook Inc. in Meta Platforms Inc. The first person to use the term is the writer Neal Stephenson, who in 1991 published the novel "Snow Crash" in which he refers to the Metaverse.

In the following we will try to define the Metaverse, as it appears in the specialized literature.

Etymologically, the Metaverse is a post-realized universe, the word "meta" meaning "post", and "verse" coming from "universe". Thus, the Metaverse can be defined as an environment where the physical reality meets

the digital one, a multi-user environment, which is in continuous, perpetual and persistent change [56]. The first version of Metavers was represented by the existence of interconnected virtual worlds, by the existence of avatars that could transit these virtual worlds and that later included different social networks attracting more and more users, allowing them to communicate in real time. Along with the evolution and transformation of the virtual environment, communication included both virtual reality and augmented reality allowing the sensory interaction of users through digital objects [1].

Mark Zuckerberg considers that the metaverse is the internet brought to life or the internet rendered in 3D, being an internet you are in, and not just looking at [66]. The metaverse is the environment that will shape the future and in which we will begin to spend more time than in the real world [37]. Lee et al. considers that the metaverse is that virtual environment where physical and digital reality meet, as a result of the facilities provided by the existence and convergence of the Internet with Web technologies and Extended Reality [38]. They believe that in order to achieve the metaverse, it is necessary to go through 3 sequential stages, which require the existence of digital twins, digital natives and surreality, i.e. the coexistence of physical and virtual reality. Under these conditions, the metaverse will interconnect all these elements, made up of 15 domains and grouped into 2 important elements, the metaverse eco-system and technology, according to Figure 1.

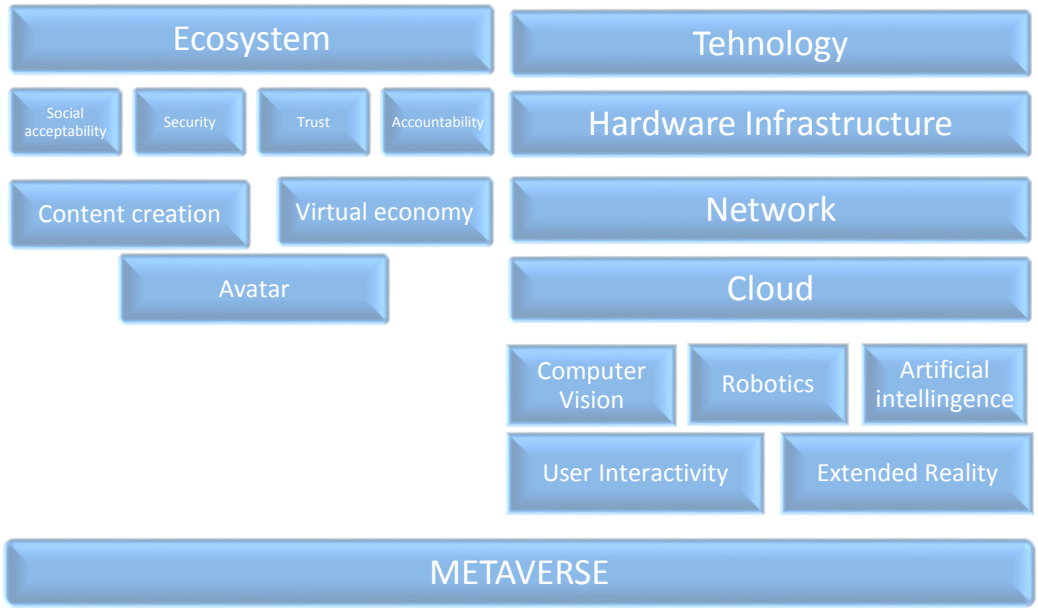

Fig. 1. The structure of the Metaverse
Source: own processing.

Turner considers that the Metaverse is a three-dimensional digital universe, designed through optical illusions so that it is perceived by the human mind as another reality [59]. Combined with the real world, the Metaverse offers people a deeper social meaning, because if it initially focused on the content of the virtual world (games), currently it represents a content-based social interaction environment [7, 32, 49].

Likewise, the Metaverse, even if it is already used, will expand to other areas of the online environment, such as commerce, education, entertainment, tourism, etc. It is estimated that the number of users will reach 1 billion in 2030, and the estimated value of the Metaverse for the next year is 800 billion dollars.

Studies show that only in the field of electronic commerce, Metaverse will bring sales increases of more than 10 times by 2030. If at the present time these sales are approximately 20 billion dollars, they will be able to reach a figure of 200 billion dollars. Also in the field of games, from a current figure of 10 billion dollars, in 2030 revenues

will reach over 160 billion dollars [26]. The total revenues made from the metaverse, at the level of 2022, amounted to 45 billion dollars, but they are estimated at 145 billion dollars in 2023 and at over 490 billion dollars in 2030.

The same statistic data shows that if 2009 was the year when Meta platform would start to generate net income, it would be 229 millions of dollars and the revenue would be 777 millions of dollars, in 2022 the net income had reached 23,200 millions of dollars, decreasing by 41% compared to the previous year, under the conditions of a revenue in 2022 of 116,609 millions of dollars and in 2021 the revenue was 117,929 millions of dollars. With the transformation of Facebook into Meta, the number of users has increased significantly. In octomber 2021, the global number of users using Facebook was over 3 billion users, while gaming and esports would have 250 millions of users, followed by global crypto with 220 millions of users. The Decentralized finance capitalize approximate 3.5 millions of users and Blockchain gaming a few under 2.5 millions. 3.0 Web users virtual worlds have been approximate 50,000 [12].

A survey carried out by Petrosyan A. in 2021 among internet users regarding the advantages of the Metaverse highlighted the fact that almost 40% of respondents considered that the virtual environment helped them overcome some obstacles or disabilities, compared to the real world. Also, 37% of the respondents considered that the virtual environment helped them to travel without moving or developing their imagination or creativity. In descending order, they followed: the possibility to connect with other people, to develop skills, to find new opportunities to work, to connect remotely with family, to study online, to be able to express, etc [52]. Certainly the acceleration of this process was favored by the Covid-19 pandemic, which in turn contributed to the development of the skills to use technology and to the increase in the need for interconnection [41].

The market, in turn, began to adapt quickly to the needs of consumers. Thus, many projects in the commercial field have started to use the term "metaverse" in the presentation of their online offers, adding a 3D interface to the IT platforms they were already using and which makes the use of their applications easier or more interactive, even if in fact they do not offer what the metaverse offers, i.e. a navigation in the form of a single set of compatible data sources and services, which would require a more complex technology, which already exists and which allows navigation in the form of avatars.

Thus, Gucci, following a collaboration with one of the Roblox developers, started selling its products in the metaverse; Balenciaga collaborated with the creator of Fortnite and created virtual boutiques; Nike bought RTFKT, a famous brand on the metaverse and will hire virtual designers to create virtual clothes; Adidas bought land on Sandbox (virtual space that uses SAND cryptocurrency); Zara has already planned her future virtual collections. And the examples can continue not only with companies famous for electronic commerce, but also in the field of car, food, entertainment, etc.

Education is another field that has found its place in the metaverse, which can thus prolong its existence and preserve its accessibility [39, 63]. Starting with the video-conference systems that played the role of classrooms during the Covid-19 pandemic and that through the Zoom, Teams, Webex, Google Meet, etc. platforms allowed distance courses to take place in real time [5, 6, 17], but also in the case of educational institutions specialized in e-Learning [2, 9, 42]. Metaverse, however, allows the creation of educational centers or virtual campuses with classrooms, libraries, sports fields, counseling centers, dining halls, where students, teachers, administrative staff can communicate, interact [43, 48, 58], but which can also contribute to improving learning experiences [18, 29, 57]. However, it is the responsibility of the decision-makers, the educators, the parents, but at the same time the virtual designers how they shape and how they use these opportunities in favor of the educable so that they are truly educational [23].

As far as tourism is concerned, the metaverse can be used not necessarily to create virtual visiting experiences, but to choose a tourist destination or to choose an accommodation

location or to choose tickets for a festival or maybe just to find the way to the respective tourist objective. Thus, the use of the metaverse is useful not only for the discovery of urban tourism, but also of rural tourism, which benefits from a rich potential that can be exploited through the use of appropriate marketing strategies. These strategies are much easier to apply to the virtual environment, in the metaverse, and this became all the more visible with the outbreak of the Covid-19 pandemic, which changed people's perception not only regarding the way tourism is carried out, but also to other activities, becoming much more dependent on the virtual, but also much more experienced in the use of technology.

Even agriculture, the branch of the econoy that must ensure the food security of the planet and that must physically ensure people's food, the basic physiological necessity [40], can be included in the metaverse by creating avatars of farms that allow farmers to production planning, as well as their commercialization, negotiation, marketing, etc. Steps are already taken in this directive through the use of digitization, precision agriculture, plant biology monitoring, etc. which, through the opportunities brought by you, contributed to the improvement of productions, obtaining benefits and simplifying the work of farmers [4, 14].

All these advances within the Metaverse are possible due to the use of several technologies, which define it and put it into practice: virtual reality which builds a simulated environment and which stimulates different senses (sight, hearing, touch and even smell) [11, 21]; augmented reality that places digital objects in reality, and that even if they do not appear in the physical environment, through devices (phone, tablet, etc.) make them available in space [31]; ioT, that is non-standard computing devices that, by connecting to wireless networks, have the capacity to transmit data and that allow the creation of real-time simulations by interconnecting them in the 3D world [44, 61]; Blockchain technology that fulfills 6 criteria of the metaverse (accessibility, interoperability, value transfer, digital proof of ownership, digital collectivity and governance) [27, 51]; artificial intelligence, so discussed and controversial recently with the appearance of the Bard chatbot, which in a single day led to the drop of Alphabet shares by 8% (100 billion dollars) following the provision of inaccurate information, but which could have capabilities related to NLP mode–s, improved rendering, cyber disease control, etc [15]; cryptocurrencies, as a version of debit or credit cards used in commerce 2.0, and which have traceability, instant transactions, allow direct peer-to-peer payments, have close to zero fees and are instant [50, 53]; NFT which is a digital asset that includes uniqueness, rarity, traceability and which is based on a blockchain network, being unique to the owner, allowing to increase the efficiency of trading, selling or buying digital goods, which reduces the probability of fraud [5, 22].

Therefore, through the metaverse, people will be able to work together, even if they are in different corners of the world, and not only with the help of the Internet, but also within it. Obviously, however, the appearance of the metaverse also comes with countless other questions related to ethics, the protection of personal data, cyber security, the use of bibliometric data [3, 10], but at the same time with other practical questions such as for example: how will the taxation of the incomes that natural persons will obtain through digital avatars be done or where will they be due, or where will social contributions be given and paid, where will the fiscal residence of a digital avatar be, that is so many problems that will have to be solved and which at this moment create unrest, at least for a part of humanity.

MATERIALS AND METHODS

The research methodology assumed both a quantitative and a qualitative analysis regarding the review of the metaverse concept in specialized literature with the aim of identifying the importance that the metaverse has in the development of fields such as business, education, sports, leisure, etc. In

order to establish the relevance of the concept in specialized literature, we combined content analysis with bibliometric analysis, with the aim of identifying the knowledge base, but also its evolution [8, 55]. The bibliometric method is used when it is desired to examine the trends in the relevant scientific literature, by revealing the issues related to the studied subject, regarding the most contributing authors, organizations, sources, keywords or publication citations [19].

The information that was the basis of the study was extracted from the ISI Web of Science and Scopus databases, these being some of the most popular publications in the world, and belonging to Clarivate Analytics. The reason for the choice is that they contain publications with a high level of accuracy and strong scientific relevance. Also, the large volume of articles it contains can provide relevant information for the present research. The database was consulted in February 15-16, 2023.

The research framework of the present study is presented in Figure 2.

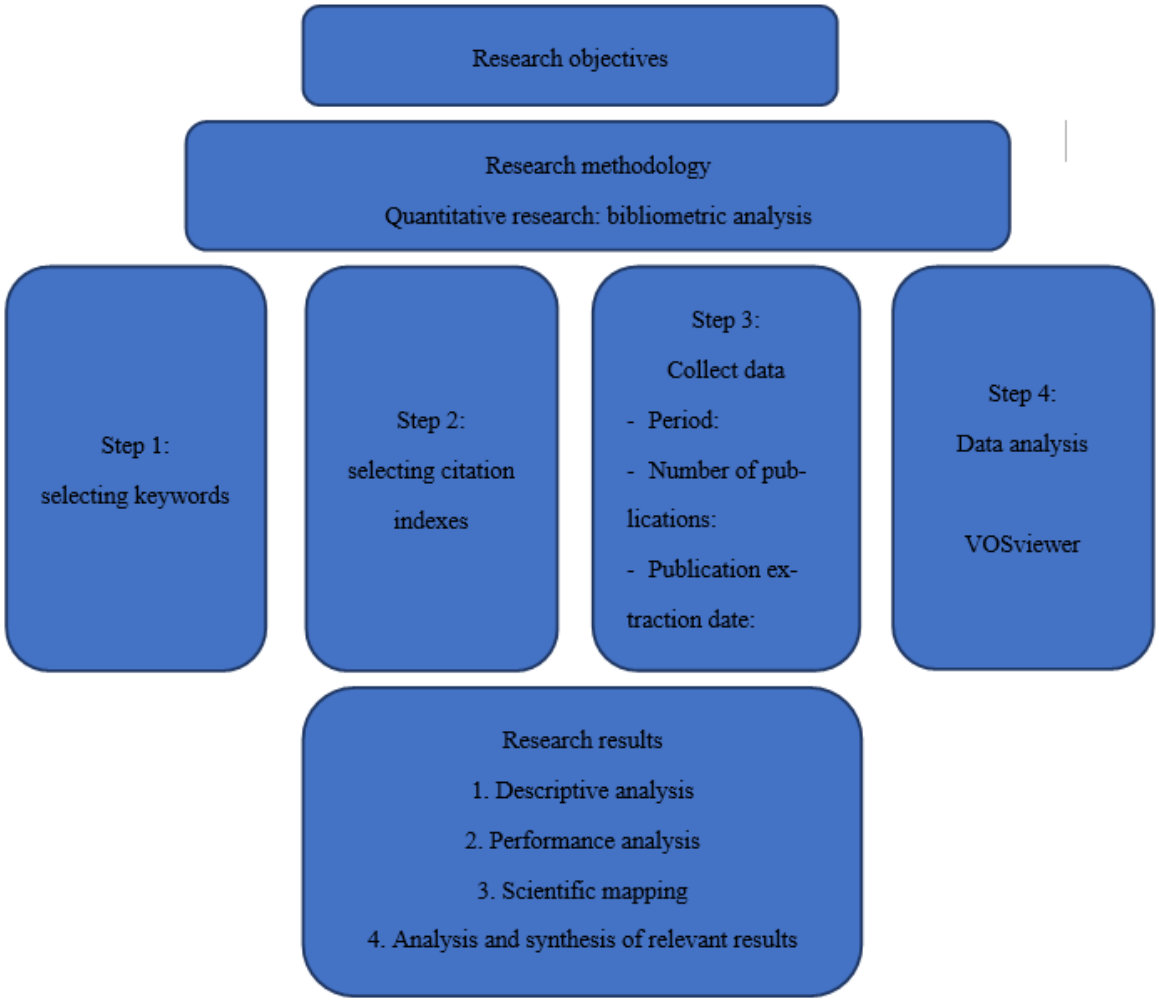

Fig. 2. Outline of the research framework
Source: own processing.

The data analysis was carried out with the help of the VOSviewer program, version 1.6.15, which allows the survey of bibliometric and sociometric networks regarding the performance of articles or specialized works, of authors, organizations, the impact factor, etc. and which allows scientific mapping starting of the conceptual, social and intellectual structure of the collected data and allows the creation of co-occurrence maps and the realization of similarity metrics [60, 62, 64]. This bibliometric representation can be done in three ways: by distance, time or visual. Thus,

to identify those networks that are located close to each other, the approach of distance and the strength of association can be used. If the distance between two modes is small, then the respective articles are close or similar, and the association index derives from the co-belonging variables between the nodes or between the references. The key terms used were: "metaverse", after which we refined the search based on two filters: "language of publication" (English) and "year of publication" to identify information about publications from 1995-2023. As a result, 733 studies were identified in the WOS database and 1,385 studies in the Scopus database, which were analyzed and interpreted with the aim of triangulation, so that a multi-dimensional perspective of the research could be achieved, which would contribute to its validity. The sample from the Scopus database was analyzed through the VOSviewer program. Thus, in Table 1, the selection criteria that were the basis of the current study are presented. Non-English ones were eliminated, resulting from the different types of publications (articles, reviews, etc.) a number of 1,400 publications. The Scopus database has a variety of research fields from which we removed book chapters, resulting in 1,385 articles, reviews, or papers written in English in the field of "Metaverse".

Table 1. Steps of bibliometric analysis

Step	Information	Criterion	Results
Step 1	Datebase	WOS; Scopus	1,400
	Date	16.02.2023	
	Index	All	
	Keyords	Metaverse	
Step 2	Language	English	1,385
Step 3	Publication	Article; Reviews; Proceedings	1,355
		Article; Reviews; Proceedings	

Source: own processing.

The data downloaded from the Scopus database were checked to ensure that they were suitable for use in the VOSviewer analysis program, following systematic review steps [47] to ensure both a transparent and rigorous study, but also so that other researchers to be able to validate the results obtained by using the same database [65]. The analysis types, counting methods and trade wind units applied in VOSviewer were presented in Table 2.

Table 2. Types of analysis, counting methods and trade wind units applied in VOSviewer

Web of Sciences Categories	Frequency	Percentage of the sample
Co-authorship	Full Counting	Authors
		Countries
		Organizations
Citation	Full Counting	Documents
		Organizations
		Countries
Co-Citation	Full Counting	Cited references
		Cited authors

Source: own processing.

RESULTS AND DISCUSSIONS

The bibliometric analysis assumed the approach of three aspects, namely: descriptive analysis (1), performance analysis (2) and scientific mapping (3).

Descriptive analysis

A first search within the WOS database for the word "metaverse" highlighted the fact that

the number of scientific works in this field is relatively low, i.e. 733 articles published in the period 1995-2023. From 1995 to 2006, the frequency was 1 article per year, and as can be seen from Fig. 3 researches about the metaverse were relatively insignificant until 2022, when their number reached 530, meaning practically 72% of the number of published articles. The survey of the Scopus database resulted in a number of 1,385 scientific works published in the same period, with the peak in 2022 represented by 1,014 works. The subject of the Metaverse began to attract the concerns of researchers in 2022, with the transformation of Facebook into Meta, which, together with Apple, Microsoft and Google, launched new hardware products and software services in a market that had only been niche that year. The success was also accelerated by the new navigation skills in the social or professional environment acquired during the Covid-19 pandemic, which changed not only the way of working, but also of spending free time, purchasing goods, education, etc. Thus, it can be observed that the first wave of studies related to the importance of the Metaverse took place in the period 2007-2014, when Web 2 was developed, followed by the period 2015-2020, when VR and AR technologies were developed, as well as Web 3, and then 2021-2022 the beginning of investments in Metaverse technology. The weight of the number is the same in the case of both databases, although in 2022 the difference is 484, which is why in the future, we will do the bibliometric analysis in relation to the results of the Scopus database.

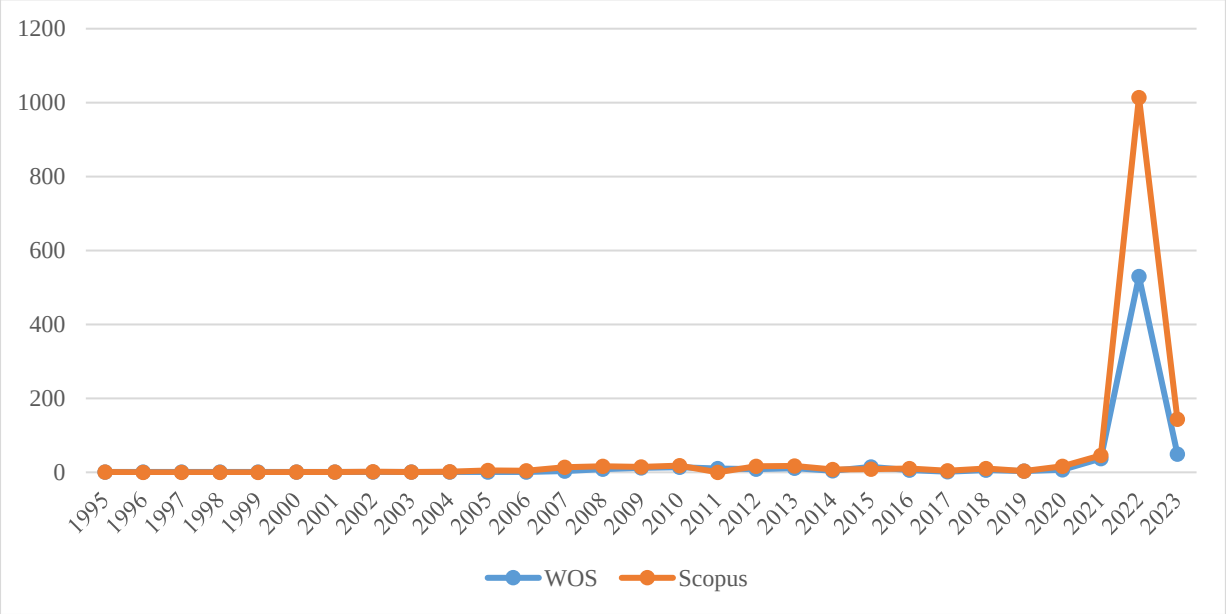

Fig. 3. The evolution of the number of scientific works on metaverse
Source: own processing.

Regarding the type of publication, it is found that most of the works are articles or works supported and published in conferences (90%), while the rest of the researches are chapters in books, editorials, etc. The attractiveness of publication in the first category of sources is justified by the faster publication procedure (Figure 4).

The main categories of scientific articles were grouped in relation to the specifics of their subject, highlighting the fact that almost half of the articles that had Metaverse as their subject were published in magazines, specialized conferences in Engineering (33.07%) or Computer Science (17.17%).

Also, almost 11% of these belong to the social field. The rest of the fields, very varied (mathematics, business, economics, physics, chemistry, agriculture, etc.) represented between 0.34 and 7.5%.

The fact that some of the articles have multidisciplinary approaches, being reported for each category separately, makes their number almost double (Table 3).

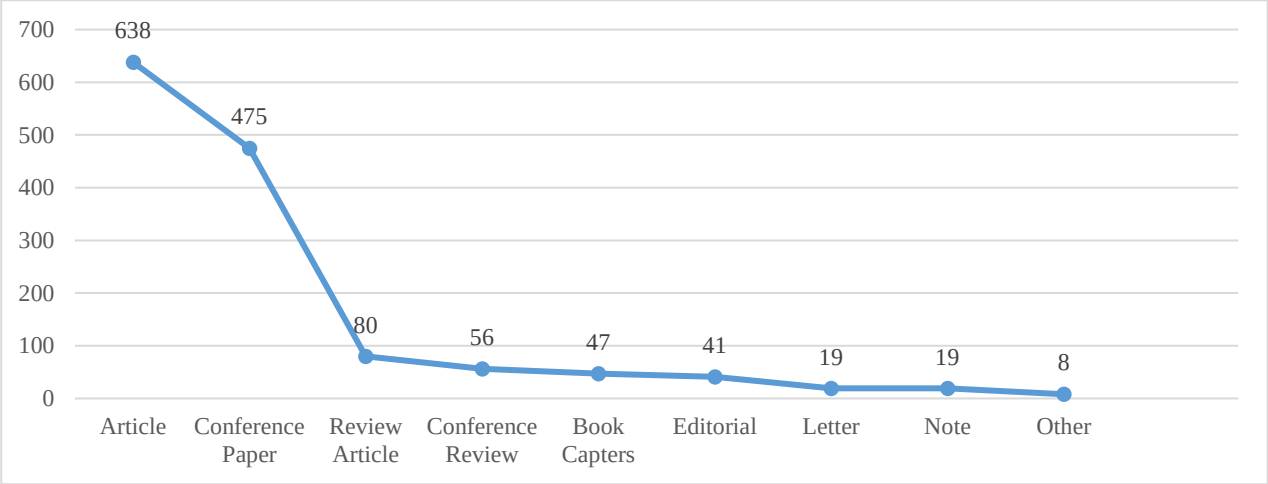

Fig. 4. The evolution of the number of scientific works
Source: own processing.

Table 3. Distribution of publications, by category

Scopus Categories	Frequency	Percentage of the sample
Engineering	882	33.07
Computer Science	458	17.17
Social Science	292	10.95
Matematics	200	7.50
Arts and Humanities	116	4.35
Decision Sciences	116	4.35
Business, Management, Economics	152	5.70
Medicine, Health, etc	135	5.06
Physics, Chemistry, Astronomy	157	5.89
Environmental Science	57	2.14
Agriculture, Veterinary	9	0.34
Other	93	3.49

Source: own processing.

Analyzing the situation of published articles in relation to the type of direct access, it turns out that in the 5 available categories, the articles are distributed as follows: 45% are published in All Open Access, 23% in the Gold category, 18% in the Green category, 10% in the Bronze, and 5% in the Gond Hybrid category, therefore the authors are determined to publish in relation to the facilities offered by the publishers, but also according to the speed of publication.

Table 4. Distribution of publications, according to the type of access

Web of Sciences Categories	Frequency	Percentage of the sample
All Open Access	533	44.90
Gold open	272	22.91
Hybrid Gold	55	4.63
Bronze	115	9.69
Green	212	17.86

Source: own processing.

Performance analysis

The 1,385 articles generated 4,166 citations, most of which were in 2022 (2,954). Thus, based on the sample, the analysis of the distribution of scientific production was carried out, finding that they had 3,202 authors. Those authors who had more than 5 citations and more than 5 published works were selected, resulting in a number of 74 authors. The selected items were 64 organized in 9 clusters, between which 289 links were established. The most cited author had 152

citations, and the number of his articles was 8, these being cited by 52 authors, of which 24 are part of the 9 clusters. On the other hand, the author with 16 works had 21 citations, also obtaining a very good score. It is remarked that the situation of citations follows the same trend as the number of publications. Therefore, there is an increase in the interest of researchers in the field of the Metaverse and its development possibilities (Figure 5).

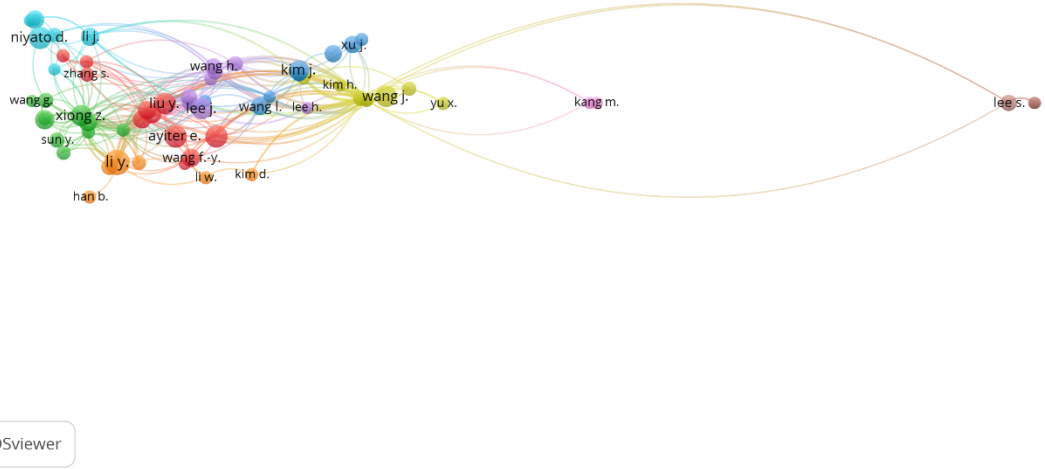

Fig. 5. The evolution of the number of scientific works
Source: own processing.

Scientific cartography

The analysis of the intellectual structure, that is the analysis of co-citations, involved the study of scientific research published in the period 1995-2023 through the VOSviewer program. The first restriction was related to the source of the citation, which took into account those sources with more than 20 citations which resulted in a number of 22,555 sources, and the second restriction was related to the minimum number of citations of a reference citations, which was set to 10. This resulted in a number of 209 sources that were grouped into 6 clusters. The strongest is cluster 2, demonstrating that most citations are related to scientific research published in IEEE, the number of co-citations being 518, through the links established between 205 publications. Also, the works from Sustainability were cited 341 times, through 171 links. In Sensors, scientific works cited by means of other 167 researches were published, the number of citations being 184. It is also noted that the publications are part of the 2021-2023 interval, being recent works and demonstrating the increase of interest in the analyzed subject.

The social structure assumed the analysis of the countries of the co-authors. In this sense, the following preconditions were established starting from the co-authored criterion: the set analysis unit was "countries", and the applied method was "complete counting".

It turned out that the authors come from 109 countries, but introducing as restrictions that the minimum number of published scientific works should be 10, and the number of citations should also be 10, the authors coming from 38 countries were selected.

The results were grouped into 5 clusters, between which 357 links were established.

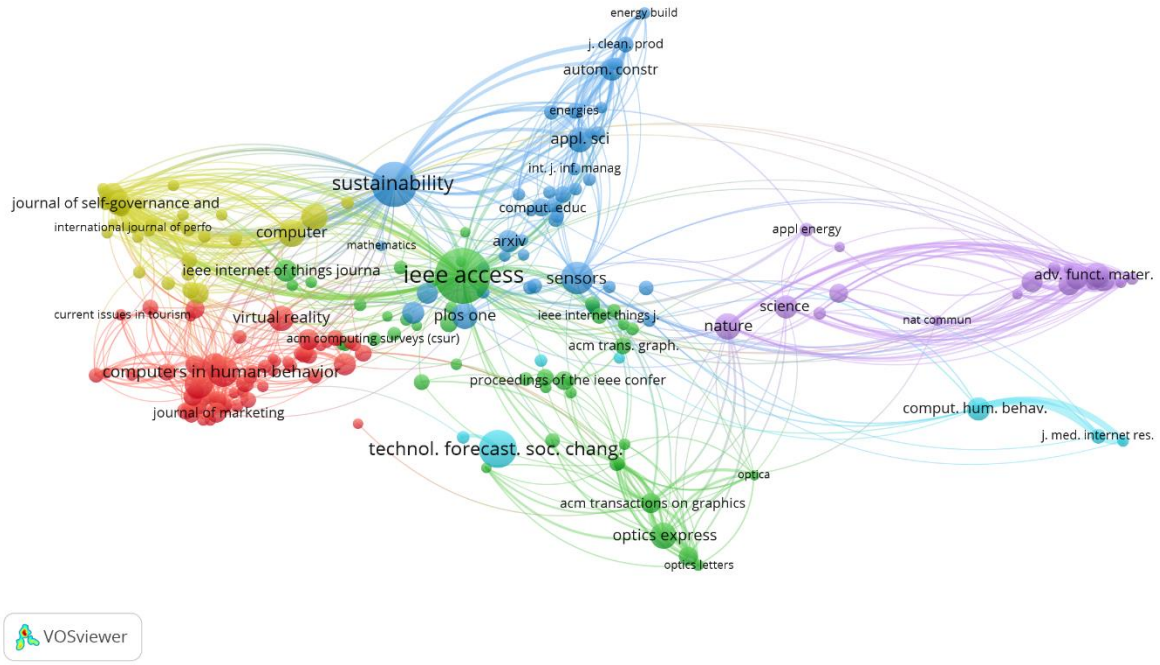

Fig. 6. The evolution of the number of scientific works
Source: own processing.

The country with the highest total strength of the link is China, this being 107, as a result of the 317 researches published and cited 727 times. The number of co-authors is 30. The USA is the second most important cluster, thanks to the 218 scientific works published in the field of the Metaverse that were cited 1,459 times. Within the cluster there are 34 connections, i.e. authors from 34 countries, the total strength of the connection being 81. Next in order is the United Kingdom with a total strength of the connection of 57, South Korea with 34, Singapore and Germany with 32. Romania is on the 17th place in this ranking, with a total power of 16, resulting from the 22 scientific works, cited 112 times. The authors of the citations come from 4 countries (USA, Germany, Slovakia and the Czech Republic). In this way, the scientific importance of the elaborated articles could be evaluated (Figure 7).

The social structure was also analyzed from the perspective of the co-authors' organizations, the method used being "full counting". The restrictions applied were the following: minimum number of documents published by the organization 3, and minimum number of citations by the organization 3. Out of the 2,654 organizations, the number of those that fulfilled these criteria was 29, they being organized in 3 clusters between which 15 links were established, with a total value of the link strength of 29.

The first cluster includes Faculty of operation and economics of transport and communications, University of Zilina, Slovakia, having a number of 7 articles of scientific research cited 49 times and having a total link strength of 12, Dimitrie Cantemir University Bucharest, Romania with 3 published articles, cited 40 times and a total link strength of 4, University of Bucharest, Romania with a number of 4 published articles, cited 46 times and a total link strength of 7 and The Institute of Technology and Business in Ceske Budejovice, Czech Republic.

The second cluster includes the Faculty of operation and economics of transport and communications, University of Zilina, Slovakia and the University of Craiova, the first having a number of 7 scientific research articles cited 49 times and having a total link

strength of 12, and the second with a number of 6 articles and 6 citations, with a total link strength of 1.

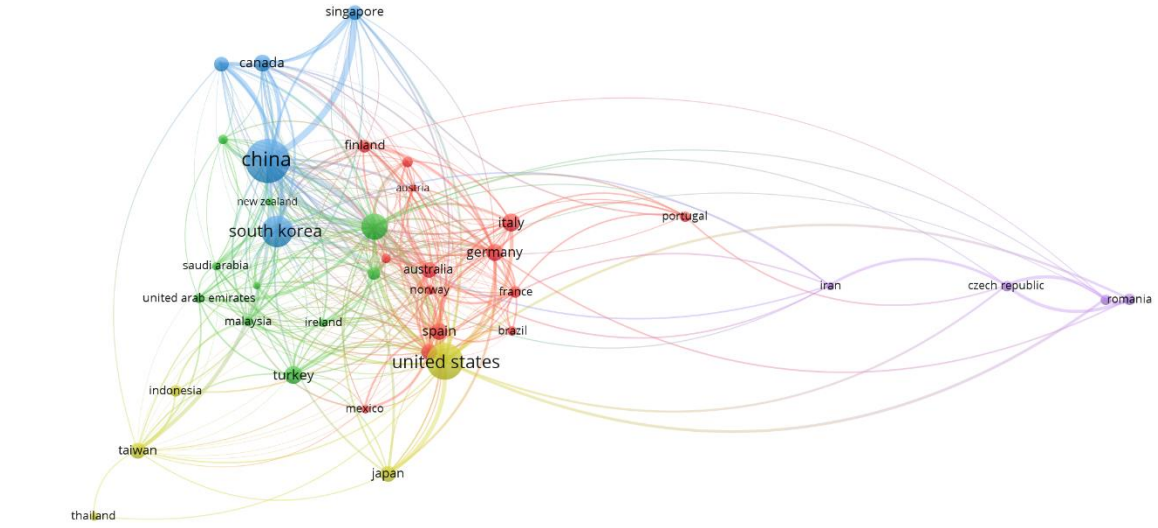

Fig. 7. Map of co-citations, by country
Source: own processing.

The third cluster includes Spiru Haret University, Bucharest, Romania with a number of 5 published works, cited 37 times and a total link strength of 7 and The Institute of Smart Big Data Analytics, New Yorh. It is thus established that there is still no sustained interest of the same researchers regarding the "Metaverse" theme, since only in 29 universities or research institutes there is a number of published works greater than 3 (Figure 8).

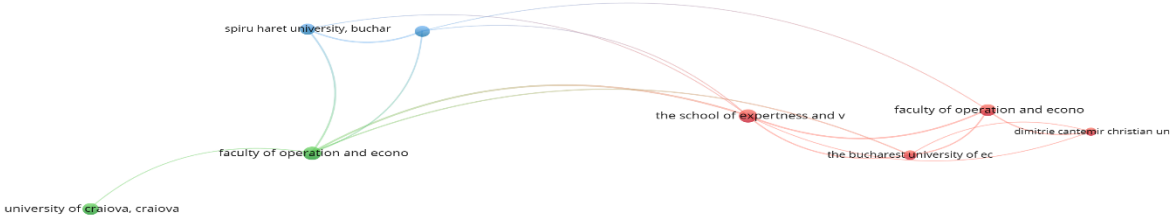

Fig. 8. Map of co-authors, according to organization
Source: own processing.

The conceptual structure assumed the analysis of the co-occurrence of the terms. This was done based on the number of appearances in the Scopus platform, regarding the terms that were most often associated with "metaverse". In the VOSvieer program, the following restrictions were applied: the analysis was performed in the "title of the works" field, resulting in a number of 3,611 words.

The second restriction was also introduced, namely the one related to the minimum number of occurrence of a terms.

It was chosen this number of 10, and the method used was binary counting, resulting in a threshold with the value of 39 terms. The VOSviewer methodology involves the selection of 60% of the most relevant terms, so that the conceptual map shows the 6 clusters and the 81 links established between the 23 terms.

It was found that the main themes associated with Metaver are "second life", having a relevance score of 4.97 and which is in the same cluster as "mataverse technology: with a score of 3.49 and augmented reality".

Another term is "virtual", with a score of 2.15 and "internet" with 1.01, which indicates the technical content of the scientific work. Another cluster highlights the concern of researchers regarding the changes and opportunities that the application of Metaverse technologies can bring to people's lives, based on the discussion of case studies (Figure 9).

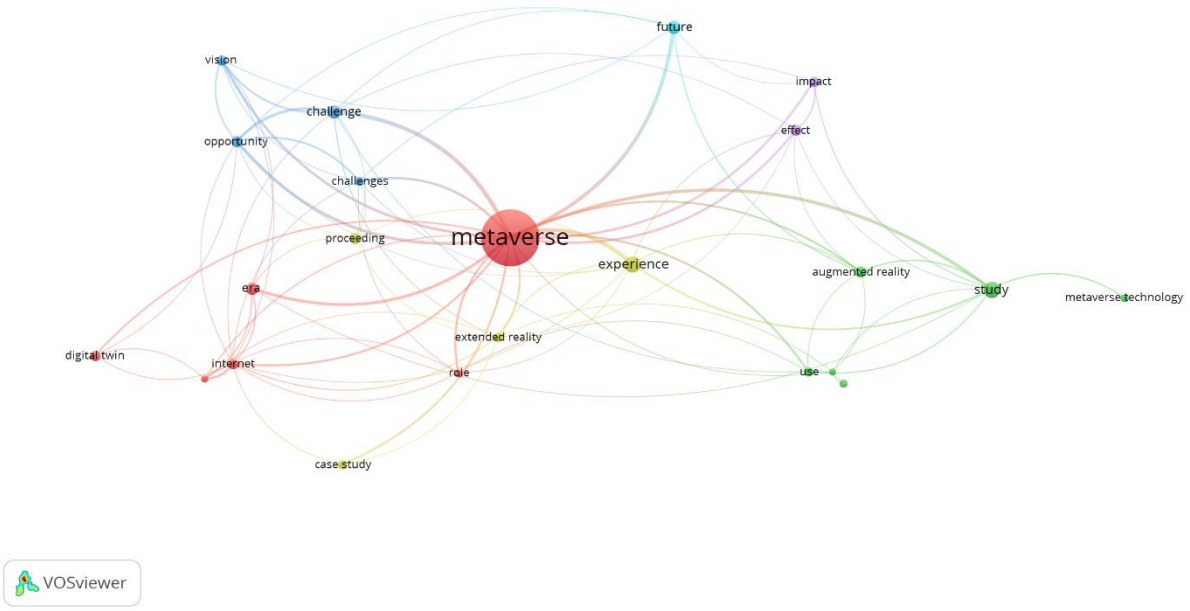

Fig. 9. Co-occurrence map, in relation to keywords
Source: own processing.

In order to determine, on the one hand, the research gaps, and on the other hand, prospective research methods in the field of "Metaverse", the most important scientific research works were analyzed, the results being summarized in Table 4.

For this purpose we used the Scopus database from which we retained Highly Cited Papers from the period 2019-2023, the minimum number of citations being 40.

The search and filters generated 12 articles, which were analyzed from the point of view of the journal, keywords, abstracts and research methodology. Scientific research works are presented in descending order of citations (Table 5).

Table 5. The most important scientific research works

Author(s).	Year of publication	Scope category	The main findings
Sang-Ming, P.; Young-Gab, K.	2022	IEEE Access	The paper presents the concepts and techniques necessary for the realization of the Metaverse, dividing them into three components and three approaches, identifying the limitations and development directions of the immersive Metaverse [55]; The research method is the review of specialized literature; used 357 bibliographic references; has 146 citations
Haihan, D; Jiaye, L.; Sizheng, F.; Zhonghao, L.; Xiao, W.; Wei, C.	2021	MM 2021 - Proceedings of the 29th ACM International Conference on Multimedia	The paper presents the main applications of the metaverse used for the development of social good, proposing a three-layer architecture containing infrastructure, ecosystem and interaction. It also proposes a prototype for a university campus developed in the metaverse and based on blockchain technology [20]; the research methodology involved the review of specialized literature and applied research; used 27 bibliographic references; has 108 citations
Kye, B; Han, N.; Kim, E.; Park, Y.; Jo, S.;	2021	J Educ Eval Health Prof	The paper presents four types of metaverse with the aim of identifying its potential application in the field of medical education through the use of augmented reality and immersion. At the same time, the advantages and disadvantages of using the metaverse are presented [36]; the research methodology involved the review of specialized literature; used 22 bibliographic references; has 72 citations
Dwivedi, Y.K., Hughes, L., Baabdullah, A.M., Ribeiro-Navarrete, S.,Giannakis, M., Al-Debei, M.M., Dennehy, D.,(...),Wamba, S.F.	2022	International Journal of Information Management	The paper presents from a multidisciplinary perspective the aspects related to the role that the metaverse has on the development of society and its various environments, as well as its transformational impact, also proposing a future research agenda, useful for specialists in the field [13]; the research methodology involved the review of specialized literature; used 80 bibliographic references; has 65 citations
Kim, J.	2021	Journal Of Interactive Advertising	The paper presents the place occupied by advertising in the metaverse, starting from the two fundamental areas, the conceptualization and the methodological framework. It also proposes a research agenda in order to develop the role that advertising has in the metaverse [33]; the research methodology involved the review of specialized literature; used 28 bibliographic references; has 55 citations
Xi, N., Chen, J., Gama, F. *et al.*	2022	Inf Syst Front.	The work is based on a case study that tests the use or non-use of XR technologies (augmented reality - AR and virtual reality - VR) and which highlights the fact that both the resources and the operating costs of realities that are mediated by XR are much higher than those of physical reality; the research methodology assumed applied research [65]; used 117 bibliographic references; has 52 citations
Kraus, S.; Kanbach, D.K.; Krysta, P.M.; Steinhoff, M.M.; Tomini, N.	2022	International Journal of Entrepreneurial Behaviour and Research	The work carries out a bibliographic analysis regarding the entrepreneurial path of Facebook. The research involved the investigation of bibliographic resources, both academic studies and other available public information that were analyzed qualitatively, from the point of view of

			content [35]; the research methodology assumed the case study; used 157 bibliographic references; has 50 citations
Haihan, D; Jiaye, L.; Sizheng, F.; Zhonghao, L.; Xiao, W.; Wei, C.	2021	MM 2021 - Proceedings of the 29th ACM International Conference on Multimedia	The paper presents the main applications of the metaverse used for the development of social good, proposing a three-layer architecture containing infrastructure, ecosystem and interaction. It also proposes a prototype for a university campus developed in the metaverse and based on blockchain technology [20]; the research methodology involved the review of specialized literature and applied research; used 27 bibliographic references; has 108 citations
Hollensen, S.; Kotler, Ph,; Opresnik, M.O.	2022	Journal of Business Strategy	The work presents and explains the concept of Metaverse, which according to the authors of the book will revolutionize almost every industry, exemplifying through a case study (Nike - Roblox) how the metaverse works, at the same time explaining consumer behavior in relation to the virtual environment [24]; the research methodology assumed the case study; used 8 bibliographic references; has 45 citations
Nevelsteen, K.J.L.	2018	Computer Animation and Virtual Worlds	The paper aims to sample different technologies in order to define the "virtual world" which is then used to classify advanced technologies. The properties of the different technologies are also presented in order to identify the differences between them [43, 46]; the research methodology involved the review of specialized literature; used 73 bibliographic references; has 45 citations
Rauschnabel, Ph.; Felix, R.; Hinsch, Ch.; Shahab, H; Alt, F.	2022	Computers in Human Behavior.	The work assumes the meaning and definitions of different XR terms, making a classification of them and a correct definition of them (AR, VR) [54]; the research methodology included bibliographic analysis and case study; used 143 bibliographic references; has 45 citations
Heang, G-J.; Cjien, S-Y.	2022	Computers and Education: Artificial Intelligence	The paper aims to find the clearest possible definition of the metaverse and to present its application methods in the educational field, emphasizing the role of AI in education based on the metaverse with the aim of challenging researchers to find new future solutions [22]; the research methodology included bibliographic analysis and case study; used 33 bibliographic references; has 42 citations
Falchuk, B.; Loeb, S.; Neff, R.	2018	IEEE Technology and Society Magazine.	The paper presents the risks faced by each individual in terms of his privacy, along with the development of technology and social engineering, thus drawing attention to the "costs" of the metaverse [16]; used 21 bibliographic references; has 42 citations

Source: own processing.

As can be seen, 7 of the 12 researches are reviews, which shows that although the theme of the matavers is a promising one, it is still at the beginning of the road, requiring more empirical studies and applied research.

Metaverse and agriculture

In the agricultural field, the metaverse is also present, being found under the name agricultural metaverse or AgriVerse and represents a way of real-virtual iteration that can be found in the production and marketing processes of agricultural products that aim not

only to increase productivity through reducing costs or replacing reduced resources (for example labor), but also achieving sustainable agriculture.

Table 6. Scientific works in the field of metaverse and agriculture

Author(s).	Year of publication	Scope category	The main findings
M. Kang, X. Wang, H. Wang, J. Hua, P. d. Reffye and F. -Y. Wang	2023	IEEE Access	Starting from plant modeling research, the article analyzes the transition of aquaculture to agriculture based on artificial intelligence (AI) and projects three scenarios regarding the possibility of using AgriVerse, identifying both the opportunities related to its development, as well as its challenges, the advantages and disadvantages of its uses [32]; The research method is the review of specialized literature; used 357 bibliographic references; has 146 citations.
N.A.Jasim, Chaari Fourati, L.	2023	IEEE Access	The work underlines the need to adapt agriculture to modern IoT, Blockchain or UAV technology with the aim of developing it and ensuring food security in the conditions of the decrease in the resources that humanity benefits from. Through the evaluation of the specialized literature regarding the latest innovations in the agricultural field, the authors propose both solutions, but also open new topics to be the starting point for future research related to the application of the metaverse in agriculture [30];
Neethirajan, S	2021	IEEE Access	The paper presents the advantage of using deepfake technologies in the case of their application in determining the health of farm animals, which have the effect of increasing productivity and ensuring the sustainability of the farm. Thus, by means of interactive 3D avatars, the behaviors and emotions of animals can be identified and monitored, aspects that can contribute to the well-being of animals. The work is an exploratory review that highlights the possibility of establishing a link between the metaverse and the agricultural field [45]; the research methodology involved both bibliographic analysis and case study; 67 bibliographic references were used; has 5 citations
Hou, Kun Mean, et al.	2023	Sensors	The work presents the main top technologies that in the coming years will be found in numerous technologies that will be part of everyday life, even if at the moment they seem inaccessible. Thus, the metaverse will be present in the form of digital applications, autonomous vehicles, leading technologies in health or life sciences, up to entertainment and intelligent agriculture. AIoT, IIoT or IoT technologies are those that contribute to the development of the metaverse, digital twins, industry 4.0, etc. The contribution of the article is represented by the analysis carried out with the aim of highlighting the trends and challenges in this field. In the agricultural field, the application of deep learning algorithms has contributed to increasing the yield of crops or reducing water consumption, but also to the detection of plant diseases, the classification of plants or the use of precision agriculture [25]; the paper is a case study regarding the development of an application with use in agriculture; the number of bibliographic references is 79.

Source: own processing.

At the same time, it is a way of modernizing agriculture, of moving to the use of precision agriculture, of intelligent agriculture, of artificial intelligence on a larger scale as a result of the foundation of some functional models of agriculture.

However, the specialized literature has not recorded an important number of researches on this subject, but in the following we will present 4 articles and the current research directions.

Therefore, the metaverse can also be found in the agricultural field, in the practices of intelligent agriculture, precision agriculture, thus contributing to the development of applications that lead to the improvement of agricultural practices, both in the plant and livestock fields.

Another field in which the virtual world makes its presence felt is the food industry and the aspects related to the traceability of food, which is very much based on the blockchain technology applied in the world of the Metaverse, traceability that will not be reduced in importance at the time of the change of social patterns, located in a continuous progress, but will become more and more complete and reliable. In this way, through the Metaverse, by connecting reality with the virtual environment, new experiences will be created, which will make us enjoy both the culinary experiences, but also the social environment that could be different from the real one.

Regarding the research methodology, in addition to the review of the specialized literature, it was also based on case studies or holistic approaches. Thus, the existence of a gap in terms of primary research can be found, a gap that could be completed with studies related to the impact of the use of the metaverse on different environments, its advantages and disadvantages, but also the impact it will have on the future evolution of mankind.

CONCLUSIONS

We consider that the present analysis based on the study of bibliometric data contributes to the development of applied research regarding Metaverse, starting from the fact that longitudinal studies of scientific interest can contribute to the clarification of some research directions in the process of development, considering the actuality of the concept and the modality in which he can change the future. At the same time, the results obtained allowed an objective scientific mapping thanks to the resulting conceptual maps, contributing to the dissemination of previous scientific research, but also to the establishment of trends, mutual concepts, collaborations and citations, identifying the most productive authors, organizations, countries, as well as the most cited sources and documents. There is an increase in interest towards the "Metaverse" concept, especially in recent years, a fact proven by the increase in the number of scientific papers and citations from the years 2022 and 2023. The analysis of the most relevant and important scientific research articles showed that that these are mostly reviews, which highlights the need for the publication of more applied studies. Through this research, we consider that we were able to make an important contribution in the scientific field regarding the theme of the metaverse, as a result of the systematization of existing knowledge, this being one of the few bibliometric analyzes of this concept. Also, through the research, we managed to identify the research gaps in the analyzed field.

Our research highlights the fact that although it followed the analysis of information related to the application of Metaverse in different fields, it has some limitations that must be recognized, among which the fact that the information obtained is limited, as a result of the consulted databases (WOS and Scopus) and the words key that we used in the bibliometric analysis; the fact that the number of published studies is still low, although there is an increase in interest in this field of research. We therefore consider that this study can offer both researchers and practitioners the potential directions for research and investigation of this topic, related to the application of Metaverse in different fields.

Last but not least, it should be emphasized that the implementation of Metaverse can lead

to the expansion of business development opportunities, to overcoming time and space barriers, which otherwise cannot be overcome in the real world. Although Metaverse is not a new technology, it is a technology in continuous change and development, on the rise, with an increase in popularity especially among young people and due to the technology that requires certain skills, we note that in many works its advantages are presented, without too much recognition of its shortcomings, vulnerabilities, social and physiological impact of its use, moral principles, cyber security, confidentiality.

The present study shows that Metaverse is a fashionable concept, still at the beginning of the road in many fields, which can simplify our life, but at the same time it can irreparably complicate it. It is a Pandora's box, which if we want to open, we should make sure that we are ready to face its challenges. Or maybe this Pandora's box has already been opened?

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