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Journal of Metaverse publishes scientific/original research and review articles. It is published electronically twice a year, in June and December. It is an **international scientific refereed journal** that publishes articles written in **English**, and includes acedemicians from different countries in its boards. Uses "Double-Blind Peer Review" in reviewing processes. It has adopted the open access principle. No fee is requested from the authors for open access, processing, publication fee or otherwise. It is totally **FREE**.

FOREWORD

Dreamers unite!
It's an honour to write for the first preface of our new spaceship "Journal of Metaverse"

Let's start with "The Road Not Taken" poem by Robert Frost

Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,

And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference.

(Robert Frost, 1916)

I want to tell you about the main crew of our spaceship which is destined for the future.

It's Dr. Enis Karaarslan speaking. My main area of study is cyber security, however, I am interested in disruptive technologies which will change the way we do things. My main path became decentralization technologies and smart contracts. The decentralization and the elimination of intermediaries, prevention of censorship amazed me. It still is.

I met Dr. Ömer Aydın on my way. He is a dreamer who wants to change academic publishing. He founded İzmir Academy Association (www.izmirakademi.org) and is doing nonprofit publishing besides his academic career. We have been working on several projects together, and this journal will be the most promising one. He is a genius in publishing and making everything efficient. Thank you for your support. We wouldn't start this quickly without you.

Then I met Dr. Senem Yazıcı Yılmaz, who is a technology enthusiast. She is working on tourism technologies and gamification, experimenting with virtual reality, augmented reality, cryptocurrencies and blockchain. She is a dreamer who believes in technology and innovation. She is our metaverse guide. Her curiosity and insight are helping us to find our way in cyberspace.

I am an engineer. I find myself focusing on the technological problems and saying “Hey we are not there yet!”. There are many challenges, but by the way, I love challenges. The difficulties that challenge us made the evolution of humans. Let’s dream about future technologies and study them.

You are invited to publish your findings in the “Journal of Metaverse”. The journal aims to bring new approaches to the metaverse with new theories, ideas, designs, frameworks, mechanisms, and technologies. The financial, sociological, cultural, literary, psychological, and other interdisciplinary aspects of this newly emerging field are also welcomed. We aim to bring the academia and industry to present their original research and achievements. High-quality survey articles will also be published. The journal welcomes studies on all aspects of the metaverse.

You are welcome.
Hoşgeldiniz.

Hope you enjoy your journey.

Dr. Enis Karaarslan
Journal of Metaverse, Chief Editor

CONTENT

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Metaverse Shape of Your Life for Future: A bibliometric snapshot

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***Abstract*— The metaverse was first introduced in 1992. Many people saw Metaverse as a new word but the concept of Metaverse is not a new term. However, Zuckerberg's press release drew all the attention to the Metaverse. This study presents a bibliometric evaluation of metaverse technology, which has been discussed in the literature since the nineties. A field study is carried out especially for the metaverse, which is a new and trendy subject. In this way, descriptive information is presented on journals, institutions, prominent researchers, and countries in the field, as well as extra evaluation on the prominent topics in the field and researchers with heavy citations. In our study, which was carried out by extracting the data of all documents between the years 1990-2021 from the Web of Science database, it was seen that there were few studies in the literature in the historical process for the metaverse, whose popularity has reached its peak in recent months. In addition, it is seen that the subject is handled intensively with virtual reality and augmented reality technologies, and the education sector and digital marketing fields show interest in the field. Metaverse will probably have entered many areas of our lives in the next 15-20 years, shape our lives by taking advantage of the opportunities of developing technology.**

Keywords*— *Metaverse, bibliometrics, virtual world, literature minings, literature-based discovery.

I. INTRODUCTION

Mark Zuckerberg announced in October, 2021 that Facebook will change its name to Meta and also make significant investments in Metaverse [13]. Many people saw Metaverse as a new word. But the concept of Metaverse is not a new term. The word metaverse first appeared in 1992 in a speculative piece of fiction called Snow Crash by Neal Stephenson. In this novel, Stephenson defines the metaverse as a large virtual environment [9]. More recently, a metaverse called OASIS has been featured in the novel and movie Ready Player One [22]. In the novel, the metaverse is a virtual shared space that combines virtual reality, augmented reality, and the internet [13]. But in the intervening 30 years, the concept has never been more popular. Developments show that the concept will make itself mentioned even more.

Alang [1] defined the Metaverse as the layer between you and reality. Metaverse refers to a 3D virtual shared world where all activities can be carried out with the help of augmented and virtual reality services. Such platforms have gained popularity over the past few years as people shift their activities online, especially during the coronavirus pandemic [25]. The metaverse refers to a shared 3D virtual world in which all activities can take place using augmented and virtual reality equipment. These platforms have gained popularity in recent years as people shift their activities online, especially during the COVID-19 pandemic [6].

With the SARS-CoV-2 virus, which entered our lives in January 2020, and the devastating effect of this virus on our lives, humanity is deprived of many opportunities in its daily life. Hundreds of millions of people around the world have had our lives paralyzed by the spread of COVID-19, the viral disease of the coronavirus, and its associated severe acute respiratory syndrome. Due to the contagious effect of COVID-19 and the desire to prevent this transmission, humanity has been subject to restrictions in its movements [7,11]. This disease, which affects all sectors from the education sector to the production sector, has further increased the importance of concepts such as distance work or distance education. Masters et al. [12] stated that the importance of distance education has increased in the increasing Covid 19 disease, and the ways to make it more realistic in order to increase the effectiveness and range of education are being questioned.

Zuckerberg's vision didn't have to do with advertising, which provides the bulk of Facebook's current profits, or the increase in the total size of the social network, which already has around three billion monthly active users [2]. In summary, Facebook's introduction by Mark Zuckerberg has shifted everyone's attention to Metaverse and has made it a topic that is discussed in our daily lives. Humanity has begun to question the concept of the Metaverse even more now. At first glance, the concept of the metaverse is directly associated with augmented reality and virtual reality issues. But it is also clear that it is much more than what Mark Zuckerberg imagined or what the Seoul municipality of South Korea imagined.

As Zuckerberg revealed to the media before the Facebook Connect conference, the company claims it will be the next big computing platform after the rise of smartphones and the mobile web [8]. Not only Facebook's Meta company, but also companies such as Microsoft and Nike are struggling to take their place in this market. Even states are getting hungry for national policies on this issue, with South Korea the only government trying to recreate the virtual public square [23]. In summary, it is not just private businesses that support Metaverse. The South Korean State has started to carry out policies on this issue and they have started to share it with the public. The first statement on this issue came from South Korea. It has been announced that a large enterprise involving 500 companies including Samsung, Hyundai Motors, SK Telecom, and KT will be provided by the state, for example, $26 million in just 2022 [10]. The future of the Metaverse is almost entirely built by companies.

Alang [1] stated that the first thing to ask about the metaverse is whether it is something wanted. He also stated that a great deal of work will be done in the process of providing technological development for the metaverse and that this is not a single product presentation, but much more. For this, he gave the example of the Uber initiative and stated that Uber is not just a car calling application on your phone, but actually, an infrastructure that includes the entire transportation infrastructure. He stated that the company aims to be the technology layer that not only drives rides but also drives bicycles, scooters, public transport, and ultimately autonomous cars. But Uber sold its autonomous car division after it became clear that solving self-driving is a much more difficult problem than anyone knows.

Shotton et al.[19] stated that the ability to explore, integrate and reuse relevant scientific outputs from previous studies is critical for innovative research [19]. He emphasized the importance of information regulation to shape the future of societies and stated that information has become the most important resource for the future of late modern societies [17]. With the processing of information in the right hands, a strategy can emerge for institutions, countries, and businesses. Rotolo et al. [15] said that Conventional tools of strategic intelligence include science and technology foresight, innovation policy evaluation, and technology assessment. Thanks to the fields of bibliometry or scientometrics, it can be used for common science and technology assessment to see the outputs of policies and activities carried out in certain periods in such strategic associations. Metaverse is one of the most up-to-date technological developments in the rapidly transforming world in this regard. It is valuable to observe and follow the equivalent of the discussions in this direction in the literature.

Zuckerberg betting that it will be the next big computing platform for the metaverse, after the rise of smartphones and the mobile web [8]. Will this expectation come true, as in the case of Uber, and what kind of discussions have been made in the literature in this direction from past to present. At this point, the bibliometric field provides good tools for exploring the texture of work done in a particular field or topic. Bibliometric studies are important studies to define a particular field and to better understand the researcher's texture in that field. In this way, researchers working in the field can have information and ideas about the development of the literature and researchers who have come to the fore in the field. Likewise, there are important journals that stand out in certain fields. The motivation for this study is the lack of a bibliometric study in the literature on a topic that has been so popular recently. It is thought that it will be a guide for researchers and will provide information about important congresses, journals, and institutions of the field.

II. METHOD

This study, publications in the field of "metaverse", which are in the Web of Science database and scanned by SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI indexes, were evaluated. Data were collected on 26.11.2021. The search keywords used in the study is as follows: (ti="metaverse" or ak="metaverse" or kp="metaverse")

93 documents were accessed in the Web of Science database, 1560 different sources and a total of 1855 different references were used in 93 documents. It has been seen that related studies have been carried out by 155 different authors, 29 different countries, and 96 different organizations. The research questions that the study focuses on are as follows:

- What are the distribution, languages and document types of documents produced on Metaverse by years?
- What is the situation of researchers, institutions and countries doing intensive research on the Metaverse?
- What is the bibliometric trends according to published documents types such as book chapters, proceedings and articles on the Metaverse?
- What are the journals that publish the most on Metaverse, the publishers that come to the fore, and the congresses that stand out in the field?
- What are the most frequently cited works on Metaverse?
- What are the generally accepted debates on the Metaverse and what is the general trends of the topics discussed in the historical process from past to present?

Vosviewer program was used for bibliometric analysis in the study. VOSviewer is the software package for analysing and visualising large bibliographic datasets. VOSViewer applies its own algorithm that is a modularity-based clustering technique, which is similar to the multidimensional scaling and is based on the smart local moving algorithm [26,27].

III. DISCUSSION AND FINDINGS

The findings obtained from the bibliometric analysis carried out in the study will be carried out in the form of general view, focus on book chapters, focus on proceedings, focus on the article, and finally content analysis for all documents. These contents are presented under the headings in order below.

A. General View

The number of documents accessed via Web of Science is 93. These publications in total times cited:281 and average per item:3.02 and our h-index value is 9. These documents were produced by 155 different researchers. When sorted these documents according to their types; articles (f:42), proceedings papers (f:38), book chapters (f:14). In the Web of Science environment, a document can be included in the same class as both articles and book chapters as a document type.

When evaluated document productivity by years; 2021(f:6), 2020 (f:5),2019 (f:3), 2018 (f:5), 2017 (f:5), 2016 (f:6),2015 (f:12), 2014 (f:2),2013 (f:6),2012 (f:5), 2011 (f:6),2010 (f:10),2009 (f:9), 2008 (f:7), 2007 (f:2), 2006 (f:1), 2000 (f:1), 1996 (f:1), 1995 (f:1). Publishing organizations that have produced a minimum of two documents when sorted according to Publishers; Springer Nature (f:20), IEEE (f:15), IGI Global (f:7), Elsevier (f:6), Assoc Computing Machinery (f:5), MDPI (f:3), Kassel Univ Press Gmbh (f:2), Sage (f:2), Taylor & Francis (f:2).

When ranked the obtained works according to the researach area; computer science (f:42), engineering (f:17), education educational research (f:8), psychology (f:8), art (f:7), business economics (f:7), information science library science (f:5), science technology other topics (f:5), communication (f:4), cultural studies (f:4), imaging science photographic technology (f:3), public administration (f:3), religion (f:3), telecommunications (f:3), arts humanities other

topics (f:2), chemistry (f:2), geography (f:2), philosophy (f:2), environmental sciences ecology (f: 1), government law (f:1), health care sciences services (f:1), instruments instrumentation (f:1), music (f:1), social issues (f:1), social sciences other topics (f :1), sociology (f:1).

When the studies are evaluated according to the subject area, it is seen that they concentrate on computer science and engineering (f:17). However, when the research area texture is evaluated, it can be seen that the studies on the metaverse find application in many different fields, from the field of health to the field of education, from the field of culture to the field of environmental sciences. It is seen that metaverse studies are carried out on psychology, religion, philosophy, and social issues due to human-computer interaction.

When ranked the works according to the languages in which they were produced; English (f:87), Spanish (f:4), Portuguese (f:1), Russian (f:1). The countries that come to the fore in this productivity are respectively; USA (f:19), Japan (f:10), Brazil (f:8), South Korea (f:8), England (f:7), Turkey (f:7), Spain (f:5), Belgium (f:3), Colombia (f:3), France (f:3), Sweden (f:3). The data of book chapters, proceedings, and articles are presented below, respectively. While South Korea has come to the forefront in studies and the expansion of countries, South Korea is behind the USA and Japan in terms of the metaverse. In addition, although recently, both Facebook manager Zuckerberg's statement [2,8,10], it has been seen that the subject that have discussed extensively in daily life has been evaluated by few studies and researchers in the literature. It is thought that the literature on metaverse will be enriched after the concept is overlapped with the words augmented reality and virtual reality, and there is more work in the literature in this direction, the definition of a general concept as an umbrella term as metaverse, and the discourses of important companies and some states are developing policies.

B. Focus on Book Chapters

Distribution of book chapter studies on Metaverse by years; 2017 (f:1), 2015 (f:7), 2013 (f:3), 2012 (f:1), 2010 (f:1), 2009 (f:1). A total of 14 book chapter studies were carried out and related studies received 25 citations in total. All of the book section studies have been published in the English Language. Book chapters' publishers are IGI Global (f:7), Springer Nature (f:6), Ashgate Publishing Ltd (f:1). Book Series Titles are Advances In Educational Technologies And Instructional Design Book Series (f:7), Human-Computer Interaction Series (f:1), New Directions In Planning Theory (f:1), Smart Computing and Intelligence (f:1).

Researchers who carried out the work of the book section; Backes L (f:7), Schlemmer E (f:7), Calongne C (f:1), Dede CJ (f:1), Devisch O (f:1), Huvila I (f:1), Jacobson J (f:1), Lombardi J (f:1), Lombardi M (f:1), Power D (f:1), Richards J (f:1), Sheehy P (f:1), Sonvilla-weiss S (f:1), Sonvillaweiss S (f:1), Stricker A (f:1), Teigland R (f:1). Distribution of researchers who made book chapters to countries; Brazil (f:7), USA (f:3), Sweden (f:2), Belgium (f:1), Finland (f:1), Norway (f:1). It was seen that Brazil came to the fore in the book chapters. The reason for this issue is the study of the book Learning in Metaverses: Co-Existing in Real Virtuality: Co-Existing in Real Virtuality [16], edited by Eliane Schlemmer in the Metaverse field in the relevant country.

The institutions of the researchers who carried out the book section are as follows; Centro Universitario La Salle (f:7), Universidade Do Vale Do Rio Dos Sinos Unisinos (f:7), Uppsala University (f:2), Aalto University (f:1), Colorado Technology University (f:1), Consulting Services for Education (f:1), Duke University (f:1), Enterprise VR (f:1), Harvard University (f:1), PHL University College in Belgium (f:1), Stockholm School of Economics (f:1), University of Agder (f:1). In addition, the distribution of book chapter studies according to research areas is as follows: psychology (f:8), communication (f:3), cultural studies (f: 3), computer science (f:2), art (f:1), education educational (f:1), geography (f:1), public administration (f:1).

C. Focus on Proceedings

The progress of the papers by years is as follows: 2019 (f:2), 2018 (f:3), 2016 (f:4), 2015 (f:4), 2014 (f:2), 2013 (f:2), 2012 (f:3), 2011 (f:4), 2010 (f:5), 2009 (f:4), 20082), 2007 (f:1), 2006 (f:1), 2000 (f:1). When this course is evaluated, there is no significant jump. It has been seen that 3-4 papers are presented in the related congresses a year. Facebook and South Korea's serious releases on the metaverse and their sharing of their strategic action plans with the public promises hope in the number of papers produced in the coming years and even in the planning of new congresses related to the metaverse.

When the papers produced on Metaverse are evaluated; Japan (f:10), USA (f:7), Turkey (f:4), England (f:3), Austria (f:2), France (f:2), Netherlands (f:2), South Korea (f:2), Spain (f:2). When the papers are evaluated according to the institutions where they are produced (minimum 2), the following table is encountered; Sabanci University (f:4), Clarkson University (f:3), Ritsumeikan University (f:3), Suzuka College (f:3), Gifu College (f:2 Graz University of Technology (f:2), Nagaoka University of Technology (f:2), Tsuyama College (f:2), University of La Reunion (f:2) There are not very serious differences between countries and related countries.

The prominent researchers in the paper are as follows. Ayiter E (f:4), Barry DM (f:4), Fukumura Y (f:4), Kanematsu H (f:4), Ogawa N (f:4 Kobayashi T (f:3), Thawonmas R (f) :3), Conruyt N (f:2), Dharmawansa A (f:2), Sebastien D (f:2), Shirai T (f:2), Yajima K (f:2) When both institutions and researchers are evaluated, It is thought that the relevant data will be a reference for researchers who want to do post-doctoral research on the metaverse, who want to do their postgraduate education in the metaverse field, and who are looking for an institution.

When the papers are sorted according to the research areas in which they are located, the following view is encountered; computer science (f:35), engineering (f:12), imaging science photographic technology (f:3), business economics (f:2), education educational research (f:2), telecommunications (f:2), chemistry (f:1), health care sciences services (f:1), information science library science (f:1), philosophy (f:1), public administration (f:1), religion (f:1), science technology other topics (f:1), social issues (f:1). It can be stated that the trend in the field of proceedings research is similar to the general trend.

The conferences that come to the fore in the field for papers can be expressed as follows; International Conference on Cyberworlds, International Conference on Entertainment Computing, Biennial Pan Ocean Remote Sensing Conference Porsec, International Conference on Entertainment Computing, International Conference on E-Commerce and

Web Technologies, World Marketing Congress on Looking Forward Looking Back Drawing on the Past to Shape the Future of Marketing, International Conference on Knowledge-Based and Intelligent Information and Engineering Systems, IEEE International Conference on Games and Virtual Worlds for Serious Applications vs Games, International Conference on Advanced Information Networking and Applications, International Conference on Virtual Reality Held at the Human-Computer Interaction , International Conference of the Chilean Computer Science Society, European Conference on Games Based Learning, International Conference on Intelligent Interactive Multimedia Systems and Services, International Conference on Internet and Web Applications and Services, International Technology Education and Development Conference, International Conference on Intelligent Games and Simulation, Augmented Human International Conference, Virtual Reality International Conference, Conference on Engineering Reality of Virtual Reality. Related congresses can also be expressed as congresses where the most intense discussions about its development in the field are held. It can be expressed as qualified congresses where researchers can present their scientific studies in the field.

TABLE I. TOP TEN PROCEEDINGS ABOUT METAVERSE

Rank	Title	Year	C
1	Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses	2008	153
2	3D Virtual Worlds and the Metaverse: Current Status and Future Possibilities	2013	111
3	Introduction: Virtual, Augmented, and Mixed Realities in Education	2017	85
4	User-Friendly Home Automation Based on 3D Virtual World	2010	70
5	Retail spatial evolution: paving the way from traditional to metaverse retailing	2009	62
6	A content service deployment plan for metaverse museum exhibitions-Centering on the combination of beacons and HMDs	2017	53
7	Retailing in Social Virtual Worlds: Developing a Typology of Virtual Store Atmospherics	2015	28
8	Virtual world, defined from a technological perspective and applied to video games, mixed reality, and the Metaverse	2018	21
9	Metaverses as a Platform for Game Based Learning	2010	19
10	Innovation and imitation effects in Metaverse service adoption	2011	19
11	Synthetic Educational Environment - a Footpace to New Education	2017	18
12	Multilingual Discussion in Metaverse among Students from the USA, Korea and Japan	2010	15
13	Splendid isolation: 'Philosopher's islands' and the reimagination of space	2012	14
14	Virtual STEM class for nuclear safety education in metaverse	2014	11
15	Opening the Metaverse	2010	15
16	Distributed Metaverse: Creating Decentralized Blockchain-based Model for Peer-to-peer Sharing of Virtual Spaces for Mixed Reality Applications	2018	10
17	Evaluation For Students' Learning Manner Using Eye Blinking System in Metaverse	2015	10
18	Blinking Eyes Behaviors and Face Temperatures of Students in YouTube Lessons - For the Future E-learning Class	2016	8
19	Virtual World as a Resource for Hybrid Education	2020	7
20	From Industry 4.0 to Nature 4.0-Sustainable Infrastructure Evolution by Design	2018	6

[a.] Citations: C

When the general titles of the congresses related to the metaverse subject were evaluated, it was seen that the metaverse subjects were discussed more in the most intense computer science, information systems and engineer, intelligent systems congresses. However, along with these fields, the metaverse is also discussed intensively in congresses on e-health, education, e-commerce, web technology and digital marketing, interactive multimedia systems and services. In addition to these, it can be stated that the metaverse matures in these congresses and these congresses are important for its structuring, especially considering the 11th-12th conferences on augmented reality and human interaction, and the fact that the field will be built on virtual reality and augmented technologies.

Table 1 below presents the most frequently cited proceedings on the metaverse. The fact that the congresses in which the works are presented are not similar, the fact that almost 10 papers are presented in different congresses shows that the word metaverse does not find its exact equivalent in the literature and academic environment. In general, it was seen that the discussions went over topics such as augmented reality, virtual reality, intelligent interactive multimedia systems.

D. Focus on Articles

There are 42 articles produced on the subject of Metaverse, and these articles are 217 times cited, average per item 5,17 and h-index:7 in total. 42 articles were produced in the following languages; English (f:37), Spanish (f:4), Russian (f:1). The productivity frequency of the articles by years is as follows: 2021 (f:4), 2020 (f:5), 2019 (f:1), 2018 (f:2), 2017 (f:4), 2016 (f:2), 2015 (f:8), 2013 (f:3), 2012 (f:2),2011 (f:2), 2010 (f:4), 2009 (f:1), 2008 (f:2), 2000 (f:1), 1995 (f:1). As in the papers and book chapters, the development of the field in the literature and the interest in the word metaverse have been realized in a small number of articles, generally changing between 3-5 articles over the years. It can be stated that this situation is perhaps because the concept does not approach until 2021, like Mark Zuckerberg. Of the articles produced, 10 are scanned in the Emerging Sources Citation Index (ESCI), 12 in the Social Sciences Citation Index (SSCI), 9 in the Science Citation Index Expanded (SCI-EXPANDED), and 4 in the Arts & Humanities Citation Index (A&HCI). Others were scanned by Book Citation Index - Social Sciences & Humanities (BKCI-SSH), Book Citation Index - Science (BKCI-S), and Conference Proceedings Citation Index - Science (CPCI-S).

When the studies are evaluated according to the research area, they are as follows: psychology (f:8), computer science (f:6), business economics (f:5), education educational research (f:5), engineering (f:4), cultural studies (f:3), art (f:2), arts humanities other topics (f:2), communication 2 geography (f:2), information science library science (f:2), public administration (f:2), religion (f:2), science technology other topics (f:2), chemistry (f:1), environmental sciences ecology (f:1), instruments instrumentation (f:1), music (f:1), philosophy (f:1), social sciences other topics (f:1), telecommunications (f:1).

The researchers and their institutions that have published the most intensive articles on the metaverse are given in Table 2. Backes L and Schlemmer E are Brazilian researchers who have come to the fore in the field with seven articles. When the researchers who carried out the studies are evaluated according to the countries; USA (f:10), Brazil (f:7), South Korea (f:6), England (f:4), Colombia (f:3), Spain (f:3), Turkey (f:3), Belgium (f:2), Sweden (f:2), Ecuador (f:1), France (f:1), Israel (f:1), Mexico (f:1), Peru (f:1), Ukraine (f:1).

Fifteen journals and their research domains that stand out in the field are presented in Table 3. When the research domain of the journals is evaluated, computer science, software engineering, business; management, engineering, electrical & electronic seem to come to the fore.

TABLE II. MOST PRODUCTIVE RESEARCHERS AND INSTITUTIONS PUBLISHING ARTICLES ABOUT METAVERSE

Rank	Authors	Organizations	Country	Number of Doc.
1	Backes L	Centro Universitario La Salle	Brazil	7
2	Schlemmer E	Universidade do Vale do Rio dos Sinos	Brazil	7
3	Ayiter E	Sabanci University	Turkey	2
4	Bourlakis M	Cranfield University	England	2
5	Diaz JEM	Univ Cundinamarca	Brazil	2
6	Li F	City University London	England	2
7	Papagiannidis S	University of Newcastle	Australia	2

[a.] Number of Document Count: N

TABLE III. JOURNALS AND THEIR RESEARCH DOMAINS OF INTEREST IN METAVERSE-RELATED PUBLICATIONS

Rank	Journal Title	JIF (2020)	Research Domain
1	ACM Computing Surveys	14.098	Computer Science, Theory & Methods
2	Computer Animation and Virtual Worlds	1.020	Computer Science, Software Engineering
3	Data Base for Advances in Information Systems	1.828	Information Science & Library Science
4	Electronic Commerce Research	3.747	Business; Management
5	Geoforum	3.901	Geography
6	Harvard Business Review	6.870	Business; Management
7	Human Centric Computing and Information Sciences	5.900	Computer Science, Information Systems
8	IEEE Technology and Society Magazine	1.554	Engineering, Electrical & Electronic
9	IEEE Transactions on Consumer Electronics	2.947	Engineering, Electrical & Electronic; Telecommunications
10	International Journal of Information Management	14.098	Information Science & Library Science
11	Journal of Consciousness Studies	1.348	Social Sciences, Interdisciplinary
12	Journal of Electronic Commerce Research	2.861	Business
13	Journal of Visual Culture	0.400	Cultural Studies
14	New Scientist	0.319	Multidisciplinary Sciences
15	Sensors	3.576	Chemistry, Analytical; Engineering, Electrical & Electronic; Instruments & Instrumentation

[b.] Journal of Impact Factor: JIF

Table 4, The most prominent and most cited studies for researchers are as follows. In the study, the citation values obtained from Google Scholar were updated by taking the citation numbers from Web of Science as a reference.

E. Content Analysis About Title, Abstract and Keywords

In the analysis, the keywords most heavily associated with the word metaverse were second life, virtual worlds, avatar, 3d, augmented reality, virtual reality, virtual environments, art, mixed reality, collaboration, e-learning, multi-user virtual environment (muve), open simulator, virtualization, metaverse retailing, haptics, blockchain, industry 4.0 are the most frequently used keywords in published studies. In addition, words such as education, higher education, informal education, e-learning, schools, panoramic, museums, exhibition content, virtual excavation, church, smart maintenance, came to the fore. The reason for this is the intense work of virtual or augmented reality studies in educational studies. Boeing 737 maintenance education can be given as an example of the studies carried out in the field of education [21]. Recently, in the emerging world of mixed reality applications, various industries are already taking advantage of these technologies [4,5,18,20].

Metaverses embedded in our lives create virtual experiences according to part of life scenarios inside of the physical world (Siyaev & Jo, 2021). For example, the concept of haptics stands out among the researcher keywords used. Haptics differs from other robotic devices; It allows people to feel the shape, roughness, and vibration of the surface in a virtual reality environment or while controlling slave robots. Real perception is an important factor for the user to experience.

TABLE IV. TOP 20 MOSTLY CITED ARTICLES ABOUT METAVERSE

Rank	Title	Year	C
1	Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses	2008	153
2	3D Virtual Worlds and the Metaverse: Current Status and Future Possibilities	2013	111
3	Introduction: Virtual, Augmented, and Mixed Realities in Education	2017	85
4	User-Friendly Home Automation Based on 3D Virtual World	2010	70
5	Retail spatial evolution: paving the way from traditional to metaverse retailing	2009	62
6	A content service deployment plan for metaverse museum exhibitions-Centering on the combination of beacons and HMDs	2017	53
7	Retailing in Social Virtual Worlds: Developing a Typology of Virtual Store Atmospherics	2015	28
8	Virtual world, defined from a technological perspective and applied to video games, mixed reality, and the Metaverse	2018	21
9	Metaverses as a Platform for Game Based Learning	2010	19
10	Innovation and imitation effects in Metaverse service adoption	2011	19
11	Synthetic Educational Environment - a Footpace to New Education	2017	18
12	Multilingual Discussion in Metaverse among Students from the USA, Korea and Japan	2010	15
13	Splendid isolation: 'Philosopher's islands' and the reimagination of space	2012	14
14	Virtual STEM class for nuclear safety education in metaverse	2014	11
15	Opening the Metaverse	2010	15
16	Distributed Metaverse: Creating Decentralized Blockchain-based Model for Peer-to-peer Sharing of Virtual Spaces for Mixed Reality Applications	2018	10
17	Evaluation For Students' Learning Manner Using Eye Blinking System in Metaverse	2015	10
18	Blinking Eyes Behaviors and Face Temperatures of Students in YouTube Lessons - For the Future E-learning Class	2016	8
19	Virtual World as a Resource for Hybrid Education	2020	7
20	From Industry 4.0 to Nature 4.0-Sustainable Infrastructure Evolution by Design	2018	6

[c.] Citations: C

Hardware and software are now sufficiently advanced. Metaverses that use virtual or augmented reality on affordable devices, pioneered by games, are likely to become much more popular. It can start to offer practical or fun features. And of course, there is a lot of money to be made. Fortnite generated $9 billion in revenue in 2018 and 2019 as people paid to customize their avatars [22]. This situation is also becoming appetizing for blockchain technology.

In Stephenson's metaverse, companies all pay for slices of digital real estate to an entity called the Global Multimedia Protocol Group. Users also pay for access; Only those who can afford cheaper common terminals appear as grainy black and white in the metaverse [2]. In fact, in the literature, it is seen that the subject has been discussed intensively, especially

with blockchain technology, from the day the novel was written.

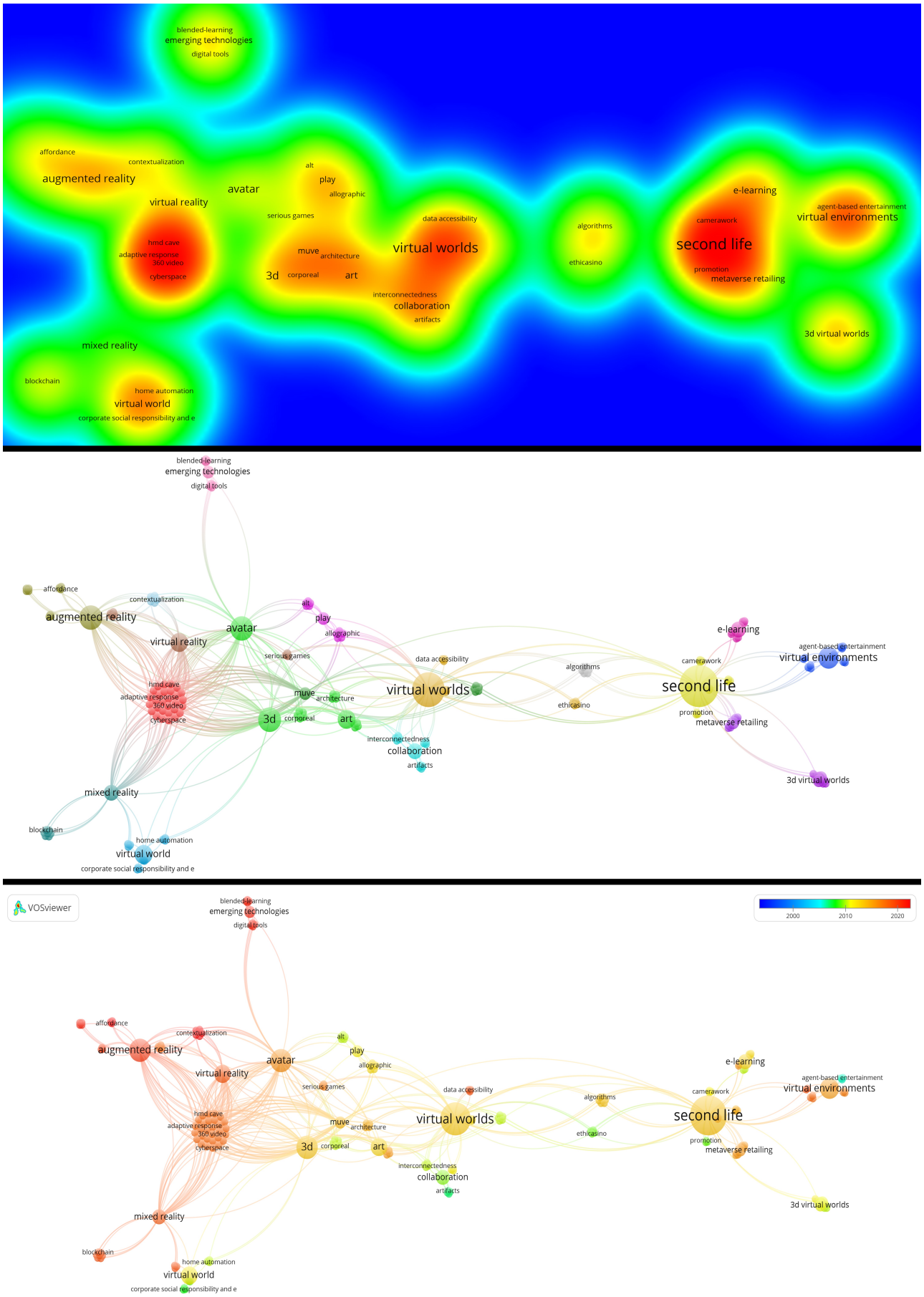

Fig. 1. Keyword Density, Overlay and Network Visualizations about Metaverse

The video game second life, released by Linden Lab in 2003, created a virtual world where users can navigate by building their structures [22]. In the literature, it has been seen that intensive studies have been made on Second Life. Roblox, a children's video game released in 2006, has recently evolved into an immersive world where players can design and sell their creations, from avatar costumes to their own interactive experiences [14]. Sci-fi "metaverse" concepts are slowly becoming reality as products like Fortnite, Minecraft, and Roblox bring immersive social experiences to hundreds of millions of people and blur the lines between games and social networks [24].

Sweeney [24] foundational principles and technologies are applied computing, computing methodologies, and networks and on the other hand computer systems organization, real-time systems, human-centered computing, theory of computing for the metaverse. Siva et al. (2018), to create a virtual environment, use of intelligent avatars and holographic projects, can simulate a real-world classroom scenario.

IV. Conclusion and Recommendations

It seems that the world of the Metaverse is now clearly coming. This world can harbor both benefits and harms as expected. Just as social media has good and bad sides, the metaverse also has good and bad sides. The hotspot is the usage area. Of course, these issues will be discussed in many scientific studies.

Despite the increasing interest of researchers on the subject of the metaverse, there are few explanatory and comprehensive studies on the subject of a metaverse in the literature. However, it is thought that this situation will increase especially in recent years with the developments in blockchain technology, sensor technology, the advancement of augmented and virtual reality technologies, and the recent statements of South Korea and Facebook founder Zuckerberg.

Facebook is not the only tech company that is invested in exploring a 3D virtual reality where people interact with others using avatars of themselves. Video games such as Roblox and Fortnite are already popular among Gen Z, where they create and interact with each other within their universe [10]. And also they believe this will be the successor to the mobile internet [2]. It can be stated that many different companies may enter the field in this future, enterprises operating in technologically parallel or related sectors are only 3-5 steps ahead of the race at this point, but the sector is fresh and appetizing for entrepreneurs at this point.

Metaverse is not a single product that a company can handle alone. Just like the internet, the metaverse will exist with or without Facebook. It will also not be built overnight. Many of these products will only be fully realized in the next 15-20 years. This situation strengthens the possibility that the subjects will be evaluated from many different aspects in the literature in this development process. This shows the importance of Metaverse and the valuable analysis of the studies carried out in this direction in the literature. It is thought that it will be beneficial for the researchers to compare the data obtained from different databases with the data obtained, and to present a texture analysis on the metaverse periodically, in terms of the development of the field and for the researchers to see the general view.

Facebook is considering recruiting 10,000 new teammates across the EU at Facebook and putting its European presence at the center of plans to help build the metaverse [3] in fact, this situation confronts us with the possibility of many big IT companies entering this field in terms of the metaverse. and it can be seen that it will create new employment areas.

Of course, at this point, it is considered beneficial for higher education institutions to include topics that will be related to the metaverse in some way, such as virtual reality, augmented reality, simulation technology, blockchain technology. In this way, higher education institutions will be able to support and meet the demands of the sector in terms of trained human resources that the sector needs.

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Computer Vision in the Metaverse

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Abstract **- Metaverse is a rapidly developing new technology today. The purpose of this article is to examine this technology from a computer vision and general perspective. In this study, a comprehensive review of Metaverse concepts in computer vision has been made. Its history, process, techniques, architecture, advantages, and disadvantages are mentioned. The adaptation of Metaverse to life, the ideas of companies about this technological change, and how society will take place in Metaverse are also discussed. The future of Metaverse and what needs to be done to adapt to this technology are explained. As a result, since there are few studies in the literature, this article aims to be a review article that increases academic studies.**

Keywords— ***Metaverse, computer vision, virtual world, extended reality, augmented reality, blockchain, artificial intelligence in metaverse, architecture of the metaverse.***

I. INTRODUCTION

Since the term metaverse is a newly emerging term, it has been observed that there are not many studies in the field of computer vision when the literature is searched. Therefore, this article is a review study. Metaverse, the combination of the prefix "meta" (imply-ing transcending) with the word "universe," describes a hypothetical synthetic environment linked to the physical world. The term 'metaverse' was first coined in a speculative novel named Snow Crash, written by Neal Stephenson in 1992 [1]. In this novel, Neal Stephenson described it as a 3D virtual world where people exist as avatars and interact with software agents. The term Digital Twins was first used by Michael Grieves at the Society of Manufacturing Engineers conference at the University of Michigan in 2002. Digital Twins was introduced as a digital equivalent of a physical object and the conceptual model underlying product lifecycle management. Second Life is an online virtual world game developed with Philip Rosedale and his team. In this game, as in Metaverse, human beings exist as avatars and are in a virtual world. This game is at an important point in the Metaverse world. Second Life started to be developed in 2003, and today, it has millions of active users.

Before examining the subject of computer vision in the Metaverse, it will be useful to examine some terms. Subjects to be examined are Extended Reality (XR), Mixed Reality (MR), Augmented Reality (AR) and Virtual Reality (VR).

Extended Reality (XR) refers to real and virtual spaces created by wearable devices. In other words, it can also be called human-machine interaction [2]. Mixed Reality (MR) combines virtual and real worlds to produce new environments in which digital and physical objects interact in real-time. Mixed Reality (MR) does not coexist two realities; it is a hybrid of two realities [3]. Augmented Reality (AR) is a technology used to increase the visual fields of users with necessary information [4]. In Virtual Reality (VR), users are entirely virtual. They have no connection to the real world. Virtual Reality (VR) allows the user to transition into a three-dimensional (3D) virtual world with a computer [5].

Continuing from the history and development of computer vision, described as the father of computer vision, Larry Roberts, while doing his Ph.D. at MIT, first discussed the possibility of extracting 3D geometric information from 2D perspective views in his thesis. In this way, the foundations of computer vision began to form in 1960 [6]. David Marr defined vision as proceeding from a two-dimensional vision to a three-dimensional visual recognition in 1982 [7]. David Marr's approach is one of the most influential studies ever done. David Marr approach uses low-level image processing algorithms applied to 2D images to obtain a 2.5D sketch of the scene and calls it the first draft. It then obtains 3D model representations of the scenes using high-level techniques. After this approach, many researchers supported David Marr. The Marr approach is complicated to execute, and also, in most computer vision applications, 3D models are not required to be imported. Only one purpose-built computer vision application can be used. For example, only face detection may be necessary, not requiring a full 3D model. This new approach defines those algorithms that should be targeted only and are called "Purposeful Vision". The main proponent of this approach is Yiannis Aloimonos of the University of Maryland [8].

II. ADVANTAGES OF METAVERSE IN COMPUTER VISION

Computer vision plays an essential role in building humans' ability to experience the virtual world in the Metaverse universe. Digital avatars in computer vision and virtual reality offer an almost real-world equivalent experience. While you can reach this virtual world using extended reality products, extended reality is based on the basis of computer vision. Computer vision plays a vital role in XR applications. Visual information and computer vision play a vital role in processing, analyzing, and understanding visuals as digital images or videos to derive meaningful decisions and take actions. Computer vision allows XR devices to recognize and understand visual information of users' activities and physical surroundings, helping build more reliable and accurate virtual and augmented environments. Human pose tracking refers to the computer vision task of obtaining spatial information concerning human bodies in an interactive environment [9].

Computer vision, in XR applications, recreates the user environment in 3D. It determines the direction and location of the user. XR interactive system needs to track the body and pose of users. Metaverse, the human users will be followed with computer vision and represented as avatars. Metaverse also requires users to perceive their environment. Therefore,

image processing is an important area for developing a better metaverse. The metaverse is connected seamlessly with the physical environments in real-time. An avatar needs to work with a physical person in such a condition. It is crucial to display the 3D virtual world with less noise, blur, and high resolution in the metaverse. In adverse visual requirements, such as haze, low or high luminosity, or even rainy weather conditions, the interactive systems in the metaverse still need to show the virtual universe [10].

III. Disavantages of Metaverse in Computer Vision

One of the significant disadvantages of computer vision on Metaverse is the inability to access a fast and secure internet resource and the difficulty in making the relevant extended reality (XR) technology accessible to everyone [11]. Since a vast virtual universe is mentioned, it may not be accessible in the future to make these enhancements in this sizeable virtual universe and keep the user experience always at maximum performance when using computer vision. Also, as the number of users begins to increase, these technologies will always need to work up to date, smoothly, and at high performance. These technologies will always need to be developed.

IV. Applications of Metaverse in Computer Vision

Metaverse domains include healthcare, military, real estate, manufacturing, education, and retail. Metaverse Health applications accelerate surgical procedures, examine data obtained by 3D scans in real-time and augmented reality, help patients detect, diagnose and treat possible diseases, and allow patients to look at their bodies.

Some Metaverse military applications provide a more realistic experience by putting soldiers in more physically and psychologically challenging war environments.

A. Metaverse Real Estate Applications

It allows real estate marketers to review the property with virtual reality tours before making any selections for their clients. In this way, it offers customers the advantage of inspecting under all conditions and reduces travel time to zero.

B. Metaverse Production Applications

Factories significantly reduce the likelihood of accidents by using virtual reality applications. You also do not need to spend time and money training a new employee because, with augmented reality simulations, employees can be prepared quickly and safely.

C. Metaverse Education Applications

Traditional teaching approaches can never provide the high efficiency of using concepts visually. Students prefer watching rather than reading. For this reason, dealing with a subject with visual dimensions with virtual reality will always give better learning results.

D. Metaverse Retail Applications

One of Metaverse's most significant recent developments is that Meta (formerly Facebook) plans to launch direct-to-consumer virtual stores with virtual reality and augmented reality. This promising news also plays an encouraging role in charting different routes in Metaverse.

V. Computer Vision Techniques

A. Image Classification

Classifying pixel and vector groups in an image by applying specific rules is called image classification. It is among the best-known techniques. However, it has several problems to be overcome in its implementation. Let's say we have a set of images belonging to a category, and we prepared a test image set to measure the accuracy of our predictions. The difficulties here are; changing perspectives, deformation, and light settings are some points that must be overcome.

B. Object Detection

Object detection is a method used to identify and locate specific objects in any image or video. Object detection allows us to determine the positions or movements of said objects in the scene and draws them with the bounding box. The major difference between object detection and image recognition is that it defines and labels a bounding box for every object in an image or video defined as a specific object. The model predicts the object's label and location.

C. Object Tracking

Object tracking is defined as tracking a moving object in any or many scenes. First, object detection is used, and then deep learning applications are used, where the object's movement is monitored. Tracked objects have an indicator next to them. The bounding box that shows where the object is can be seen in Fig.1.

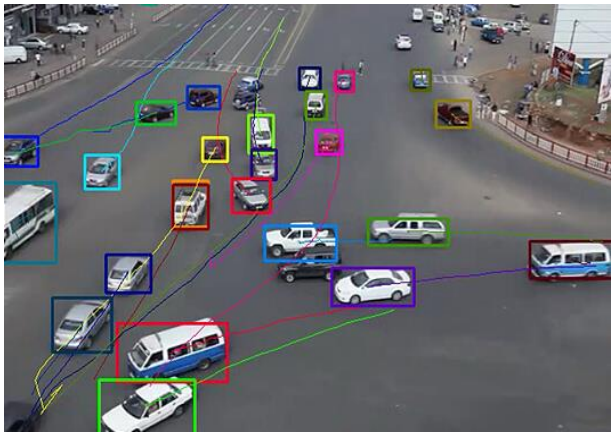

Fig. 1. Bounding Box in Object Tracking [12]

VI. Impact of Covid-19 on Metaverse

Before Covid-19, Metaverse was seen as just an entertainment platform for the community, like spending time, playing games. But after the pandemic, a potential second world came to the Metaverse for society. The community is discussing business integration, collaborations, retail merchandising, investment, and how to adapt this model to life around the world. Building a virtual universe has gained extreme importance after the pandemic, as it can be a solution to some problems. An example of this is holding interactive virtual business meetings. The Covid-19 pandemic has played an important role in accelerating the evolution of the Metaverse universe.

VII. Future of Metaverse in Computer Vision

It looks like Metaverse will be at an important point in our lives in the future. Therefore, many investments are made. Today, while the business world is trying to adapt quickly, it is predicted that many sectors will take place in the Metaverse in the future. From the point of computer vision, extended reality (XR) and augmented reality (AR) technology products will develop, or new products will begin to emerge in the future.

VIII. Blockchain on Metaverse

Blockchain technology is originally the name given to the design underpinning the operation of the digital currency Bitcoin. Bitcoin's creator never used the term "blockchain" in his whitepaper. Reading the paper, one gets the distinct impression that the author was not introducing a new technology in the traditional sense of the word. Still, a software design drawing on several existing technologies allows him to create a "purely peer-to-peer version of electronic cash" [13]. There are some projects in Metaverse. Metaverse also aims to create a digital economy. It has cryptocurrencies for it. The benefits of Blockchain in the Metaverse are as follows; digital proof of ownership, digital collectability, transfer of value, governance, accessibility, and interoperability. It also offers a transparent and cost-effective solution.

IX. Artificial Intelligence In Metaverse

Artificial intelligence applications; Features deep learning provide higher performance for developers and designers in Metaverse than traditional approaches. However, it is not enough to implement artificial intelligence to make users' work easier and provide a high-performance experience. Existing AI models are often intense and require large computations. Therefore, it is essential to design light and efficient artificial intelligence models [14].

X. Extended Reality (xR)

The Metaverse moves from concept to reality and requires a VR/AR/MR intermediate stage. To some extent, virtual environments form the technical basis. Technologies like Metaverse will shape the new form of the internet. VR will also make the virtual world operation more similar to the real world, allowing users to have a more realistic and memorable experience. On the other hand, AR/MR can transform the physical world into a virtual one. The future of the physical world is being integrated into the Metaverse.

Ideal model; MR and Metaverse advocate full integration of virtual entities with the physical world. Thanks to these technologies, users with digital assets can interact and collaborate with objects [15]. Also, some keys are given for the Metaverse in Fig.2.

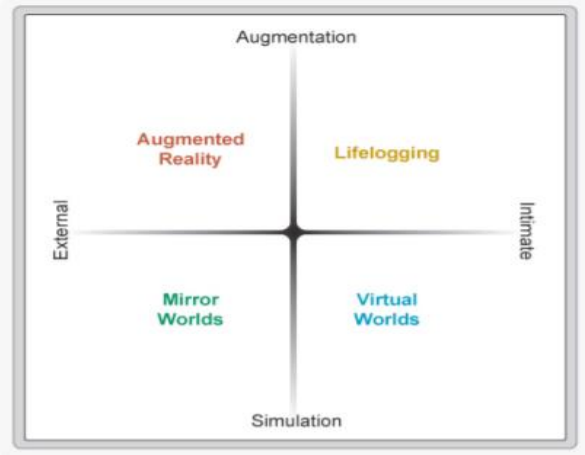

Fig. 2. Metaverse Keys [16]

A. Augementation

It refers to technologies that add new features to the existing system. In Metaverse, it means technology that adds new information to our perception of the environment.

B. Simulation

It refers to technologies that model reality and offer new environments. In Metaverse, it means technologies that provide simulated worlds in the Metaverse.

C. Intimate Technologies

It refers to the identity and actions of users or objects. In Metaverse, it means technologies in which the user or object is the avatar or actor representative in the system.

D. External Technologies

It refers to the outside, that is, to the general world. In Metaverse, it means technologies that control the world around the user.

XI. Architecture Of The Metaverse

The Metaverse is still in the active phase of development. Therefore, there is no consistent definition of architecture. Jon Radoff proposed a seven-layered architecture from bottom to top [17]. These; infrastructure, human interface, decentralization, spatial computing, creator economy, discovery, and experience. This architecture represents the industrial division. However, the Metaverse architecture should be viewed from a more micro perspective. A three-layer architecture is shown in Fig.3. These; infrastructure, interaction, and ecosystem. The basic requirements of the Metaverse require the transition of the architecture from a physical world to a virtual one. These are briefly mentioned in Fig 3.

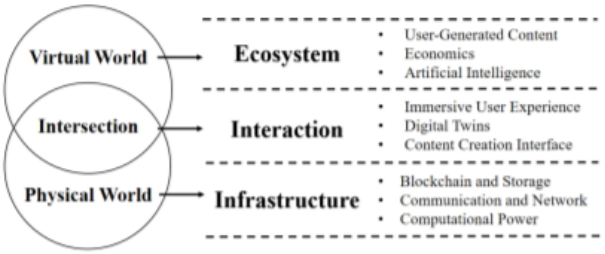

Fig. 3. Three-layer Architecture of the Metaverse [18]

XII. Conclusions

In conclusion, Metaverse is an essential and promising topic today. It is foreseen that the Metaverse approach will focus on how this technology will be adapted to people's lives rather than how this technology will be developed in the future. For this reason, this technology currently needs to be further researched and developed. The subjects that need to be developed are computer vision, augmented reality, and extended reality technologies, which will make a faster and positive contribution to Metaverse. Companies need to invest more in this direction, and technologies emerge quicker and more advanced. Especially in the business world, the sector's leading companies should take place in Metaverse and set an example in this regard. This vision's rapid acquisition and realization play an essential role in our future. In addition, these technologies need to be more accessible in society. This technology, which will be an integral part of our lives soon, should be suitable for people at every economic level of the organization. Instead of a high-cost product, cheaper-cost products should be developed and made fit for the use of all people.

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MetaHealth - How will the Metaverse Change Health Care?

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***Abstract*—We are living in a digital age, and the Pandemic has accelerated innovation in health care and has surfaced new business models and opportunities for health. Beyond the applications in telehealth, supply chain, payments, secure data sharing, and remote monitoring are also essential innovations in Blockchain and Non Fungible Tokens (NFTs) that allow people to exchange value on a decentralized network. Futurists and technologists are also exploring how the Metaverse can play a role in different sectors. This Commentary aims to explore how the Metaverse may be used in the future to change, enhance, and possibly transform health care. The five covered areas are collaborative working, education; clinical care, wellness, and monetization.**

Keywords—GameFi, tokenization, Blockchain, health care, virtual reality, augmented reality

I. INTRODUCTION

We have long been aware that the health care system is unsustainable, with the pressure of long-term, chronic disease, rising costs, aging populations, insufficient health workforce, and limited resources. It is necessary to find models that move health care from the hospital to the living room.

Digital Health is revolutionizing care directly and becoming a critical enabler of change in the pharmaceutical and biotechnology sectors. The Covid-19 pandemic also encouraged innovators and health workers to find ways to enable patients to be managed out of hospitals and remotely. The increasing coverage of smartphones and greater use of wearable devices have also been enablers.

Earlier in 2021 [1], I predicted three significant shifts in the global health landscape, the move of the big tech companies into healthcare, the monetization of consumer data, the creation of health data marketplaces, and the growth of Asia as a leader in digital health.

We are now moving fast to a Metaverse age. The World Economic Forum [2] already predicted that the introduction of digital services would be one of the most critical factors in transforming health care over the next decade.

The combination of Blockchain and gamification is enabling tokenized incentivization in virtual worlds. Futurists and technologists explore how the Metaverse can play a role in different sectors. One of the boldest to date has been the announcement by the city of Seoul [3], Korea, which plans to create a Metaverse for its municipal administration, including economic, cultural, tourism, educational and civic service. Bardi [6] highlights that while the entertainment industry has been the first to embrace extended reality, increasingly such advancements are being used to enhance building and construction, communications, health care, and emergency response training.

Outlier Ventures [4] suggest the defining characteristic of a true Metaverse is that it has its own economy and currencies native to it, where value can be earned, spent, lent, borrowed, or invested interchangeably in both a physical or virtual sense, without the need for a government. The Metaverse is a combination of DeFi, NFTs, decentralized governance, decentralized cloud services, and self-sovereign identity and can enable the exchange of physical, economic, and content assets.

In this Commentary, I explore how the Metaverse may be used in the future to change, enhance and possibly transform health care. I will discuss the five areas: collaborative working, education, clinical care, wellness, and monetization.

II. COLLABORATIVE WORKING

The COVID-19 pandemic has dramatically changed social interactions. Social distancing policies, lockdowns, and mandatory quarantines have accelerated the technological mediation of communication on an unprecedented scale. Many physical activities such as office work, education, and conferences have moved to the online space through social media apps, the Metaverse, or mobile phones.

During the pandemic, we saw social networks accelerating and platforms becoming more immersive [5]. Manalova [6] describes the emergence of a brand-new internet minute, which creates fundamental dependence and emotional investment into digital solutions as a bridge between families, friends, communities, and societies.

In the Metaverse, 3D avatars of health workers will have space to collaborate with tools such as digital whiteboards, and they will be able to meet face-to-face without any complex conferencing equipment. Machines, systems, and procedures will be safely tested via digital twins to detect faults and vulnerabilities before carrying them out in a physical environment.

Samia Rizk [7] gives the example that a health care application could include creating a digital copy of a hospital process, such as in-patient flow, then applying advanced analytics and running millions of potential scenarios to identify the root cause and test different interventions before using them.

The Metaverse can also encourage and enable collaboration. New EdTech platforms like Studyum [8] with Metaverse on-ramps create spaces to organize collaborative activities. Learners can be ranked according to their activity and performance and put together to form groups with similar levels of accomplishment. The intra-community collaboration will be incentivized with tokens.

In veterinary science, Neethirajan [9] describes how data augmentation, using digital twins, and digital avatars or Metaverse offers a timely way of exploring the subtle nuances of animal behavior and cognition in enhancing farm animal welfare.

Çöltekin et al., [10] describe how geo-visualization allows information exploration and sensemaking, where scientists design and use visual-spatial displays to explore data, generate hypotheses, develop problem solutions and construct knowledge. The Metaverse provides a space where it is possible to 3D-model virtually anything, and real-world specifications can be replicated via digital twin technology.

III. EDUCATION

The use of AR (Augmented Reality) and VR (Virtual Reality) will change medical education [11] and training as well as processes and procedures. VR allows students to literally enter the human body, providing a comprehensive view and allowing the replication of actual procedures. AR is also being introduced to give students hands-on learning, such as simulating patient and surgical encounters, allowing medical students to visualize and practice new techniques. Even more immersive experiences could be recreated from real surgery where students can experience the surgery as if they were the surgeon themselves.

Studyum [12] is an example of gamified learning in practice. Users are rewarded with tokens for every class attended, every video watched, every assignment completed, and some will be rewarded with NFT crypto collectibles. Augmented Reality allows AI (Artificial Intelligence) instructors to show learners how to stand, sing, and appear more confident. Using these techniques, people will be able to learn from a completely game-like setting, using celebrity coaches to demonstrate particular skills. This could be a "celebrity surgeon," the surgeon gets rewarded for his teaching, and the students get rewarded for their learning.

Sin-nosuke et al [13] explore a learning system for analyzing devices in a virtual world and demonstrate its significance for research collaboration and collaboration without borders. They describe this as a response to enable collaboration among remote organizations and countries. They present a concept for the learning system in the Metaverse.

Education will be transformed into an immersive experience where learning is fun, success is rewarded and data analytics target precision learning.

IV. CLINICAL CARE

Medicine has always been a hands-on personal encounter, where doctors can detect physical as well as emotional responses. However, the pandemic has forced a rapid acceleration of remote care technologies. For example, before the pandemic, 43% of healthcare facilities were capable of providing telehealth, but that percentage rose to 95% in 2020 [14].

Tufts University, in a study on the impact of Covid-19 on clinical research, found the increased adoption of electronic informed consent was the second-largest emerging trend behind the use of telehealth delivery [15]. These and other advancements have opened the exploration of remote and digital technologies.

There is immense scope for the Metaverse to be used in clinical care. Using immersive experiences recreated from surgery, real-time guidance can be provided in the surgeon's field of view. AR will allow access to the information within the sterile field of the operating room, which will improve surgical precision and flexibility. The Metaverse will allow simultaneous education, training, and planning as well as collaborative medical procedures.

Combined with AI, this can empower clinical decision-making and ensure more precise interventions which are tailored to each individual patient. An example is Veyond Metaverse (https://www.veyondMetaverse.com) which is creating a future Healthcare Metaverse ecosystem. It aims to improve education, training through a collaborative platform for simultaneous education, training, and planning as well as collaborative medical procedures.

Initially, the Metaverse will be used for surgical simulations, diagnostic imaging, patient care management, rehabilitation, and health management [16]. For patients, these technologies can expedite education about conditions or treatment plans. In a clinical setting, AR and VR can help care teams at the point of care. When combined with radiology, AR can provide clinicians with the ability to project medical images, such as CT (Computed Tomography) scans, directly onto the patient and in alignment with the patient's body, even as the person moves, to provide clinicians with clearer lines of sight into internal anatomy.

This can potentially improve patient experience, for example, intravenous injections can benefit from technologies like that from Accuvein (https://www.accuvein.com) which can project a map of the patient's veins on the skin. Medtronic acquired Digital Surgery, and Zimmer Biomet announced OptiVu™ Mixed Reality [17] which will use Microsoft HoloLens to create a merger of the real and digital worlds. Avatars will mimic realistic consultations, personalized care, treatment, and diagnosis through data interconnectivity.

Extended reality headsets are also being used as a way to alter the psychological experiences of users for the treatment of addictions and phobias [18].

V. WELLNESS

Gamification is a new way of connecting healthcare providers and patients, especially in wellness and fitness, where AR can deliver smarter workouts with guidance from virtual instructors. In another new concept, "move-to-earn", players are incentivized to be active. For example, in Genopets [19], using data from smartphones and wearables,

players can get rewarded for walking, dancing, running a daily run, or just getting up and going about life.

Medical schools are beginning to incorporate AR into the curriculum to provide students with valuable hands-on learning opportunities. With AR, programs can simulate patient and surgical encounters, allowing medical students to visualize and practice techniques during training.

VI. MONETIZATION THROUGH GAMIFICATION

The monetization of health data will create new economic opportunities. 'Play to earn', 'learn to earn' and 'move to earn' could become a primary income for millions of people.

We will witness the consumerization of healthcare. Combining data and blockchain will enable data owners to monetize their data. Self-sovereign identity will enable individuals to monetize their health data in the future and consumer-focused health care driven by data will change the institutional models of the past. Harnessing technology will also give consumers a better ability to proactively manage their own health and wellness and to make better, more informed decisions.

New platforms that are also creating ways that people can "learn to earn" can be integrated into healthcare. This may be for wellness, or for community collaboration, or medical education. Non Fungible Tokens (NFTs) will play an important role in value exchange.

Interoperability is essential to digital healthcare. Blockchain and token economies will allow both the secure sharing as well as the monetization of data and intellectual value

VII. ETHICS

Digital ethics are not different from conventional ethics but there is huge potential for inadvertent or deliberate automation of unethical conduct at scale. Given the potential scale of impact, it is important to start exploring ethical questions for health in the Metaverse. Recently, I had posed these ten questions [20]:

1) Should we have an open or closed Metaverse?

2) How much open-source is open? If you create in the Metaverse, who owns it?

3) Should avatars have agency?

4) If you share biometric data in the Metaverse, what data security, privacy, and rights should you have?

5) Should consumers be protected in the Metaverse?

6) Should we mitigate the physical and mental health impacts of the Metaverse?

7) How will informed consent be possible in the Metaverse?

8) Should children be allowed in the Metaverse?

9) Should we create an equitable, inclusive, and truly decentralized Metaverse?

10) How do we maximize the incredible economic and social possibilities and minimize harm?

Samia Rizk [21] recommends that the convergence of digital solutions will require an additional set of standards and approaches as new applications arise. In particular, the risk of bias amplification in AI needs to be addressed by market players involved in the development of XR (Extended Reality) solutions. Likewise, the challenges for ethics will expand as the areas of digital convergence grow and the scenarios diverge to reflect individual use scenarios.

Research is needed on all aspects of health in the Metaverse. Examining prospectively, how the new decentralized architecture is being developed, how blockchain token economies and GameFi is being applied, and the impacts and benefits. Ethical questions and implications need to continue to be explored and new ways of automating ethics in the technology stack and applications.

VIII. CONCLUSION

In this commentary, the ways in which the Metaverse may be used in the future to change, enhance, and possibly transform health care are explored. The five areas discussed are collaborative working; education; clinical care, wellness, and monetization. There are no doubt risks, but the opportunities are immense. The power to harness the digitally literate young population to take control of their health care and be incentivized to learn, follow wellness, and educate their peers in a safe social virtual setting is a powerful thought. Innovators are revolutionizing health education into immersive micro modules that can be taught online to anyone, anywhere. The precision possibilities for clinicians, collaborating around the world and using augmented reality to assist them, opens possibilities to overcome health worker shortages. The ability for the community, patients, and experts to be rewarded for their efforts to improve health opens a whole new economy and earning opportunities.

This is a new world that is advancing daily, and our knowledge grows with the innovators who are building these new Metaverses. It is possible to create a sustainable and affordable paradigm in health care, and health leaders need to be part of its creation. It is time to lean in and see just what the possibilities are.

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Content Analysis of Metaverse Articles

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***Abstract*— Metaverse, which was first defined as fictional about 20 years ago, refers to a virtual universe where people feel entirely mentally with augmented virtual reality devices today. The first applications of metaverse were computer games consisting of virtual worlds. Gaming companies were racing to offer more unique experiences to their users. With social media giants and big technology companies announcing the metaverse as the future of the internet, it started to attract the attention of the wider masses. The concept of metaverse has been the subject of academic studies in many different fields, from literature to art, from music to education over the years. In this review article, a total of 40 journal articles containing the "metaverse" keyword in all fields in the Web of Science database were examined in terms of content and method. The outputs of this study provide a piece of brief information about the research area to both researchers and technology developers.**

Keywords—metaverse, content analysis, second life, virtual worlds

I. INTRODUCTION

The metaverse, first described in author Neal Stephenson's novel "Snow Crash" published in 1992, has become a concept used to describe 3D (three-dimensional), VWs (virtual worlds) in which people interact with each other and their environment without the physical limitations of the real world. The first metaverse was CitySpace [1], which was active from 1993-1996. Subsequently, numerous metaverses such as Active Worlds [2] and There (www.there.com) emerged. The most popular of these was Second Life (SL, www.secondlife.com), developed by Linden Lab in 2003. With SL, the doors of the web-based VWs were opened to game enthusiasts. SL promised its users a second world where they can create their own avatars and determine all the features of them, the limits of which depend only on one's imagination. In this world, a person could socialize, buy real estate, design, and even realize all kinds of fiction, up to university education. SL created its own economy, even had the Linden Dollar currency. Moreover, the Swedish government opened an embassy in SL, where many cities, universities, artists, and individuals created virtual assets.

In the game world, examples of metaverses such as Roblox (www.roblox.com), Sandbox (www.sandbox.game), Fortnite (epicgames.com/fortnite) are increasing day by day. However, with the press release of Marc Zuckerberg in which he announced that he changed the company name to Meta, wider audiences began to explore what the metaverse is [3]. As of October 2021, according to google trend reports, there has been a severe increase of searches on Metaverse in the google search engine. Considering the importance of social media, especially for the Z generation, investments in the metaverse are shaping the technology of the future. While talking about the future metaverses, it is also necessary to examine the academic studies on the metaverse in the last 20 years. For this purpose, academic journal articles containing the keyword metaverse in the Web of Science (WoS) were examined in terms of scope and method in this survey. Proceedings, books, and other works are ignored. In the search carried out in all fields, 48 journal articles containing metaverse keywords were found. When these articles were examined in terms of method and scope, it was determined that 40 of them were suitable for the study. The aim of this study is to provide a projection to the researchers by making a detailed analysis of the articles.

The following section introduces the research method and contains general information about the publication years of the articles, within the scope of the research, the journals in which they were published, and the research areas. Section 3 briefly introduces the selected papers in chronological order from the past to the present in terms of scope and method. Section 4, where discussion and findings are given, classifies the articles as content. Section 5 ends with a discussion of the implications, main limitations, and contributions for researchers who will work in this field.

II. METHOD

A. Google Trend

After Marc Zuckerberg's press release, the increased interest in the metaverse is seen in Google Trend data [4]. In Fig. 1, the graph of the weekly values of YouTube and Google searches in the last year is given. In October 2021, there was a significant increase in metaverse searches on both YouTube and Google. Furthermore, it is observed that there was a jump in YouTube searches in April as well.

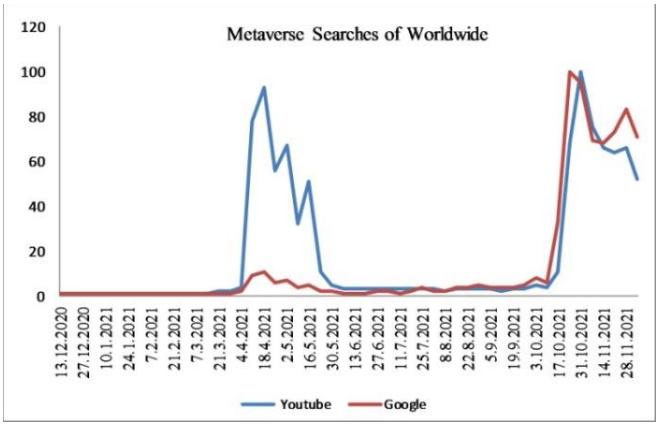

Fig. 1. The number of Metaverse searches performed on Youtube and Google in the last year with Google trend [4].

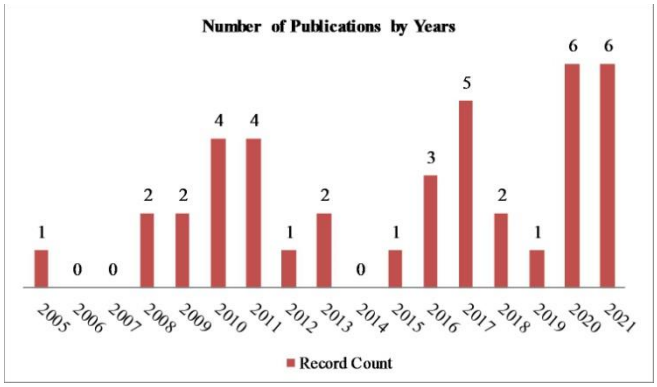

Fig. 2. Number of publication by years

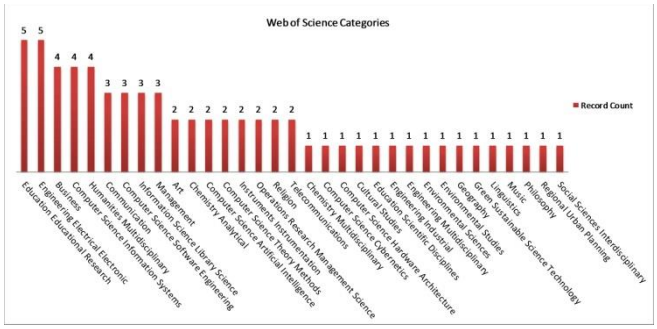

Fig. 3. Number of publications by Web of Science categories

B. *Web of Science Analysis*

In this study, publications containing the keyword "metaverse" in all fields in the journals in the WoS database and scanned in the SCI-Expanded, SSCI, A&HCI, ESCI index were examined [5]. Data were collected on 28.11.2021. The distribution of 40 articles determined to be suitable for the purpose and scope of the study by journals was determined as SSCI (33%), SCI-Expanded (31%), ESCI (25%) and A&HCI (11%).

The distribution of the number of articles by year is given in Fig 2. After the first academic article was published in 2005, it is seen that the number of publications, which has fluctuated over the years, has increased in recent years.

Articles are classified into 33 different categories given in Fig 3 in the WoS database. Some articles are included in more than one category. The most published categories are Educational Research and Engineering Electrical Electronic classes. The number of publications according to the research areas is given in Fig. 4. According to the study's design, it is seen that the publications covering more than one research area are mainly in the field of computer science and engineering.

C. *Keywords*

The word cloud given in Figure 5 was created from the keywords defined by the authors in the articles. The sizes of the words were determined according to the frequency of their occurrence in the keyword list. A total of 190 different keywords were used. Words such as virtual worlds, second life, AR (augmented reality), avatar, 3D, VR (virtual reality) are the keywords most associated with the metaverse.

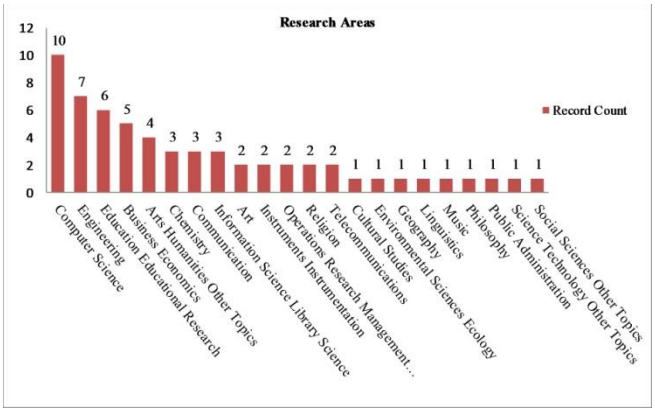

Fig. 4. Number of publications by Research Areas

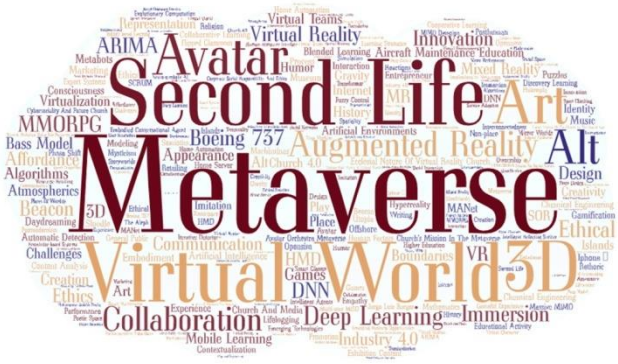

Fig. 5. Word cloud of metaverse-related keywords

D. *Research Questions*

This study focuses on the contents of the articles and presents a detailed review in terms of scope and method. It focuses on the following research questions:

- What is the content of the articles published in the metaverse?
- What are the application examples in the metaverse?
- What are the methods used in studies in the metaverse?

III. Focus on the Articles

This section briefly introduces the selected papers chronologically from the past to the present in scope and method.

The first article on metaverse in the literature was published by Jaynes et al. [6]. The study discusses the problems in the design and application of the metaverse. Papagiannidis et al. [7] examined the social, political, economic, and ethical implications of online games in which large numbers of players from around the world interact with avatars created using their existing identities in the physical world or creating virtual identities with no connection to their identities. Kumar et al. [8] examined the virtual world in two classes: online games and metaverse. They defined the basic features of the VWs as multimodal input, heterogeneous clients, server scalability, network constraints, object encodings, physics engine, security, privacy, and fairness [8]. Davis et al. [9] explained virtual collaboration and teamwork in detail to understand the opportunities and risks found in metaverse environments. They developed a conceptual model of five constructs:

- The metaverse itself
- Humans/avatars in the metaverse
- Technology capabilities in the metaverse
- The behavior of avatars in the metaverse
- The outputs of the metaverse

They also explored how the concepts of communication, creation, interaction, and team process could expand the metaverse [9]. Bourlakis et al. [10] examined the effects of product and service marketing and specifically retailing in the online VW where individuals and organizations operate. They presented a comparative study of traditional store retailing, e-retailing, and metaverse retailing. They drew attention to many essential questions, such as: Which criteria do retail in the virtual world? Which regulatory agency will oversee product pricing? Whether virtual currencies used in metaverse retailing be converted to real currency? Tasa and Görgülü [11] explained what meta-art is and discussed whether the metaverse will be a new art medium in the future. They stated that the collective and connecting nature of the Internet could be used to connect avatars and create a space attached to other levels of reality. As a result, they argued that for art to be local in the metaverse with its form, content, and creative process, art must be context dependent [11]. Brennen and Dela Cerna [12] examined the effects of journalism in a virtual environment and how the relationship between real life and SL influences and shapes news content. In addition, the Alphaville Herald, Metaverse Messenger, and SL newspapers developed in VR evaluated, and implications were made for future journalism applications. Ayiter [13] analyzed 'alpha.tribe', an experimental avatar group establishing a virtual fashion business in SL. In the research, the author, a designer, and art educator brought together five avatars of both human and non-human genders in a design initiative to create a design that follows the creation line of each virtual personality [13].

Han et al. [14] created a 3D user interface for the home automation system in VR. They explained the necessary protocols for the relationships between the metaverse client, metaverse server, and home server. They showed that home devices could be monitored and controlled over the internet from anywhere and anytime via this interface [14]. Owens et al. [15] examined how metaverse technology capabilities interact with the social and technical aspects of virtual teams, how metaverse capabilities differ from other collaboration technologies, and how these capabilities affect virtual projects. Lee et al. [16] studied the innovation and reflection effects of metaverse services used to express services such as life logging, mirror world, AR, and VWs. To measure the acceptability of Twitter, Google, iPhone, and SL products, IP traffic, and iPhone sales volume data of "twitter.com," "maps.google.com," "secondlife.com" addresses from the first quarter of 2008 to the last quarter of 2009 collected. They modeled the data with the Bass model based on time series. They showed that each service gives different innovation and reflection coefficient values and that the reflection effects are higher than the innovation effects for all metaverse services [16]. Leone [17] examined the relations between the religious dimensions of the first life and the second life in terms of sociology and psychology of religion. The study showed that, based on six months of "virtual" ethno-semiotic participatory observation, digital places of worship revealed five main characteristics: isolation, prototypicality, didacticity, anarchy, and parasitism [17].

Arroyo et al. [18] explored the possibilities of using meta bots with mobility capabilities in complex VWs. They also built a learning model based on techniques used in evolutionary computing to optimize fuzzy controllers to be used by meta bots to move around in a virtual environment [18]. Cameron [19] examines the concept of philosophers' islands as a literary and philosophical metaphor. The author argues that "utopic" islands provide a fictional field of experimentation to form "real" state spaces. In the study, he examines the concepts of Utopia, Endotopia, and Xenotopia in detail from a similar perspective. Dionisio et al. [20] examined the issues required to move from a set of independent virtual worlds to an integrated network of virtual worlds, or Metaverse, that creates an alternative space for human sociocultural interaction. In particular, they drew attention to (1) realism, (2) ubiquity, (3) interoperability, and (4) scalability, which are considered central components of a valid metaverse [20].

Crespo et al. [21] analyzed educational virtual environment applications and the dissemination of knowledge in the form of free courses in the metaverse. They performed a simulation that checked the properties of objects created in the metaverse with GNU tools. They showed the importance of implementing OpenSim in some engineering fields. They also used the ARIMA model to estimate server load due to access by students who might want to take online courses and showed that the model produced acceptable results [21]. Hassouneh and Brengman [22] examined 27 virtual stores in SL and proposed a virtual store typology based on atmospheric classifications. In addition, the study provides a framework for investigating the shopper behavior in the virtual store environment and the factors affecting the performance of metaverse retailers [22]. Villalba [23] studied SL as an example of cultural interaction through virtual worlds and explored the reasons for declining interest in SL. He first examined the technology factor but concluded that it was not very decisive. The author concluded that the inability to classify SL as just a game or social media reduces users' interest, and they turn to more real platforms where users can interact with their acquaintances. In the article, reasons such as the utopic elements produced in SL embody the flaws and problems of real society, lack of story, difficulty in finding others, and lack of eroticism were cited as causing the alienation of users. However, it was predicted that these problems would be resolved soon, and the way of user interaction in SL could be reorganized [23].

Romero et al. [24] highlighted the arts and examined how SL could pave the way for the creative process in many areas. The article showed that in SL, an artist could act as a curator, theorist, critic, collector, producer, and art publisher as he is. Vaca Barahona et al. [25] examined students' communication, interaction, and collaboration in virtual learning environments where 3D simulations are integrated. The article discussed the interaction between the participant and the 3D object and the interaction that develops among the participants as an interaction that encourages students to learn. Martín [26] examined whether personal interaction through virtual environments enhances collective creativity. The article discussed the metaverse environment effects, in which a different symbolic connection is formed among the participants, on creativity, with an Avatar Orchestra example. It has been determined that environments where participants do not have face-to-face contact and where there are no

barriers such as age, ethnicity, and geographical diversity in the physical world are suitable environments that encourage collective creativity [26]. Pinchuk et al. [27] examined the problems of synthetic learning environments in the metaverse. The article analyzed new learning environments based on information and communication technologies. In addition, they discussed game-based learning based on the simulation of the actual physical world and the combined use of social networks with a "synthetic environment" [27]. Choi and Kim [28] presented a virtual museum experience by connecting a pointer placed in an actual space exhibition hall to an HMD (head-mounted display). Metaverse, which is a combination of AR and VWs, diversified the user experience about the features and stories of the works in the museum with the content of the exhibition.

Ayiter [29] discusses the transformation of a small 3D artwork created in the meta-universe inspired by Jorge Luis Borges' story Aleph. The author philosophically redefines Aleph as a time machine for avatars. Jaramillo-Mujica et al. [30], in their articles on education in Metaverse, present the idea of designing and applying education in the 3D environment to Physics Engineering students. The study explains the development, conceptualization, and implementation stages of scenarios on the OpenSim platform, which is expressed with a virtual classroom in Moodle. Nevelsteen [31] described a "virtual world" that uses grounded theory to be applied directly to technology. The resulting definition was compared with related studies and used to classify advanced technologies such as persistent video game, MANet, virtual and mixed reality, and metaverse. As a result, the study includes a breakdown of the features that distinguish the various technologies from each other. It also presents an ontology showing the relationship between complementary terms and abbreviations [31]. Zhou et al. [32] discussed virtual world ownership and income generation in the virtual world. They examined the concept of ownership in the metaverse under two headings: content ownership and virtual platform ownership. The study collected data from real court case files, discussion boards, expert comments, interviews, news, and blogs. The findings suggest that the intrinsic interdependencies of content and platform ownership need to be addressed separately as they pose significant challenges for entrepreneurs.

Ayiter [33] discussed the following questions linking Marc Augé's concepts of 'place/non-place' and Gaston Bachelard's 'poetic space' to the avatar of real-time, continuous, online, three-dimensional virtual worlds as metaverses: *"Are metaverses 'places' or 'non-places'? Do we really live in the metaverse, or do we go through this world in the sense that Marc Augé describes them as transition loci assigned only to limited and specific locations? [33]"*. Díaz [34] discussed virtual worlds in higher education and innovations in the teaching-learning process in the metaverse. In the study, a virtual world was developed as a digital tool to provide teaching support to Cundinamarca University System Engineering Faculty students and teachers. The study, which aims to facilitate and make flexible the access of students and teachers to information inside and outside the classroom, explains the integration of developing technology with hybrid and mobile learning models. Diaz et al. [35] deal with the design, development, and implementation of a virtual or metaverse world in an educational environment within the scope of Scrum methodology. In addition, access to synchronous and asynchronous information provides an alternative way of transmitting and acquiring knowledge through technological tools. Designed to resemble a real university for Systems Engineering Faculty students, the metaverse considers hybrid and mobile learning models that change with the inverted and collaborative classroom. Murray [36] positioned VR as a medium that evolves media traditions to support continuous interaction and immersion, rather than thinking of virtual reality as a magic technology. He introduced VR not as an inevitable and misleading metaverse but as a representational environment that always requires active belief creation.

George Reyes [37] analyzed the perceptions of upper-middle-level students at a private educational institution in Mexico regarding the development of teaching strategies using augmented reality based on the metaverse mobile application. One hundred ninety-two first-term students attending the Mathematics Fundamentals course participated in the research in the period of August-December 2018. The research was carried out using a digital questionnaire. The results showed that the application of augmented reality in mathematics teaching significantly increased student performance. Estudante and Dietrich [38] developed a mobile AR application to use escape games in education. In the study, a scenario was proposed that directs students to follow the footsteps of Belgian Physicist Ernest Solvay to improve students' motivation and communication skills. According to this scenario, participants discover a secret room in Brussels that contains Solvay's secrets through riddles. AR escape games can be easily applied to crowded classrooms without any teacher and without any systematic preparation. The advantages and limitations of such tools are discussed in the study. It has been shown that the proposed approach is effective in increasing motivation in the trials in which the students participated.

Jun [39] studied religious activities in the metaverse. With the development of augmented reality and virtual reality technologies, virtual reality churches began to be created to fulfill the missions and duties of churches in the virtual world. Although virtual reality churches have new mission boundaries in the digital age, the article addresses theological issues from the perspective of traditional church ministry and mission. Siyaev and Jo [40] introduce a metaverse environment for Boeing-737 aircraft maintenance training and education, including legacy manuals, 3D models, 3D simulators, and aircraft maintenance information. It uses Neuro-Symbolic Speech Executor (NSSE), which is different from traditional speech recognition methods, as a speech comprehension module. NSSE uses Neuro-Symbolic AI, which combines neural networks and conventional symbolic reasoning to understand users' requests and respond based on context and aircraft-specific information. Synthetic data were used for training the model. The model's performance was realized with automatic speech recognition metrics on the data of real users. As a result, it has been shown that the model can generalize with an average accuracy of 94.7% and a word error rate (WER) of 7.5%. [40].

Siyaev and Jo [41] discuss Boeing 737 maintenance training using digital twin and mixed reality technologies in the metaverse. A realistic training environment is suggested for trainee engineers in the study. This environment allows controlling planes by maintaining social distance through virtual assets and voice commands, especially during the

pandemic. In the study, a convolutional neural network (CNN) was used for voice recognition. Command recognition and language recognition performance of the CNN model trained for English and Korean languages were found to be 95.7% and 99.6%, respectively, according to the F1-Score metric [41]. Park et al. [42] investigated the differences in learning motivation among different types of players. The study was conducted on 91 university students who were instructed to attend a classroom using gamification. In the study, it is stated that creating environments where all kinds of players can create their own game experiences, rules and strategies is an important factor in gamification design. As a result of the research, it was determined that gamification is effective on motivation, but there is no significant difference in motivation between player types [42].

Bolger's [43] work focused on the evolutionary integration described by Teilhard/Delio while guided by Bevans' five (early) contextualization models. The contextual integration method provides ways to see, embrace, communicate, complicate, and create in the metaverse. The author explores the nature of the metaverse in the first half of the article. He discusses these insights in the second half, after collecting insights from the dialogue between contextual theology and culture in the first half [43]. Park et al. [44] focused on identifying the factors that can affect the user's social perception (likeness, familiarity, attractiveness, liking, and participation) of personalized virtual avatars designed by considering the user's facial features. In this study, the researchers showed that the avatars with familiar facial expressions of the participants looked more like the participants and gave a more familiar feeling than the others. The study of Heo et al. [45] proposes a new AR-based system for traditional sport climbing training. With this method, where an instructor shows the positions of the hands and feet one by one, the climbing movements and stances of a novice athlete are spontaneously demonstrated to the student with a character animation on an artificial climbing structure. In addition, in this system, the student can choose the route he wants to learn and can study many times without the help of the instructor. Research results showed that AR support for climbing is as effective as the traditional teaching method [45].

IV. Discussion and Findings

This review article is designed to provide a projection for researchers who want to do academic studies in the metaverse field. Metaverse is used synonymously with virtual worlds or Second Life in many studies. However, this study only includes journal articles filtered by the keyword "metaverse" in the WoS database. Some of the studies defined the basic concepts and features of virtual worlds, and some discussed the metaverse's sociological and philosophical effects. In addition, applications based on 3D, AR, VR, and mixed reality have also been developed in different work areas over the last 20 years. The articles were examined in terms of method and content, and the findings were discussed in this section.

A. Focus on Methods

The articles were examined in terms of methodology except those published to introduce conceptual structures and technologies and explore sociological, philosophical, and cultural aspects. The methods used, especially in education and engineering, are given in Figure 6 in the form of a tree graph.

In these studies, together with 3D, AR, VR technologies, GNU[21], OpenSim [21,30], Moodle [30], Minitab 18 [37], Microsoft Excel Pro 365 ProPlus [37] and Neuro-Sembolic Speech Executor [40] tools have been used.

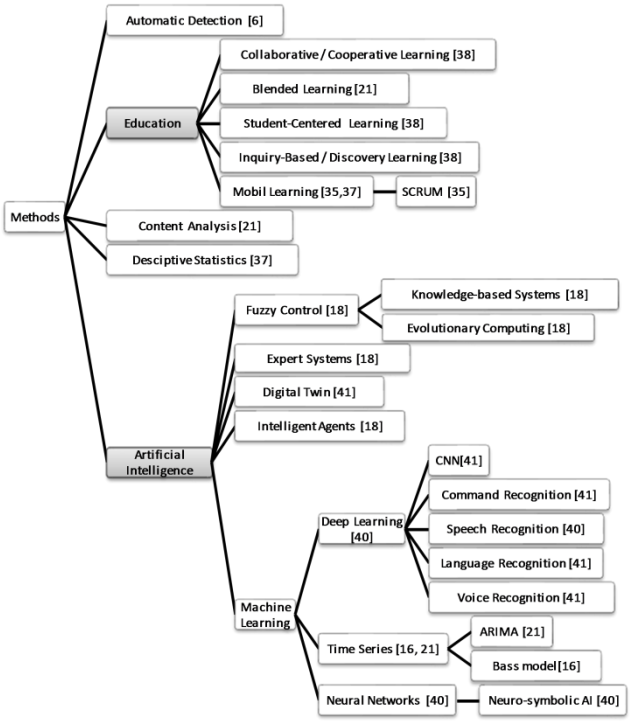

Fig. 6. Methods used in the studies

While different learning methods are used in metaverse research in education, it is seen that other artificial intelligence (AI) based methods are mostly used. While studies focused on design at first, in parallel with technological developments, it turned to developing new methods to provide users with realistic experiences in the virtual world. In this sense, more personal data and the preferences and tastes of users have begun to come to the fore. The prominence of AI methods, especially in studies conducted in recent years, gives an important clue for the future of metaverse studies. Combining AR, VR technologies with AI is predicted to improve the quality of personalized applications in VWs.

TABLE I. Classification of Articles on Metaverse

Classification of Articles on Metaverse		
ID	***Titles***	***Years***
Education		
[26]	Use of ARIMA mathematical analysis to model the implementation of expert system courses by means of free software OpenSim and Sloodle platforms in virtual university campuses	2013
[30]	The communication in simulated learning environments	2016
[32]	Synthetic educational environment-a footpace to new education.	2017
[35]	An experience using metaverses for teaching mechanical physics to engineering students	2017
[39]	Virtual world as a complement to hybrid and mobile learning	2020
[40]	Virtual World as a Resource for Hybrid Education	2020

Classification of Articles on Metaverse		
ID	***Titles***	***Years***
Education		
[42]	Perception of high school students about using Metaverse in augmented reality learning experiences in mathematics	2020
[43]	Using augmented reality to stimulate students and diffuse escape game activities to larger audiences	2020
[45]	Neuro-Symbolic Speech Understanding in Aircraft Maintenance Metaverse	2021
[46]	Aircraft Maintenance Metaverse Using Speech Interactions with Virtual Objects in Mixed Reality	2021
[47]	Differences in Learning Motivation among Bartle's Player Types and Measures for the Delivery of Sustainable Gameful Experiences	2021
[50]	Effect of Augmented Reality Affordance on Motor Performance: In the Sport Climbing.	2021
Definition and Properties		
[11]	Rapidly deployable multiprojector immersive displays	2005
[14]	Avatars, people, and virtual worlds: Foundations for research in metaverses	2009
[20]	An empirical investigation of virtual world projects and metaverse technology capabilities	2011
[21]	Innovation and imitation effects in Metaverse service adoption	2011
[23]	Adaptive fuzzy knowledge-based systems for control metabots' mobility on virtual environments	2011
[25]	3D virtual worlds and the metaverse: Current status and future possibilities	2013
[29]	New artistic behaviors in "Second Life"	2016
[36]	Virtual world, defined from a technological perspective and applied to video games, mixed reality, and the Metaverse	2018
[41]	Virtual/reality: how to tell the difference	2020
Art on Metaverse		
[16]	Meta-art: art of the 3-D user-created virtual worlds	2010
[18]	alpha. tribe	2010
[24]	Splendid isolation:'Philosopher's islands' and the reimagination of space	2012
[29]	New artistic behaviors in "Second Life"	2016
[31]	Social and psychological impact of musical collective creative processes in virtual environments; The Avatar Orchestra Metaverse in Second Life	2018
[33]	A content service deployment plan for metaverse museum exhibitions—Centering on the combination of beacons and HMDs	2017
[34]	Building a (virtual) aleph: the visual transformation of a tiny cosmogony	2017
[38]	Spatial poetics, place, non-place and storyworlds: Intimate spaces for metaverse avatars.	2019
Game		
[12]	Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses	2008
[13]	Second life and the new generation of virtual worlds	2008
[43]	Using augmented reality to stimulate students and diffuse escape game activities to larger audiences	2020
[47]	Differences in Learning Motivation among Bartle's Player Types and Measures for the Delivery of Sustainable Gameful Experiences	2021
Religion		
[22]	The semiotics of religious space in Second Life	2011
[44]	Virtual reality church as a new mission frontier in the metaverse: Exploring theological controversies and missional potential of virtual reality church	2020
[48]	Finding Wholes in the Metaverse: Posthuman Mystics as Agents of Evolutionary Contextualization	2021
Cultural Simulation		
[28]	Cultural simulation through virtual worlds. The case of Second Life: an approach to the representation, narrative and rhetorical potential in the new media cultures	2015
[49]	Individual's Social Perception of Virtual Avatars Embodied with Their Habitual Facial Expressions and Facial Appearance	2021

Classification of Articles on Metaverse		
ID	***Titles***	***Years***
Education		
Retailing / Virtual Merchandising		
[15]	Retail spatial evolution: paving the way from traditional to metaverse retailing. Electronic Commerce Research	2009
[27]	Retailing in social virtual worlds: developing a typology of virtual store atmospherics.	2015
Misc		
[17]	Journalism in Second Life	2010
[19]	User-friendly home automation based on 3D virtual world	2010
[37]	Ownership in the virtual world and the implications for long-term user innovation success	2018

B. Focus on Content

The articles discussed within the scope of the research were divided into seven different classes according to their application areas and similarities with content analysis. These groups are listed in Table 1 according to the number of publications.

The articles that were not included in any other group were gathered under a single title. It has been observed that most publications in the literature are in the field of education in the metaverse. In order to design a learning process in which students are actively involved by modeling learning-teaching processes in virtual environments, applications for mathematics [42], engineering education [39], climbing training in sports [50], and the maintenance and control of Boeing 737s have been developed. In addition, there is a study that introduces the virtual campus application [26] together with the studies in which the gamification [43,47] approach is used in education.

Articles that focus on the concept of a metaverse in general and introduce the features and technologies required for designing the metaverse are classified under the title of metaverse definition and characteristics. After education, the most studied private field has been art. In this group, which is discussed under the heading of art in the metaverse, there are studies on literature and philosophy [18,24,34,38] that explain 3D designs in the virtual world [16,29], examining an avatar orchestra [31], present a virtual museum experience [33].

Although there are many metaverse applications in the game world today, only four articles have examined the subject of pure gaming. These are studies promoting online multi-user games [12] and the popular game Second Life [13] and blending education and game in a gamification approach in education [43,47]. The perception of the metaverse as a second life gave birth to the concept of religious activities and belief in the SL. There are three articles dealing with the idea of religion in the metaverse. In other studies, the metaverse through simulations [28,49], retailing in the virtual world [15,27], journalism in the second life [17], home automation in the virtual world [19], and ownership and revenue management in the metaverse [37] have been examined.

V. CONCLUSION AND RECOMMENDATIONS

Metaverse, a simulation of the real world, covers all areas of human and society and offers a suitable working platform for researchers in all fields from health to sports, from education to art. This research dealt with the scientific aspect of metaverse studies. Most of the studies in the literature explain the concept of the metaverse. Some of them perform

metaverse applications in certain areas by examining education, art, religion, and socio-cultural interactions in the metaverse fictionally. In the last 20 years, academic studies carried out in parallel with technological developments such as 3D augmented reality and virtual reality have remained only at the level of prototypes. These studies, which make significant contributions to the literature in terms of design and editing, have a high potential to be realized when sufficient technical infrastructure is provided.

With the Covid 19 pandemic, people had to stay at home and carry out many activities in digital environments, accelerating digitalization. The recent investment of media giants and some large companies in the metaverse has been a vital sign that the internet will gain a new dimension. It was promised that in the future, it would be possible to perform many daily activities such as working, traveling, shopping, going to school, having fun by creating a 3D avatar in a digital universe. Although many ideas are still in the fictional stage, the metaverse has been accepted in many areas as the future of the internet. Non-Fungible Token (NFT) and blockchain technologies have added a different dimension to the metaverse. Recently, NFT has made it possible to sell land, buy and sell digital products in the metaverse, and events such as metaverse concerts with the participation of millions of people have begun to be held. All these developments heralded an exciting future.

Therefore, with the attention of researchers to this field, it is expected that the number of scientific studies in the field will increase, and richer contents will emerge soon.

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Tweet Classification and Sentiment Analysis on Metaverse Related Messages

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***Abstract*— The data obtained from social media platforms is a popular study subject nowadays. These studies give important information about the thoughts of the society towards an event, situation, or concept. For this purpose, several studies have been carried out with different methods in the literature. These studies mainly try to obtain meaningful results by applying various methods according to the language of the social media content. One of these platforms where people freely express their feelings and ideas is Twitter. It is a popular and useful study to examine people's feelings and tendencies about a topic by doing tweet analysis. In this study, feelings about Metaverse are tried to be evaluated. We evaluate the tweets posted one week ago and later of the date Mark Zuckerberg announced that her company would change its name to Meta. Tweets sent in English with the "metaverse" hashtag on Twitter were used as the dataset. These tweets were analysed by the Sentiment Analysis method. Obtained findings and results are shared comparatively.**

Keywords— Sentiment analysis, Metaverse, tweet classification, Twitter, NLP

I. INTRODUCTION

The concept of Metaverse was put forward in the early 1990s and with the development of technology, this concept has become applicable. The concept of Metaverse has increased its popularity as the internet connection has reached a sufficient level, its prevalence has increased, and the hardware that will provide access to this environment has been produced and accessible. This concept, which we can also call a virtual universe, allows people to exist mentally in a virtual world. Unlike today's systems, it promises to experience the feeling of reality in a virtual world while being physically in any environment with virtual reality equipment. It has similarities with the situation in which people are mentally in a different universe from their physical existence, such as daydreaming, dreams and hallucinations. However, in the Metaverse, signals received from people's bodies in the real world can be transferred to the virtual world. Its current core application necessitates physical activity in the real world. It can be predicted that in the future, there will be the possibility of existence in the Metaverse by processing thoughts directly without the need for physical activity. There are those who see this universe as the next version of the internet. Others see it as a great opportunity and developmental step for humanity. In this sense, the number of people who have positive ideas is quite high. Especially the elimination of physical boundaries, the possibility of people to realise what they want freely and without harming other people, and even the feeling of being immortal in this environment attracts people. Despite all these reasons, serious reactions have emerged that show that it will cause serious damage to the future of humanity and that humanity will even come to an end.

In the current technological environment, social networks are used extensively by people. Due to their nature, social networks are an important opportunity for people to share their ideas and feelings. People share ideas for all kinds of events, situations, and news in these environments. By examining what is shared in this environment, the tendencies, ideas, and possible actions of large masses can be predicted. Therefore, the processing and examination of social media data is an important issue. Every day, different applications are put forward on different data sets.

There are many studies in the literature to make sentiment analysis from data obtained from social networks. It is possible to have an idea about the future of these topics by examining current or popular topics with sentiment analysis over social network data. This study is set out to examine the tweets shared on Twitter about the reactions and thoughts about Metaverse and to evaluate them according to whether they are positive or negative.

II. RELATED WORKS

There are many studies in the literature examining sentiment analysis. Pang and Lee reviewed the studies conducted for the sentiment analysis in 2008 [1]. In their early study, classified the texts primarily according to whether they contain sentiment or not. They then proposed a hierarchical scheme that classifies them as positive or negative [2]. In another study, emotion icons were used to analyse sentiment [3]. Successful results can be obtained in such a method because many tweets contain icons and icons are designed for emotional expression [4].

Twitter sentiment analysis is basically handled as a text classification problem. The results of the pre-processing technique used for text classification may vary. In some studies, methods such as information retrieval, text classification and document filtering can be used. In 2018 Çoban and Tümüklü-Özyer examined term weighted methods which are newly proposed for various research areas. They suggested a term weighting method to be used in Twitter sentiment analysis. In this study, Bag of Words (BoW) and character level (N-gram) models were used for feature extraction. Turkish and English tweets were used as dataset. Latent Dirichlet Allocation (LDA) based subject model was applied for sentiment classification. In addition, the Support Vector Machine (SVM) algorithm was used in classification. They claim that this method is the most

effective method by looking at the experimental results they obtained [5].

In some studies, sentiment analysis was used on twitter to detect customer opinions. Thus, companies and organisations have the opportunity to receive feedback on their success in the market. Sarlan et al. did a study that examined a large number of tweets and used prototyping. As a result of their analysis, they found 84.1% "null", 6.5% "negative" and 9.4% "positive" tweets. As can be understood from the results, the study has serious shortcomings and needs to be improved [6].

Karayiğit et al explained the relationship between the concepts of opinion mining.and sentiment analysis. The terms used for these two concepts are explained and examples are given for Turkish sentiment analysis. In addition, the problems encountered while carrying out Turkish studies were examined and solutions were offered for these problems [7]. Abali et al conducted a study using Turkish tweets from the Aegean Region of Turkey. With this study, it is aimed to identify the problems of people and to create an intelligent system that find out the location of the problems [8].

Ayan et al. tried to determine the situation of Islamophobia on social media with sentiment analysis. For this reason, tweets obtained from Twitter were examined. Linear ridge regression and Naive Bayes Classifier were used for training the models. Afterwards, estimations were made using precision, recall, F1 measures [9].

Fadel and Öz applied sentiment analysis to understand the comments and thoughts. In their study, they proposed a method to automatically classify tweets sent on Twitter after a terrorist attack. They used a machine learning approach. They used a lexicon approach to generate labelled training datasets. Naive Bayes applied majority voting among the Support Vector Machine and Logistic regression machine learning classification algorithms. The results show that the model achieved 94.8% accuracy with an F1 score of 95.9% [10].

Alqaraleh proposed a new and efficient sentiment analysis system. This system also supports the Turkish language. Due to the language structure of Turkish, a preprocessing model has been applied in order to work for agglutinative language. He made experiments using the "Turkish movie reviews" [11] data set. He reported that the approach he came up with gave an efficient and good performance for Turkish [12]. However, since the dataset used belongs to 2013, it could be worked with a more up-to-date dataset.

Kemaloglu et al. proposed a sentiment analysis system using data from RSS feeds, Youtube, Facebook, Instagram and Twitter. Classification and deep learning algorithms such as Logistic Regression, Random Forest and Long Short-Term Memory (LSTM) were used. The LSTM model provided the highest accuracy in their study [13].

Ergül Aydın et al. conducted a sentiment analysis (SA) on Turkish tweets collected about an Open and Distance education (ODE) System to monitor students' views and feelings about the system. In the study, they collected 63699 tweets. It is aimed to develop strategies that will increase the quality of education and training services by quickly learning the ideas of the students about the system [14].

Dalkilic and Cam analysed the tweets shared on Twitter about current series and movies with sentiment analysis. In this way, they will be able to make suggestions about TV series and movies. Turkish TV series and movie reviews were examined. Naive Bayes (NB), Support Vector Machines (SVM) and Random Forest (RF) from machine learning models were used. It is also trained for sentiment analysis by taking polarity values obtained by the general ensemble algorithms such as Bagging and Voting. The voting algorithm's accuracy is 87%. On the other hand, SVMs give the best area under receiver operating characteristics curve (AUC) of 0.96 [15].

Tokcaer examined sentiment analysis studies that used Turkish texts and also applied methods, databases, and open source libraries used in previous studies [16].

III. METHOD AND IMPLEMENTATION

In the study, tweets in English shared with the word "metaverse" were examined and classified as positive, negative and neutral. Exploratory data analysis and data pre-processing stages are very important for performing accurate analyses on social media data. Different data exploration and pre-processing will result in different analysis results. For this reason, the application of standard methods for analysis produces an optimum result. In this study, Twitter posts containing the word "metaverse" in two different date ranges will be examined. While doing this review, the first step is to obtain the data. For this, the snscrape tool will be used. The collected data will be kept in two different csv files. Different notebooks were used for each data set. The second step is to transform the obtained data into a structure suitable for analysis. For this, data pre-processing processes covering 80% of data science processes will be applied. These processes are discussed under two headings, data and text pre-processing. After the data is brought into a structured state, sentiment analysis inferences will be made with Textblob, Vader and Afinn sentiment analysis tools. The applications in this study were Python 3.7.12 and Colab Notebook. The flow of the methods to be applied is given in Fig 1.

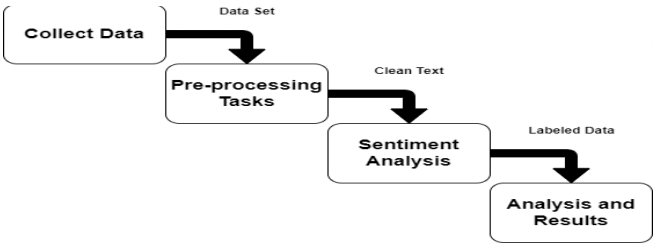


Fig 1. Flow chart of the method to be applied

A. Dataset

Since no ready-made data on the studied subject could be obtained, these data were obtained using specific web mining and web scraping tools. There are many methods to obtain Twitter data. Some of these methods are using the Twitter API and some are methods that do not need the API. Tweepy, TwitterAPI and Orange frameworks are scraped with Twitter API information. But Twint, GetOldTweets3, Selenium, BeautifulSoup, twitter-scrapper and snscrape frameworks allow scraping without any API knowledge. These methods are all free and most of them are python libraries. Among these methods, snscrape is the best method to pull both specific date ranges and unlimited data. The snscrape interface

is also very easy to use.Therefore, in the study, data was collected via twitter with snscrape, a library of the Python programming language.

TABLE I. DATASET DESCRIPTION

Colum Name	**Description**
Datetime	The date the tweet was posted
Tweet Id	Unique tweet identifier
Text	The content of the tweet as text
Username	The person who shared it
Language	The language in which the sharing is made

Within the scope of this study, tweets with metaverse keywords were collected from Twitter. These posts were pulled using the snscrape library without the need for the Twitter API. The tweets were exported to files with the ".csv" extension. Exporting over csv is because csv is easy to access and manage with Python. Tweets were collected in two stages. The first phase is between 2021-10-21 and 2021-10-28, and the second part is between 2021-10-28 and 2021-11-04, each of which is a one-week process. Facebook CEO made statements about the metaverse on 2021-10-28. The first stage covers one week before this date. The second stage covers a one-week period, including 2021-10-28 and the following 6 days. In the first stage, 84,803 tweets were collected. In the second stage, 350,988 tweets were collected. In total, two different data sets were collected, one before and one after. At the same time, there are 5 columns on tweets collected with snscrape as we can see in Table 1. These columns are: 'Datetime', 'Tweet Id', 'Text', 'Username' and 'Language'.

B. Pre-processing Tasks

Tweet messages contain some parts that should not be used in our analyses, which we can call noise in the text data. It is an important step to clear the data to be analysed from noise. After this stage, the texts can be analysed in a way that gives results with higher success.

In this section, data pre-processing and manipulation steps will be explained. First, the process of removing repetitive tweets is performed. Afterwards, the datetime column was converted to a just day date format. We also removed non-English tweets because we only aimed to analyse tweets in English in our study. Finally, we remove all columns except Text. These steps will include the following which will be described in the following paragraphs:

- Remove duplicate tweets
- Convert datetime column as a just day date format
- Remove non-English tweets
- Remove all columns except text

Tweets with the same content cause biased analysis results. Therefore, it is necessary to clean the content of repetitive tweets. For this, the repetitive tweets will be deleted according to the "Text" column in the dataset. A total of 84,803 tweets were sent between 2021-10-21 and 2021-10-28. The number of tweets sent after deduplication was determined as 82,602. In other words, 2,201 tweets with the same content were deleted from the dataset. At the same time, although the total number of tweets sent on 2021-10-28 and 2021-11-04 was 350,988, this number was determined as 345,086 after deduplication. In other words, 5,902 tweet lines were deleted from the dataset.

The format of the "Datetime" column in the dataset must be edited to analyse tweets based on time. The date format in the dataset is yyyy-mm-ddThh:mm:ss.s+zzzzzz. This format has been converted to yyyy-mm-dd. These transformations were applied for two different datasets.

After deduplication, there are 82,602 tweets in the first dataset and 345,086 tweets in the second dataset. There is a "Language" column for these datasets. In the first dataset, there are tweets written in 48 different languages, one of which is undefined. In the second dataset, there are tweets written in 64 different languages, one of which is undefined. Tweets, where the "Language" column equals "en" for both datasets, will be used for analysis. In other words, only tweets written in English will be reviewed. In the first dataset, the number of tweets in English is 67,024. In other words, 15,578 tweets are tweets posted outside of English. In the second dataset, there are 262,561 tweets in English. In other words, 82,525 tweets are tweets written outside of English. As a result, in the first dataset, a total of 67,024 and in the second dataset, 262,561 rows of tweets will be analysed.

The datasets consist of 5 different columns. Unnecessary columns will be deleted from the data set after data analysis is done. What is needed for sentiment analysis is the content of the tweets. In other words, all tweets in the dataset will be deleted except for the "Text" column. In this way, we can now also do text analysis. Both datasets have only a "Text" column. In the last case, there are 67,024 rows and 1 column in the first data set. The second dataset has 262,561 rows and 1 column.

After the necessary data manipulation operations are performed on the obtained data set, the obtained data becomes text data. Many social media data consists of unstructured text data. Unstructured text data contains non-significant expressions. This "dirty" data needs to be cleaned for NLP work to be done effectively. In addition, non-English characters should be cleaned in tweet texts to carry out NLP work on English texts. At the same time, the words must go through the normalisation process to carry out the emotion analysis work correctly. These steps will include the following which will be described in the following paragraphs:

- Noise removal in Tweet Texts
- Normalization
- Tokenization
- Stemming
- Lemmatization
- Remove Stopwords

There are many different symbols, emojis and characters among the tweets. Among these, words and characters containing numbers, punctuation, special characters, emojis, link addresses (http), tagging (#) and mention (@) have been cleaned. Also, non-English characters have been removed. Since sentiment analysis work is a work based on words, these need to be cleared. After these operations applied on the "Text" column, a new column named "clean_text" was added to the data set.

Before starting the analysis, it is necessary to perform word-based normalization processes. These normalization stages will be applied so that words with the same meaning and spelling are not perceived differently in the sentence. This process allows us to perform a standard and acceptable analysis. These operations are divided into 4 parts, respectively, Tokenization, Stemming, Lemataziation and

Remove stopwords. The results of each of these stages are shown in Fig 2. Natural Language Toolkit (NLTK) will be used to do all these steps quickly. The most used library in the natural language processing stages of the Python programming language is NLTK. On the other hand, one of the most important normalization operations is the conversion of letters to lowercase. This process was applied after the Tokenization step.

Tokenization is one of the first text normalization operations to be implemented. The purpose of this step is to divide the text or paragraphs into smaller sections. In this way, more accurate transactions and analyzes are made. Tokenization can be used in two different ways, either word-based or sentence based. In this study, a word-based tokenization process will be applied. Tokenization has been applied to the texts in the "clean_text" column of the dataset. The words in the text for each line formed the new "tokenized" column as a list.

Stemming is applied to remove the inflections (prefix or suffix) of words. Words that have the same meaning and spelling are evaluated as different words by taking a prefix or a suffix. Stemming process is used to prevent this. After the tokenization process, the words kept as a list will be converted into root words. The results of this operation are added to the data set as the "stemmed" column.

Lemmatization is appliedas stemming can sometimes fail to find root words. Lemmatization, which considers the morphological analysis of words and appropriately separates the meaningful word into its roots, can be used as an alternative. Lemmatization is a very important method to find the smallest root form of a word. In this way, each word becomes able to represent itself. The lemmatization process has been applied to the "stemmed" column and added as a new column to the dataset as "lemmatized".

Remove stopwordsstep is applied afterwards. While creating sentences, words that do not mean anything in terms of emotions and meanings are used. These words are the most common words in a language (such as “the”, “a”, “in”), which are usually helpful in sentence construction. These words are called stopwords. There are different stopwords for each language. In this study, English stopwords are discussed. Removing these words from the sentence will not have any effect in terms of sentiment analysis in the sentence. For this reason, stopwords in the "lemmatized" column with root words will be removed.

The new texts obtained after all these text preprocessing stages were added to the data set as the "processed_text" column. The results of each of these stages are shown in Fig 2.

Text	clean_text	tokenized	stemmed	lemmatized	processed_text
@WuBlockchain #BlockchainNative #Metaverse #NFTgaming Because they don't learn the second law of hacker metaverse. @FoundrunS @hackernoon https://t.co/IgePwHEeSX	Because they dont learn second hacker metaverse	[Because, they, dont, learn, second, hacker, metaverse]	[becaus, they, dont, learn, second, hacker, metavers]	[becaus, they, dont, learn, second, hacker, metavers]	becaus dont learn second hacker metavers
@BrianDEvans Hey Brian with the @SVSNFT x #888innercircle collab just announced for Halloween, $blood token utility, SVS video game, metaverse @WilderWorld, and gen 2 around the corner… I'd say grab a vampire! Don't forget to stake it for $blood 🩸🧛🩸 https://t.co/Jh1f24GQr6	Brian with collab just announced Halloween blood token utility video game metaverse around corner grab vampire Dont forget stake blood	[Brian, with, collab, just, announced, Halloween, blood, token, utility, video, game, metaverse, around, corner, grab, vampire, Dont, forget, stake, blood]	[brian, with, collab, just, announc, halloween, blood, token, util, video, game, metavers, around, corner, grab, vampir, dont, forget, stake, blood]	[brian, with, collab, just, announc, halloween, blood, token, util, video, game, metavers, around, corner, grab, vampir, dont, forget, stake, blood]	brian collab announc halloween blood token util video game metavers around corner grab vampir dont forget stake blood

Fig 2. Text preprocessing step results in the dataset

In addition, tweets with a length of more than 3 texts in the "processed_text" column obtained were discussed. This process has taken place because texts of less than 3 letters or characters do not provide any emotion or meaning. These operations were made according to the texts in the "processed_text" column. As explained above, 67,024 rows were found in the first data set and 262,561 rows in the second data set. In addition, row data with a text length less than 3 was removed from both datasets. Accordingly, 8,598 rows in the first data set and 38,616 rows in the second data set were deleted. As a result, there are 58,426 rows in the first data set and 223,945 rows in the second data set.

C. Sentiment Analysis

There are many methods for sentiment analysis in English texts. Among these methods, unsupervised sentiment analysis methods such as Bert, IBM Watson, Textblob, and Vader are used for sentiment analysis in English with rule-based and dictionary-based Afinn libraries. Bert, TextBlob, and Vader are open source and free, while IBM Watson is a paid library. IBM Watson provides API for understanding natural language and performing sentiment analysis. However, it has not been used because it has a limited and paid use opportunity. . In addition, sentiment analysis work with the deep learning NLP Bert model developed by google was not performed in this study due to slower processing power. As a result, sentiment analysis will be performed with Textblob and VADER, which are unsupervised learning models. Apart from these, sentiment analysis will be done with the dictionary based Afinn library. They are models that have a high accuracy rate, especially for social media data. For preprocessed tweets, emotion classification will be made with the three models above. In our study, we used Textblob, Vader and Afinn methods for sentiment analysis. We will share the details of these methods under this heading.

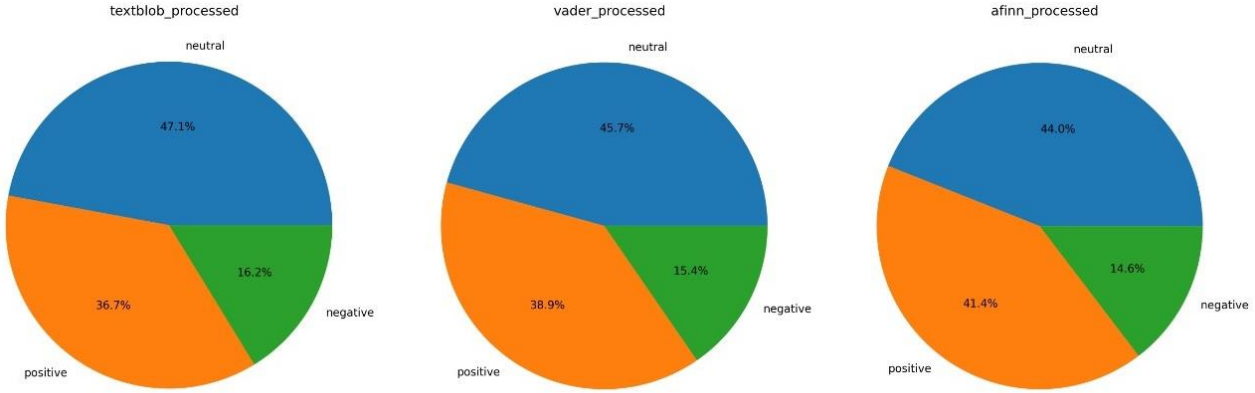
Textblob is a completely free and open-source Python library. In addition, Textblob is an NLP package that contains many functions such as classification, translation, parsing and sentiment analysis on texts. It will be used as sentiment

analysis in this study. It has a rule-based structure for sentiment analysis. Using the NLTK base, it uses a corpus where emotion values were previously registered. It makes sentiment analysis based on the frequency of the words used. The sum of the polarity values of each word gives the sentiment analysis result of the sentence. Sentiment analysis processes of each sentence sent to Texblob are classified according to the estimated polarity value. Polarity consists of decimal numbers between [-1,1]. -1 indicates negative emotion and +1 indicates positive emotion. It will label the tweet as neutral if the sentiment score, that is, polarity value is equal to 0, negative if it is less than 0, and positive if it is greater than 0. The emotion tag of each tweet was determined with Texblob separately for both data sets. This application was applied on pre-processed tweet rows.

Vader (Valence Aware Dictionary and Sentiment Reasoner) is an open-source and free library maintained under the MIT license. It is also a dictionary and rule-based sentiment analysis tool specifically tailored to the emotions expressed on social media. That's why Vader is optimized for social media data. Also, it is a very important analysis tool for NLP. It is available in the NLTK package and can be applied directly to unlabeled text data. The emotional intensity score is in 4 different ways: ('neg', 'neu', 'pos', and 'compound'). The negative, positive and neutral percentiles of a sentence are shown in the labels 'neg', 'neu' and 'pos'. The sum of these three possibilities is 1. In emotion classification, the feature with the highest probability is accepted. However, classification was made based on "compound", that is, compound density scale. Based on this score, emotion classification was determined in three different ways. The 'compound' value is labelled as negative if less than 0, neutral if equal to 0, and positive if greater than =0. In this way, Vader emotion labelling was performed for both data sets.

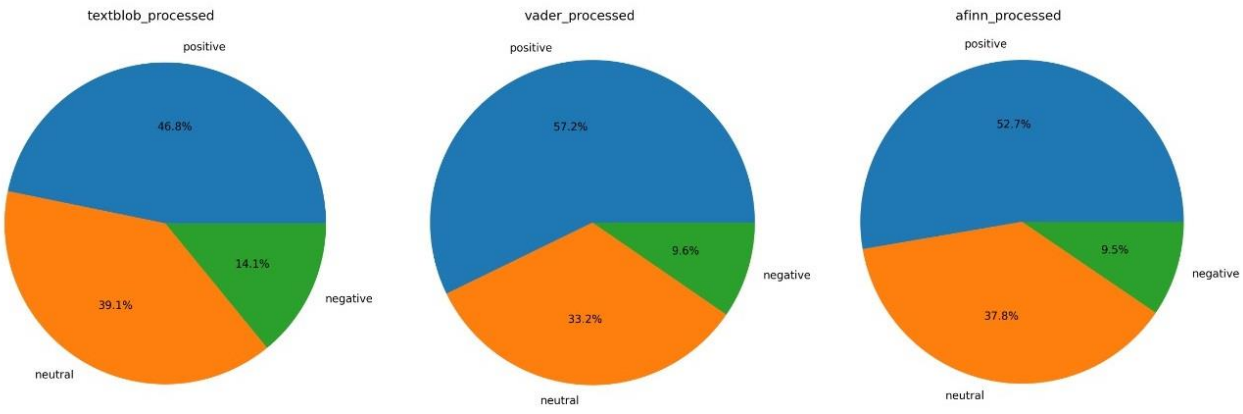
Afinn is one of the simplest and most popular dictionaries that can be used extensively for sentiment analysis. This dictionary is completely free and open source. Contains more than 3,300 words with a polarity score associated with each word in the texts. In the emotion definition of a tweet, words not included in the Afinn word list are assumed to have a "0" emotion score. Afinn is a list of words rated as a score with an integer from -5 (negative) to +5 (positive). The score values of the words in the sentence are found by adding the values of the words in the Afinn dictionary. As a result of this sum, classification is made according to the triple ranking scale. If this summed result is less than 0, the sentence is labelled negative, equal to 0, neutral, and greater than 0, the sentence is labelled as positive. These processes were applied to all pre-processed tweet rows in both datasets.

IV. Discussion



Cite: *Agrali, Ö., Aydin, Ö. (2021).* Tweets Classification and Sentiment Analysis on Metaverse Related Messages. Journal of Metaverse. 1(1). pp.25-30.

Fig 3. Results of the sentiment analysis for the tweets posted before Mark's speech



Cite: *Agrali, Ö., Aydin, Ö. (2021).* Tweets Classification and Sentiment Analysis on Metaverse Related Messages. Journal of Metaverse. 1(1). pp.25-30.

Fig 4. Results of the sentiment analysis for the tweets posted after Mark's speech

Results of the three different sentiment analysis model for the tweets posted before Mark Zuckerberg's speech about change Facebook name to Meta can be seen in Fig. 3 and also results for the tweets posted after it can be seen in Fig. 4.

When the tweets sent in the one-week period before Mark's speech on the change of his company's name on October 28, 2021 were analysed with 3 different models, the Textblob results were 46.8% positive, 14.1% negative and

39.1% neutral. In the analysis made with the Vader method, 57.2% positive, 9.6% negative and 33.2% neutral analysis results were obtained. Results were obtained as 52.7% positive, 9.5% negative and 37.8% neutral with the Afinn method. Our analysis of the tweets sent the week after Mark's statement yielded the following results. With the Textblob method, 47.1% were neutral, 36.7% positive, 16.2% negative. In the analysis made by Vader method, 45.7% neutral, 38.9% positive and 15.4% negative results were obtained. With the Afinn method, 41.4% positive, 14.6% negative and 44% neutral results were obtained. You can see these results comparatively in Table 2.

TABLE II. SENTIMENT ANALYSIS RESULTS

	A week before Mark's Speech			**A week after Mark's Speech**		
	Textblob	Vader	Afinn	Textblob	Vader	Afinn
Positive (%)	46.8	57.2	52.7	36.7	38.9	41.4
Negative (%)	14.1	9.6	9.5	16.2	15.4	14.6
Neutral (%)	39.1	33.2	37.8	47.1	45.7	44

When the results in Table 2 are examined, it is seen that the tweets are generally positive in the analysis made with 3 methods before the Mark's speech. After Mark's speech, positive tweet rates are decreasing and both neutral and negative tweet rates are increasing. The main reason for this may be that the topic became more popular after Mark's speech and negative-minded people who did not tweet about it started tweeting.

V. CONCLUSION

Sentiment analysis is a method that is used in many areas and provides effective results. With this method, data from different data sources are processed and sentiment analysis is attempted. For these operations, preliminary operations are performed on the dataset and then inferences are made on the data that is ready to be processed.

Today, an old topic can become popular again or a popular topic can lose its importance. The concept of metaverse is also old, but it is a concept that has become popular again today. It gained a serious momentum especially when Facebook CEO Mark Zuckerberg changed the name of his company to Meta. Of course, many different companies are also working in this field. In this study, we examined this newly popular concept with sentiment analysis. In particular, tweets posted on Twitter before and after Mark Zuckerberg's speech were evaluated. The obtained data are shared in the article comparatively.

In the future, the relevant dataset can be expanded to cover wider time periods so that the findings can be examined. It would be appropriate to realise this with a more convenient study in terms of time and resources.

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