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Futuristic Approach to Health Applications in Metaverse Environment

Eda TANOĞLU[1], Selçuk BAYER[2]
[1, 2] İstanbul Commerce University, Türkiye
[1]edatanoglu@hotmail.com, [2]selcuk.bayer@gmail.com

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Abstract: The healthcare system in Metaverse provides an interactive, immersive and recreational healthcare experience customized to meet the needs of individual patients. The metaverse consists of advanced technology revolutions such as artificial intelligence, augmented reality (AR), virtual reality (VR), telepresence, digital mirroring, and blockchain (Park, 2022) that have had a major impact on healthcare (Park, 2022). The development of virtual health institutions and even virtual physicians, where health services can be provided in the metaverse environment, will contribute to the development of sustainable health systems in many respects. It is common for areas such as health education, daily disease management, virtual consultation, psychological and dietitian counseling to be transferred to the metaverse environment and carried out effectively. The fact that the legal infrastructure in this area is not yet developed in the world, the licensing and the feasibility of the necessary tests while developing technologies on an important issue such as health, the need for time and money, the existence of cyber security risks, as in all other virtual systems are seen as obstacles to the transport of the health sector to the metaverse environment. Despite the fact that the demand for health is increasing day by day and the number of trained health personnel is limited, there is a potential for development in this field, although it contains issues that are open to discussion.

Keywords: Health, Metaverse, Futuristic Approach

JEL Classification: I19

1. Introduction

By the World Health Organization; "A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"-"Health", which is defined as", has become much more important with the prolongation of life expectancy. The world average life expectancy, which was 72.8 in 2019, is expected to reach 77.2 in 2050. At the same time, the population aged 65 and over is growing faster than the population under this age, and the share of the world population is projected to increase from 10 percent of those aged 65 and over in 2022 to 16 percent in 2050 (United Union, 2022).

The first reflections of these extended life spans on the health system; the increase in chronic diseases of this age group and the insufficient capacity of existing health services, and the increase in the burden of health expenditures that are reflected economically on individuals and institutions. In the literature, the first step in establishing effective health systems is the prevention of diseases before they occur. In this context, many investments are made in the health sector to prevent diseases before they occur and to maintain full well-being, and it is aimed to effectively manage health expenditures, which appear as a burden in the health sector, thanks to many innovations brought by digitalization (Bayer, 2022).

Currently, both the big companies that direct the health sector and the academicians working in the field are investigating the effects and possible future scenarios of digital technologies, which affect the health sector. The recent COVID-19 pandemic can be considered as one of the main accelerators that accelerated the digitalization process in the health sector and caused a lot of development in a short time. In this context, core components of Industry 4.0.; Internet of Things, Big Data and Cloud Computing technologies play important roles in the digitalization of health.

It is very important that the services can continue in a qualified manner for the service provider in health systems and that equitable access opportunities are provided to the service recipients. The fact that competent health workers that are trained and employed, plays a major role in the provision of this qualified health service. Based on the ILO 2019 statistics, the *Health Worker Supply and Insufficiency Ranking Report* is published in 2020. According to this ranking; when we look at the skilled health professions (such as doctors, nurses, midwives) per 10,000 health workers, almost all of the top 10 countries among the 97 countries in the ranking are high-income countries. It is stated that in these areas (especially rural and peripheral areas), they cannot access to basic health services due to the lack of health workers (ILO, 2019). In TTGV's report titled *Health Towards 2030 (2018)*, it is stated that the United Nations will employ 40 million new health sector jobs in 2030 and that even new technologies such as automation and digitalization used in the sector will not adversely affect this employment in the sector. In the report, it is stated that the rapidly increasing elderly population and the decreasing young population with the decrease in birth rate are seen as an obstacle to the training of needed health personnel. It is stated that this problem will be overcome to some extent by digitalization (easy-to-use medical devices, remote health services, digital twin applications, etc.) and thus, it will enable the system to

function with less personnel and without losing the effectiveness of the service provided (TTGV, 2018).

Health is personal and unique. In this context, it is emphasized that it should be mandatory to raise certain health services to the level of personalized health experience (Rehman et al, 2022). Incorporating the use of advanced digital tools and services, providing optimized consumer satisfaction, monitoring health status and ensuring compliance with medicines are now expressed as an irrevocable need. Along with digitalization, the use of personal data has also come to the fore, and healthcare consumers have become more and more willing to share their confidential data (Mistry, 2021). By allowing people to use data the biggest obstacle to the advancement of these technologies is eliminated. Along with data-based systems, providing healthcare services in virtual environments and metaverse environments have also taken their place among the promising new technologies of the sector.

2. What is Metaverse?

This virtual world whose foundations were laid in the novel *Snow Crash* by Neal Stephenson in 1992, has recently entered our agenda as a technology that has taken the world by storm. In this science fiction novel, the author has depicted a virtual world where people live in communication with other people and beings with their virtual copies (avatars) and used the name metaverse (Bayer, 2022). Metaverse means “beyond the universe” and “other universe”. physical world beyond virtual reality with tools and avatars it is called as a three-dimensional fictional reality. This reality takes place first in a game titled "Second Life" coming out Beyond the game world, the metaverse emerges as a new socialization space that offers people a virtual version of the physical world (Duan. et al., 2021). In this environment where people live through their copies in the virtual world, they interact with each other and exist independently of time and space whatever they experience in daily life. Will it be possible to provide health services in the virtual world where such interaction is possible? It is certain that the possibilities that the metaverse world can offer are explored by companies.

To understand the metaverse and the application opportunities that can be developed in 2021 it is necessary to understand the layers of metaverse put forward by Jon Radof. The layers and their descriptions are given in Table-1 (Radof, 2021):

Table - 1Layers of the Metaverse According to Radolf

Layer Name	Explanation
Experience	This is the layer closest to users in the physical world, which can be considered equal to the application layer in network architectures.
Discovery	This layer is driven by content creators and service providers to motivate and inform users/communities. This layer consists of necessary information including relevant content, live streams, advertising e-mails, messages and notifications published/informed by the creators' marketing departments.
Creative	The creators powering the previous layer reside in this layer. They design, build and develop their applications for end users.
Spatial Calculation	This layer supports a hybrid form of computing that reduces the boundaries between the physical and digital worlds. This layer can be considered as the backbone of the creative layer, which consists of 3D engines (to illustrate geometry and animation), mapping and interpretation, spatial mapping, integration of data from sensors, and user interfaces.
Decentralization	Distributed computing is the core primary element in metaverse providing a flexible ecosystem for developers and reliability for users. Blockchain technology plays a critical role in this layer as the core component that supports the decentralized infrastructure and is responsible for queries.
Human Interface	In order to make sense of the digital world and create a natural feeling for users based on the digital world, there are physical-to-digital and digital-to-physical translators in this layer. In addition to AR and VR there may be smart glasses, 3D printers/scanners, biosensors, and perhaps even physical-to-digital and digital-to-physical translators of client nerves.
Infrastructure	This layer called as the Internet layer allows users and their devices to connect to the digital world. 4G, 5G, and WiFi are famous examples of this layer through 6G boosts speeds even more, making it the best choice for the Web 3.0 metaverse .

Source: (https://medium.com/building-the-metaverse/the-metaverse-value-chain), (Bayer, 2022)

There are some technologies that are important for the development of metaverse applications. Thanks to the use of these technologies separately or together, metaverse applications are developed and offered for use. Some of these technologies are:

a) Communication Systems and Infrastructure
b) Blockchain Technologies
c) Augmented and Virtual Reality Technologies
d) Artificial Intelligence Technologies
e) Internet of Things
f) Sensor Technologies
g) Big Data
h) Cloud Computing

Thanks to the technologies listed above it will be possible to develop applications in the metaverse environment and to create effects on the metaverse economy. According to the researches, it is expected to reach an annual economy of 1 trillion dollars in the metaverse environment (JPMorgan, 2022). In the report, Deloitte has published an ecosystem map to describe the interaction of metaverse on the virtual and physical world, its applications on the industrial and consumer side (Figure 1). In this study, the metaverse environment is divided into consumer and industrial parts and the transition from the virtual world to the physical world and the applications in between are classified. This map has grouped the applications that are likely to be developed in two different areas (consumer and industry) on the metaverse.

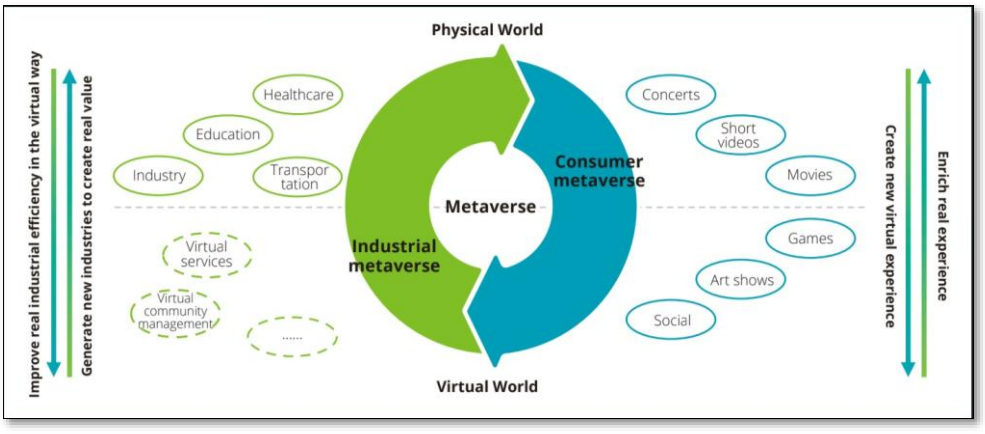


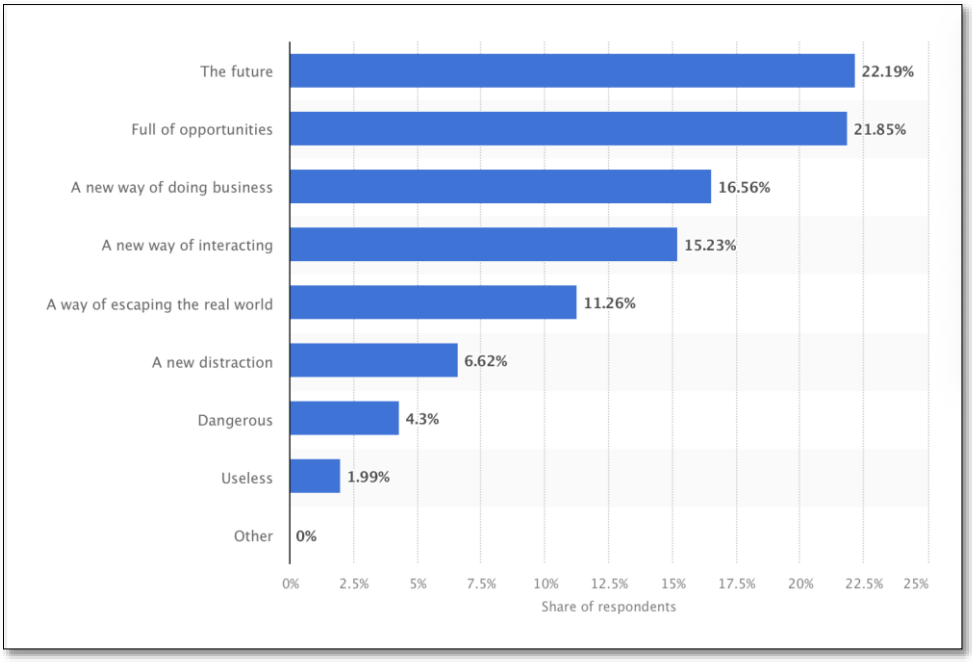
Figure 1. Metaverse Ecosystem Map (Deloitte, 2022)

Metaverse is becoming popular and many companies are making investments in both infrastructure and application areas. According to the researches it has been determined

that big technology giants such as Meta, Microsoft, Tencent, Google, Nvidia have large investments on the metaverse (Citi GPS, 2022). Many sectors in the world are making investments on this metaverse and trying to get the biggest share from this great ecosystem that will emerge. According to the results of the research conducted by Stactica.com; as of March 2022, the 5 leading sectors in terms of metaverse investments are as follows:

a-) Informatics (17%)
b-) Education (12%)
c-) Finance (11%)
d-) Marketing and Advertising (10%)
e-) Medical and Health (9%)

The perspective of the companies in the sectors that have invested in the metaverse gives important information about how the metaverse will take a place in the future. The vast majority of companies think that the metaverse will be seriously used in the future. In Figure-2, the predictions of the companies are given. This statistic shows that the metaverse will take an important place in our lives in the future. The health sector is among the sectors that will be affected by these developments.



Source: https://www.statista.com/statistics/1302156/business-point-of-view-regarding-the-metaverse-worldwide/

Figure 1. Investor Companies Point of View About Metaverse

3. Metaverse Health Apps

The health sector is one of the fastest growing areas of technology. The beginning of digital health, services using digital and internet tools have greatly affected by the interaction between the patient and the physician, and visualization of the changes has been achieved thanks to technologies such as blockchain, augmented reality, and virtual reality (Bhuiyan, et al. 2021). On the other side the extended lifespan and presence of chronic diseases, both capacity problems and high cost burdens are faced. The recent COVID-19 pandemic has put tremendous pressure on the global healthcare industry and related workforce, infrastructure and supply chain management. COVID-19 has been the primary reason for accelerating rapid change in the healthcare ecosystem, forcing stakeholders to continue the adaptation and innovation of all technologies used in this sector (Shakeel , et al., 2022). The metaverse environment also provides an opportunity for this rapid digital change to be used in healthcare services. In order to develop data-intensive digital health applications and move them to metaverse environments, the suitability of the infrastructure has now been validated both academically and commercially. According to the latest research by InsightAce Analytics; health in the market spherical metaverse of applications economic size $ 5.06 Billion in 2021 worth dead and it is expected to reach 2030 to the year up to US $ 71.97 Billion (InsightAce Analytic, 2022).

In the metaverse health system in order to meet the patients' individual needs provides a customized, interactive, immersive and recreational healthcare experience for healthcare professionals. Metaverse consists of some important technologies like artificial intelligence, increased reality (AR), virtual reality (VR), telepresence, digital twinning and block chain (Park, 2022). Although most of the obstacles are suspended via virtual health services there are still health services that will be provided as real services. Metaverse use internet to simulate behaviors and feelings and create a virtual world experience. And it keeps social and economic assets of both real and virtual world (Gadekallu TR et al., 2022). It is summarized in Figure 3 that the technologies and its application areas can be used for health services in the metaverse environment (Chengoden et al., 2022):

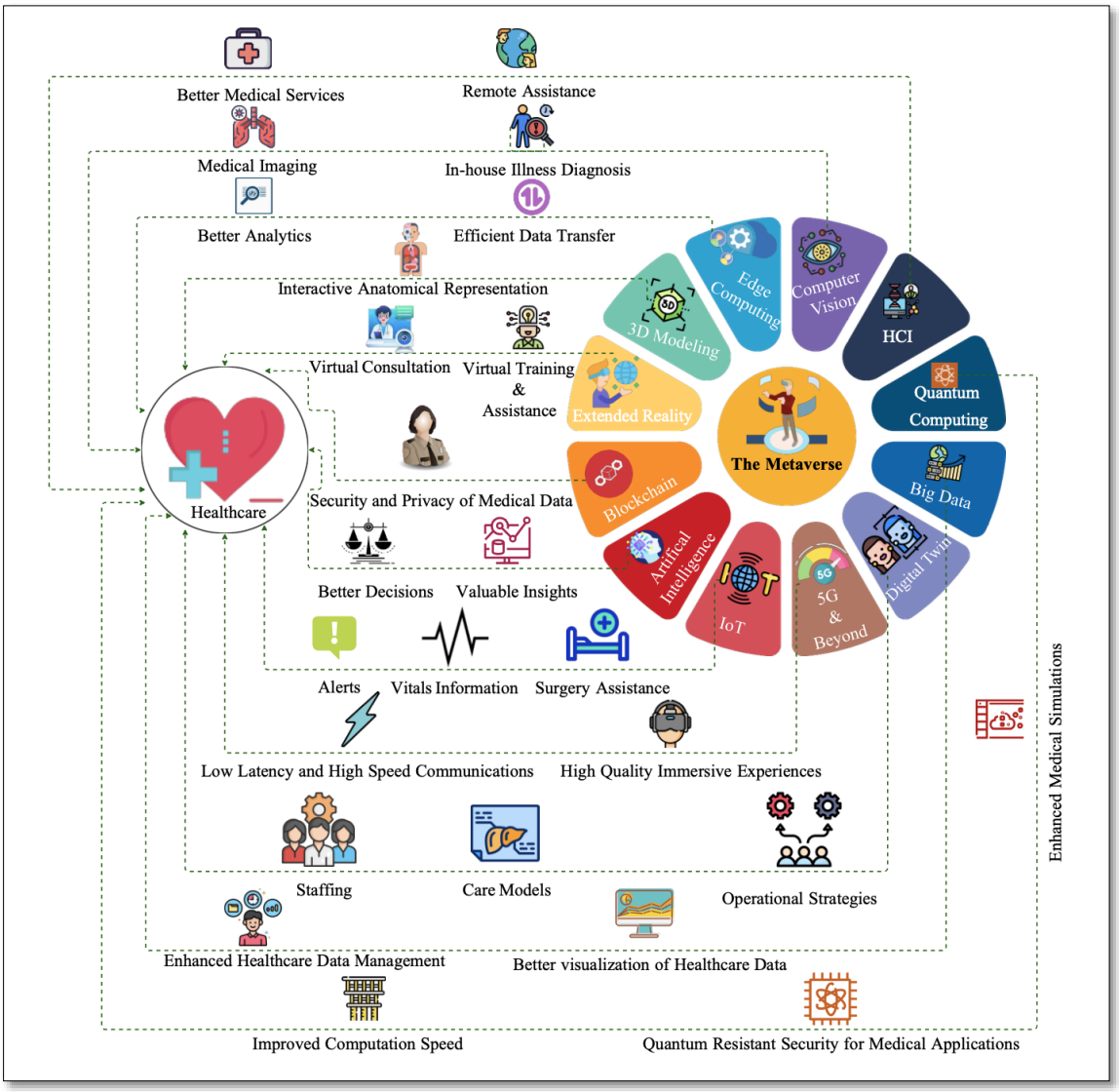


Figure 3. Technologies That Can Be Used in the Metaverse Environment

Many studies are currently being conducted on the development of health services that can be provided in the metaverse environment. However, it is certain that theoretical studies will take some time to be put into practice. At the same time, presenting different applications developed independently from each other in a single metaverse environment and transforming the obtained data into a full health service by evaluating them together should be among the important goals in this field. According to the study done by Chengoden et al. some of the plausible applications of the metaverse that have

the potential to gain momentum in the near future are virtual physiotherapy, virtual biopsy, virtual counseling and virtual stimulation. Figure 4 shows these studies:

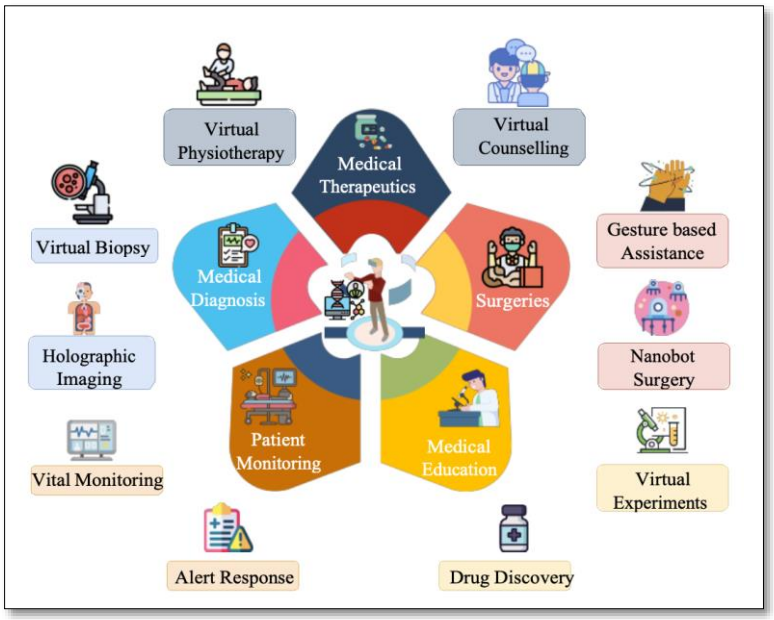


Figure 2. Metaverse Health Apps

4. Futuristic Approach to Metaverse Health Apps

In the previous chapters it is mentioned that both the aim of overcoming bottlenecks in health systems and the environments created by technical developments, the process of transferring health service delivery to digital environments has begun. By all means it is clear that there is some more time for the health issues to be entrusted only to digital systems and to be provided in environments far from physical contact. Thus addressing the legal regulations on this issue and enabling services to be provided remotely are important issues that need to be considered for the future of the sector. In this context, the following question arises:

- Is it possible to provide physical and spiritual well-being via metaverse technology?

Ensuring physical and mental well-being will be possible by constantly controlling the health status of people and processing the data obtained. In this context, people's data obtained with wearable technologies will be transferred to their digital twins who will

live in the metaverse environment. By all means well-being is not only dependent on the physical activities of individuals but also on parameters such as eating habits. From this point of view in the future it will be possible to create a copy of real life in the metaverse environment by transferring the foods that people consume in their daily lives or the activities they perform during the day to the metaverse environment. When evaluated in this context, it will be possible to detect the factors that will threaten people's health long before by processing the information in the metaverse environment, and measures can be taken. People will be able to meet with consultants on the metaverse and receive the necessary health services in this way.

It will be possible to find the most appropriate treatment for people in the real world by testing the effects of the processes and drugs on the disease, which are necessary for the treatment of health problems detected on the metaverse by algorithms. It will be possible for people diagnosed with a similar disease to come together and share in the metaverse environment regardless of time and place. Considering the metaverse environment is a virtual world, transferring people's health data and daily life routines to this virtual world is the key point. The development of Industry 4.0 technologies will play an accelerating role in this field as well and health applications will be developed in the metaverse thanks to the collaboration of technologies such as digital twin, wearable sensors, high-speed data transfer systems, cloud and data storage technologies, cyber security technologies, augmented and virtual reality technologies.

It has great potential to be transferred to the metaverse environment for the follow-up of chronic diseases as the number of patients increases day by day. It was determined that 18.3 million (52%) of the 35.5 million emergency room visits made by cancer patients in 2023, which is one of the leading chronic diseases today are potentially preventable (Alishahi, 2023). It is necessary to investigate whether it is possible to manage such unplanned emergency room visits in the metaverse environment. In addition to cancer, metaverse environments can be beneficial for people who have chronic diseases such as cardiovascular diseases, rheumatic diseases, psychological disorders in terms of managing their diseases. A metaverse environment proposal for effective and efficient management of chronic diseases are given in Figure 5:

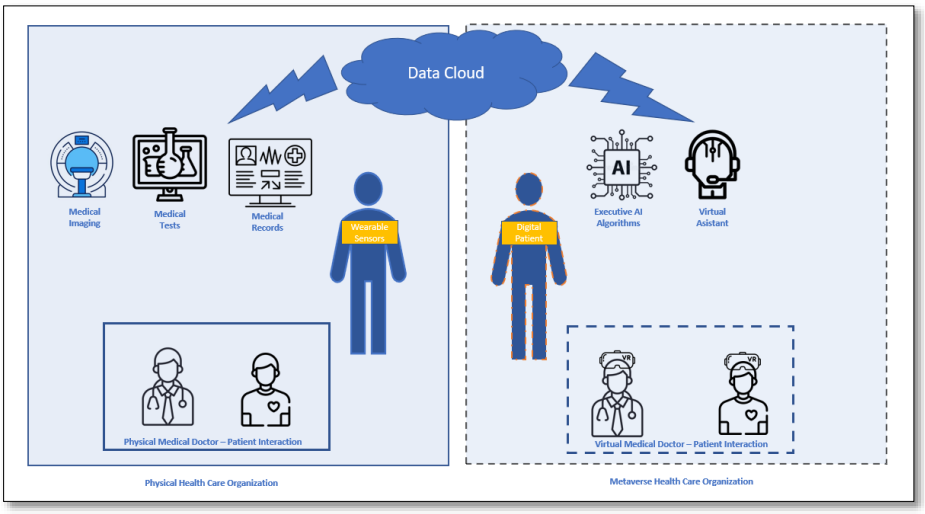


Figure 3. Chronic Illness Tracking For Metaverse Environment Concept

In this proposed concept it is considered to use wearable sensors to monitor the daily activities of an individual with a chronic disease. Thanks to these sensors the person's daily physical activities and health information (exercise, heart rate, fever, blood pressure, falling, etc.) will be tracked and transferred to the data cloud. At the same time, medical images of the patient, laboratory results and all other health records will be recorded via the data cloud. The created metaverse environment will use this data to create a digital patient twin living in the metaverse environment. Artificial intelligence algorithms developed for the follow-up of chronic disease will monitor the patient data continuously and control the occurrence of any anomalies. If a negative situation is detected by artificial intelligence, it will be possible to take precautions by warning the patient and physician through the virtual assistant. At the same time psychological counseling services of individuals with chronic diseases can also be provided in this environment. This environment, which will not require the patient and physician to come together physically, will reduce the visits to health institutions and will allow earlier diagnosis of diseases that may arise due to the patient's constant control. Since the decrease in the visits of the patients to the health institutions will reduce both the use of the capacity of the health institutions and the reduce to travels to the health institutions will have a positive effect from carbon emissions to traffic problems.

5. Conclusion and Discussion

Health sector is affected first with the developments of Industry 4.0 and it is accelerated with the pandemic. In this context health sector in order to provide productivity and sustainability, digital transformation is utilized. The concept of metaverse which has

recently entered our lives, gives us flexibility in ensuring that some transactions are carried out regardless of time and space. Also in the health sector, the abundance of services that can be transferred to this metaverse draws attention. In particular, due to the prolongation of life expectancy and the increase in the rate of chronic diseases of individuals, both labor and financial burdens are placed on health systems in order to maintain the well-being of individuals. The development of virtual health institutions and even virtual physicians, where health services can be provided in the metaverse environment will contribute to the development of sustainable health systems in many respects. It is common for areas such as health education, daily disease management, virtual consultation, psychological and dietitian counseling to be transferred to the metaverse environment and carried out effectively.

However, the fact that the legal infrastructure in this area is not yet developed in the world. Moreover, the licensing issues and the feasibility of the necessary tests while developing technologies that are based on too much time and money, and the existence of cyber security risks in all other virtual systems are obstacles to the transport of the health sector to the metaverse environment. Despite the fact that the demand for health is increasing day by day and the number of trained health personnel is limited, there is a potential for development in this field.

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