Review Article

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Metaverse and Healthcare Sector

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Abstract: From the past to the present, many concepts have evolved into a new look by undergoing radical changes with the technology that has reached dimensions that cannot be taken by the human mind. In the health sector, technological devices are as important as human resources in diagnosis and treatment. Metaverse technology also emerges as one of the important changes in terms of technological developments. Metaverse technology, which radically changes the perception of reality, shows itself in many different areas. These areas include the health sector. With the COVID-19 pandemic, radical changes have occurred in the field of health. The difficulties that have arisen in an extreme situation such as the pandemic have limited the living conditions that people are used to, the services and opportunities they can access. The use of technology has created new opportunities and ideas for overcoming barriers and limitations. Thus, the interest in the concept of metaverse, which is the product of a technological development, has started to rise. In this study, in which the concept of metaverse in the field of health is discussed; The development of the metaverse from past to present and its role in the field of health are included, and its applications in the health sector are also discussed. The advantages and disadvantages of metaverse are examined and suggestions for the future are given. Health systems where metaverse and virtual reality technologies are made available; It can be said that they will be ahead in the diagnosis and treatment of diseases, in surgical operations, and in the education sector, which includes medicine-dentistry-nursing. It is thought that countries that develop the concept of metaverse in an integrated way with the ever-evolving technology and integrate their infrastructure will make a name for themselves in the future and potentially gain advantages.

Keywords: Metaverse, Health Sector, Health Technologies

1.THE HEALTH AND METAVERSE CONSEPT

Health is a concept that is defined by many different groups. It is very difficult and complex to create a clear framework for this concept. The reason for the complexity in the definition of health can be said to be the diversity of meanings in the cultures in which people are born. Health can be defined in various ways such as "the ability of people to sustain their lives, not to be sick, to be able to perform their daily activities, to have a sense of happiness, to achieve well-being" [1]. The multiple definitions of this concept have been summarized in a general framework by the World Health Organization (WHO). In 1948, WHO defined health as "a state of physical, social and mental well-being, not only the absence of disease or infirmity" [2]. The changing world and developing technology also change the concept of health for individuals. In the period when the world is rapidly globalizing and technology is spreading to every point, the health sector also takes its share. The concept of health, which is intertwined

with human beings, has also differentiated the interaction of people on this issue with the development of technology and the change of time. This interaction is not only limited to the field of health, but has also changed the interaction of individuals with the world. The metaverse, which has attracted a great deal of global attention with COVID-19, is one of the most widely discussed topics [3, 4]. The concept of metaverse was first used in the science fiction novel Snow Crash, written by Neal Stephenson in 1992. In the novel, the concept of metaverse was used to represent the fictionalized world. The term metaverse was listed in the Oxford dictionary in 2008. According to the dictionary, it is defined as "a virtual world in which users can interact with each other and their environment in computer-generated virtual environments". Since the beginning of the 21st century, researchers have used this term to describe the ability of people to interact in the digital world by creating avatars (virtual identities) [5-7]. When we look at it from a wider context, the metaverse is a virtual space that strengthens the connection between the physical and digital worlds, allowing people to engage with these spaces [8]. Although it initially emerged as a digital gaming platform, the metaverse actually offers its users e-shops, workplace tools, social media platforms, investment tools, and allows them to organize festivals and events. Thus, it is thought to be an alternative to physical life. Metaverse is a new generation internet-based platform where users can interact with each other in a three-dimensional (3D) virtual environment through avatars and software applications and is the output of many technological developments [9].

The shift from a series of independent virtual worlds to an integrated network of 3D virtual worlds or Meta Universes relies on progress in four areas: Immersive realism, ubiquity of access and identity, interoperability and scalability. In each area, the current state and the necessary developments to achieve a functional Meta Universe should be described [10]. Virtual and augmented reality technologies are being developed to experience this visualization. With virtual reality technologies, many things that are considered difficult or impossible to do in the real world are possible. These endless possibilities affect real life. It allows work, education or entertainment environments to be more accessible and more effective [9]. Metaverse offers a virtual reality environment that integrates physical reality and the virtual universe. In addition, it aims to increase the interaction between the user and the virtual environment by utilizing technologies such as Virtual Reality (VR) and Augmented Reality (AR) [11]. With the advancement of technology, virtual reality is rapidly spreading to every field day by day. The field of health, which is directly related to human life, also has its share of the metaverse [12]. The concept of metaverse has shown various changes and developed in the historical process. This concept has been handled in 5 stages in the historical framework. It is possible to express these periods as in Figure 1.

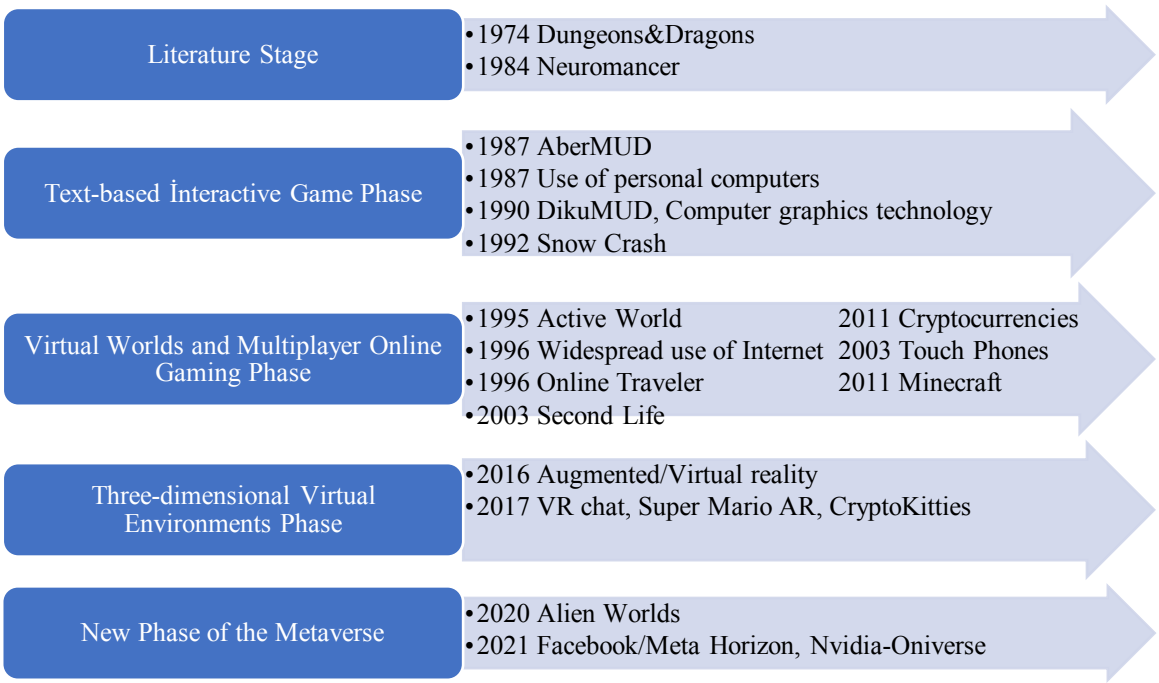

Figure 1. Historical Journey of the Metaverse [13].

Within the changing and developing technology, the metaverse has constantly changed and developed. The most recent action of the metaverse was Facebook's name change to Meta in 2021. With this name updated as Meta, the worldwide recognition has increased even more [14]. With this popularity, the metaverse has also attracted the attention of the health sector. The question of how to integrate the concept of metaverse into the health sector has come to the agenda. Large investors have attempted to move into this field and have looked for various ways. Afterwards, the metaverse entered the healthcare field rapidly with COVID-19 [15]. However, applications such as real-time online distance education systems, business meetings, games, events, etc., which started to be actively used worldwide during the pandemic period, led to the development of a potential second world. To participate in this online environment, it is sufficient to use any device with an internet connection. In the future, the metaverse will enable us to live in a virtual environment by modeling the world in 3D, using a digital avatar of our choice, and will be built on virtual reality and augmented reality technologies [16].

In order to use the metaverse more effectively in healthcare and other fields, we need to know the principles, opportunities, technologies and challenges of this concept. Hence, we can represent these aspects of the metaverse as shown in Figure 2 [11];

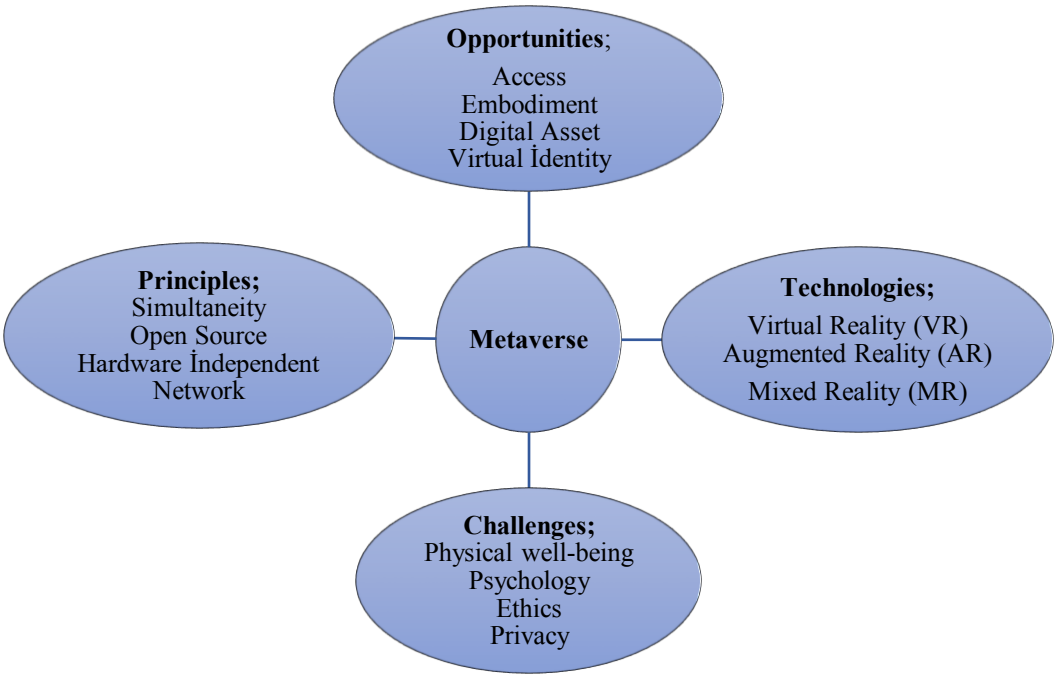

Figure 2. Possibilities, Principles, Technologies and Challenges of the Metaverse

Having knowledge about the possibilities, principles, technologies and challenges of the metaverse and knowing its details well will provide individuals with an advantage in terms of how and in which field the metaverse concept should be used. The concepts of extended reality (XR), virtual reality (VR), augmented reality (AR), mixed reality (MR), artificial intelligence (AI) are frequently used with the concept of metaverse. These concepts can be briefly defined as follows.

- **Extended Reality (XR):** It is a concept formed as a result of the blending of virtual world and real world environments with the help of technology. Extended reality (XR) is a general concept that covers environments such as VR, AR and MR [17].
- **Virtual Reality (VR):** It is the technology that offers the feeling of being in a real environment in the human mind by blending 3D pictures and animations created in virtual environments with developing technology [18].
- **Augmented Reality (AR):** It is the reality that emerges by combining digital elements produced in a virtual environment with reality [19].
- **Mixed Reality (MR):** It is a type of reality that emerges with the integration of virtual objects that have the appearance of real objects and have the ability to move. In this reality universe, individuals have a relationship with virtual and real objects [20].
- **Artificial Intelligence (AI):** It is a phenomenon that allows a computer and computer-aided device to collect human characteristics on that device [21].
- **Internet of Things (IoT):** The communication network that allows us to physically dominate and follow the events around us is defined as the Internet of Things [22].

The metaverse universe, which is a 3D virtual environment, allows participants to interact with each other through technological devices away from physical barriers. In today's world, which is called the age of technology, there are expectations for an increase in the

frequency of use of the metaverse in the provision of healthcare education. New information on the use and applications of the metaverse concept in the health sector is being added every day. It is expected that the concepts of metaverse and health, which remain up-to-date, will be mentioned more frequently in the future.

2. METAVERSE APPLICATIONS IN THE HEALTHCARE SECTOR

When we look at health-related developments, there have been many events around the world in the 21st century. The biggest of these events is undoubtedly the COVID-19 pandemic in 2019, which affected the whole world. COVID-19 has started a new era for both service providers and service recipients in the field of healthcare. Events such as the computerization of examination services, the continuation of follow-ups on the condition of patients via phones, and the differentiation of the delivery of medicines have led people to receive online healthcare services. While this has brought patient-physician relations to a different dimension, it has also caused people to differentiate their preferences for service and drug purchases. In this respect, the metaverse has had a profound impact on the health field [23-25]. When it comes to the metaverse, areas such as gaming, entertainment, socialization, and commerce come to mind. When the literature is reviewed, it is seen that there is limited research on the use of metaverse in healthcare. For this reason, studies on the concept of metaverse, which is new in the field of health, have recently started to attract attention [26]. This remarkable innovation is used in certain applications in the field of healthcare. The main current applications are shown in Figure 3.

Figure 3. Main Applications of the Metaverse in Healthcare [27].

In medical education and training, pain treatment, surgical operations, fitness and wellness, radiology, surgery and psychiatry, the use of metaverse is becoming increasingly common.

2.1. Metaverse in Medical Education and Training

Metaverse can be used effectively in the field of education as it is used in many fields. The effective use of the metaverse in the field of education will make learning more permanent and make the act of learning enjoyable. With all these, the student's interest and focus will be centered on the subject and learning motivation will increase [28]. It is also possible to apply the Metaverse in medical education, which is complex and difficult. Today, there are places using this technology. Metaverse gives medical education a wide range of freedom. By applying AR and VR technologies to medical education, it is not only possible to access unknown and inaccessible areas, but it is also possible for students to experience current practices. An example of this is the virtual glasses that can be worn on the head, making critical surgeries easier. Also, medical students can learn surgical suture training on their own thanks to 360° videos. One of the advantages of using the metaverse in the medical field is the shortening of waiting times for patients. With the widespread use of technology in medicine, procedures will speed up. Patients' waiting times will decrease. In addition, interventional procedures will speed up and patients' satisfaction after the examination will increase [15, 24, 29].

2.2. Metaverse in Pain Treatment

Pain is a condition that occurs in humans during or after many ailments. Thanks to AR and VR applications, non-pharmacological aids have been developed as an alternative to drugs used in the treatment of pain diseases [30]. In addition, thanks to the technologies (VR, XR, AR, etc.) developed with metaverse, it becomes easier to control and monitor the diseases that cause pain. As the presence of devices developed with metaverse technology increases in the field of health, the diagnosis and solution of diseases will become easier. It will also be possible to quickly treat pain associated with diseases [31].

2.3. Metaverse in Surgical Procedures

The field of health services provides services in very comprehensive branches. There is no doubt that surgical fields have a different place among these services. The introduction of technology into these areas, where the risk level is high, is of great importance. The effectiveness of Metaverse in the field of health has made a sound in the field of surgery as it has made a sound in many other fields. This technology, which is more prominent with metaverse, is used in the world's leading hospitals and universities. Thanks to these technologies, it is possible to make observations on the three-dimensional image of the patient and surgeons are more likely to be successful in operations [32]. The introduction of metaverse technology into surgical fields will undoubtedly make the work of doctors much easier. Thanks to this technology, surgeons anywhere in the world will be able to see, monitor and intervene in the operations as if they were in the operating room [33]. The subject of metaverse in surgical operations has been examined in detail in the other title.

2.4. Metaverse in Fitness and Wellness Applications

Nowadays, people living inactive lives, especially in societies that like to consume fast food, are often observed to be sedentary. This frequency has increased even more with the COVID-19 pandemic. After a while, individuals who lead sedentary lives develop a number of illnesses, especially obesity. These conditions appear as health problems at the social level. There are some actions developed to counter such problems and stay healthy. These actions are emerging and being used with the help of technology. With technological developments such as metaverse, applications developed for digital tools make people's lives easier and

make it possible to minimize the risks that may occur. These applications, which are developed to stay healthy and protect the body, record people's actions such as walking, jogging, cycling, fluid and nutrient intake with wearable technology from the moment they start their day. According to the recording chart created, it provides people with a data set about their health. According to this data, people can be allowed to act according to the outputs of activities such as the calories they need to take or burn, their exercise status, and the amount of nutrition. In this way, people can have an idea of what they need to do to stay healthier. As metaverse technology becomes more present in people's lives, people's level of awareness about their health will increase and they will be able to apply it to their lives more easily [34, 35].

2.5. Metaverse in Surgical Operations

One of the most important procedures in health service delivery is surgery. The surgical procedures need to be performed with great care and attention. As this is the case, the introduction of technology into surgical procedures has been inevitable. With technology, it is aimed to minimize the possible negative consequences of these procedures and to increase the success rate. In this direction, in 2001, the American robotics company Computer Motion developed medical robots that can be controlled by artificial intelligence. These medical robots can be remotely controlled by surgeons. [36]. Functions in surgical operations include preoperative planning, intraoperative and postoperative guidance.

The fact that medical robots have entered surgical procedures has made a significant positive contribution to surgeons. Thanks to these robots, the work of doctors and nurses has become easier. In addition to this, it has become more possible to identify the diseased area precisely. The fact that metaverse technology brings the virtual world so close to reality has also made things easier in this field. The ongoing development of this technology will give great hope to physicians and patients in the future. In addition to all these situations, metaverse technology also leads to an increase in the quality of healthcare services [37, 38].

2.6. Metaverse in Radiology

The field of radiology is of great importance in the provision of health services in order to make a more accurate and clear diagnosis to patients. Technologies such as X-ray, tomography, ultrasound, etc. play a critical role in terms of imaging the bodies of patients. Technology has also entered areas that are so important for health. Metaverse technology has also shown itself in the field of radiology and has started to be used by experts [39, 40]. In radiological imaging technology may be useful in the detection of some anomalies that may escape the human eve. With the help of increasingly sophisticated programs, computer data can be obtained on the diseases in the images obtained.

2.7. Metaverse in Mental Health

In our world, which is constantly changing and developing, people experience mental problems from time to time. Health; It is a concept that includes not only physical diseases but also mental conditions. People with psychological problems also need diagnosis and treatment. Metaverse technology aims to facilitate the solution of the problem by finding its place in this field. It can eliminate the concept of distance by enabling psychiatry specialists and patients to communicate easily. Metaverse provides a fast and fluent data flow to mental health experts by analyzing a number of parameters of patients. Thus, it helps to diagnose the problem clearly. In the long term, the development of metaverse technology in the field of mental health will make things easier and reduce current costs [41].

3. CONCLUSION

The concept of health has become a very different phenomenon for all humanity after the COVID-19 pandemic. The negative effects of the pandemic have affected the entire population living in the world. Healthcare workers were at the forefront of the fight against the virus and were affected by contagiousness. During the pandemic process, which also caused a decrease in the number of healthcare personnel, restrictions were imposed on access to healthcare services. Technology has been used to overcome such obstacles and ensure the continuity of health services. In a rapidly developing and changing world, the stages reached by technology allow health problems that were considered impossible to solve in the past to be easily solved. Metaverse universe is one of these technologies. Metaverse is a candidate to radically change the conventional order. The weight of this concept, which can be simply explained as a bridge that carries the virtual world to the real world, also shows itself in the health sector. It can be said that the concept of metaverse, a technology that is expected to result in very different developments in the future, will be used more frequently in health services. It is possible that a brand new era will be opened in areas such as the provision of health services, patient expectations and hospital management. It is seen that metaverse can offer opportunities in many areas such as health tourism, health professionals, treatment activities, distance or applied trainings, patient demands, employee rights and data storage. On the other hand, it should not be forgotten that metaverse technologies may have disadvantages in issues such as data privacy and security, investment costs of new technology, lack of training, and privacy. As metaverse technologies take place in people's lives not only in the field of health but also in other areas various problems such as asocial personality disorders, virtual addiction, anxiety, and stress may have to be faced.

With metaverse technology, it is seen that fields such as medical education, financial dimension of health services, health services management are sailing towards a new horizon. It is predicted that the metaverse will find more space for itself in the field of health and will lead the field towards digitalization. In der for this differentiation to reach sufficient maturity health institutions and companies especially people, will need a serious adaptation. This is an indispensable step for the transition from a conventional order to a technology-based order. The transition to this stage will bring along a number of challenges. People need to investigate how and in what way they will demand health services in the digital world. Healthcare organizations, on the other hand, need to plan how they will ensure uninterrupted service delivery in a digital-based field. In addition, it is among the unknowns where companies investing in healthcare will want to channel their future investments. In addition, how to prevent cyber-attacks and how to protect patients' information and documents are among the first problems that come to mind. In order to prevent these possible obstacles, it may be recommended that moves such as laying the foundation of the legal ground, preparing the social structure for the digital world of the metaverse, raising awareness, and strengthening the technological infrastructure should also be realized. Although the foreseen difficulties seem to affect a single area, it is an indisputable fact that they affect many more areas in the background. In order to minimize the negative effects of all these changes, experts will be needed in the future. It is necessary to prepare the entire infrastructure of technological breakthroughs in the field of health by making future planning and modeling with experts. Efforts should also be made to integrate the community. The necessary infrastructure should be prepared for patients to communicate with physicians. With the arrival of metaverse technology in the field of health, there will be difficulties as well as conveniences. Some of these are; acceleration of health service delivery, expansion of limited time constraints, more accurate and faster diagnoses and treatment processes for patients. With the more widespread

use of metaverse technologies, it can be predicted that the time to be allocated to patients by the manpower specialized in the field of health will increase. It can be expected that it will be simplified for patients to express some diseases that they have difficulty or hesitation in expressing to doctors. For children, innovations that will make healthcare services less of a "fearful dream" may come to life. In extraordinary situations such as the COVID-19 pandemic, it is thought that there will be a rapid social organization and people will benefit from health services more easily.

The use of metaverse in healthcare is gradually increasing worldwide. Metaverse assisted surgeries have also started to be performed in Turkey. Some countries that want to get ahead in the competition (for example, South Korea) have also started to provide incentives for metaverse. The worldwide spread of metaverse will contribute positively to the shortage of healthcare personnel. The language problems that patients experience with their physicians can be eliminated with metaverse technologies. In virtual meetings instead of face-to-face communication; it is possible that incidents of violence in healthcare will decrease. People who have to visit different countries to purchase health care can be expected to receive treatment in their country. In addition, changes can be expected in health tourism by carrying out diagnosis, prognosis and treatment processes that can be provided with remote health services in a virtual environment. With the use of remote diagnostics and devices that support this technology, remote surgery applications can be performed. This review has tried to reveal some possible scenarios for today and the future within the framework of considering the metaverse technology, which is expected to be user and widespread in the field of health, based on the technologies used today. As a result, it is obvious that metaverse technology will make a great contribution to the renewal and development of health services, employees, technological infrastructure and facilities.

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