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Metaverse: Healthcare and wellbeing

How metaverse can be used to support health workforce in their training and daily tasks

Lappeenranta–Lahti University of Technology LUT

Technology report

2024

Eerika Peltonen & Tanja Lankia

Abbreviations

AR	Augmented Reality
EU	European Union
IoT	Internet of Things
MR	Mixed Reality
OECD	The Organization for Economic Co-operation and Development
SDG	Sustainable Development Goal
VR	Virtual Reality
WHO	World Health Organization
XR	Extended Reality

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1 Introduction

Over the past two decades, Finland has witnessed a steady increase in life expectancy, surpassing the EU average life expectancy, and continuing to rise even in 2020 despite the global COVID-19 pandemic. Simultaneously, social inequalities related to life expectancy by socioeconomic status persist in Finland; these inequalities are linked to various behavioral and lifestyle risk factors, but also to access to healthcare, as waiting times to access care and the uneven distribution of healthcare resources and healthcare workers (such as doctors and nurses) vary between Finnish cities and between private and public health services, all of which increase access inequalities between lower and higher socioeconomic groups. (OECD, 2021). At the same time, according to the World Health Organization (2022), all countries in the European Region are facing severe problems related to their health and care needs, particularly in regards of their health workforce, as countries are experiencing a shortage of the employees and are struggling to find, attract and retain health and care specialists. The challenges related to the health workforce are by no means new topic, but the COVID-19 pandemic, which put healthcare systems under enormous pressure and stretched them beyond their capacity, also worsened the existing health workforce difficulties and amplified their impacts. In addition, the global pandemic massively disrupted health systems and healthcare across the whole world, as healthcare providers around the world resorted into the increased use of telemedicine, more specifically remote clinical consultations, during the pandemic. (OECD, 2023).

Noteworthy phenomena, such as the evolving demographics (e.g., the rapidly ageing population in Finland and the unequal access to care) and the worldwide challenges related to the health workforce during and in the wake of the COVID-19 pandemic, have created an even more pressing need to explore new and innovative solutions that could support the delivery of health and care services. Thus, we in our technology group believe that exploring the topic area further is not only timely but also a very important one to research and discuss, as it can help to pave the way for innovative solutions that could improve and enhance patient care and provide valuable support to the hard-working professionals working in the healthcare industry. Ultimately, new digital initiatives can also help to ensure the sustainable development of the healthcare industry and the health and care workforce in the future.

The currently ongoing technology-centric revolution has offered room for a variety of different kind of digital technology solutions that could potentially benefit the healthcare industry and society at large – as an example, as presented by Ylä-Kujala et al. (2023), new technologies such as Robotic Process Automation (RPA) could be utilized to reduce manual work done with computers which could e.g. release resources that health and care specialists could then allocate to spend more time with their patients. Digital development has also paved the way for collecting data from multiple resources in a way which has not been possible beforehand – this also means that the capability we have learned in history, from assets measurement and their future predictions, first in item level, but later on up to fleets of assets level, could be utilized in the metaverse and with digital twins to humans too, to make preventative care a more prominent part of healthcare system (Kärri et al., 2017; Kinnunen, et al., 2019). In our technology report, we have decided to focus on unveiling different opportunities that the metaverse could present to the healthcare industry. More specifically, we will explore the topic from the perspective of how the metaverse can be utilized to support healthcare workers in their daily healthcare tasks in the future. In addition, we will introduce other potential use cases for metaverse in the healthcare context, such as using it to support health workforce training. In order to give the reader a good understanding of the current status of the healthcare industry, especially from the perspective of the health workforce, we will also introduce the global healthcare industry's workforce shortage, the fallout from COVID-19 as well as on the future of health workforce to support our point of view.

The structure of our technology report is the following: in Section 2, we will present background information on both the metaverse and the current state of the healthcare industry. In Section 3 of the report, we will introduce some case examples of pre-existing healthcare industry solutions that utilize immersive interaction technologies such as Augmented Reality and Virtual Reality, and which are already used in healthcare training and daily tasks. While the metaverse does not yet exist in full extent, the pre-existing solutions presented in Section 3, utilize technologies that could likely become the building blocks of the metaverse in the future. Additionally, we will briefly present and discuss some potential future opportunities of using metaverse in the healthcare industry. In Section 4, we will introduce and discuss the challenges and the potential impacts and benefits of utilizing the metaverse in the healthcare industry, particularly from the perspective of supporting healthcare workers in their daily healthcare tasks in the future. The research data and

references for our technology report has been gathered by using LUT University's Academic Library and by utilizing different kinds of additional sources of information that have all been listed in the References section of this report.

2 Background

In this section, we will present a background on both the metaverse as a topic and give an overview of the current state of the healthcare industry. To understand the point of view of the report better, the metaverse is introduced and the current problems and status of the healthcare industry is presented. Subchapter 2.1 will go through the concept and core attributes of metaverse, while subchapter 2.2 will describe the recent events and disruptions present in the healthcare industry. In subchapter 2.3 we will describe some of the current responses to the challenges in the healthcare industry.

2.1 Background on metaverse

Metaverse has been trending across the internet for years and different companies, such as Meta formerly known as Facebook, are constantly coming up with new technology to utilize it more and more. According to the press release by the technological research and consulting company Gartner, the metaverse is predicted to be used by 25% of people for at least one hour per day by the year 2026 (Gartner, 2022). Despite the trending and buzz around the subject, according to a recent book written about metaverse, it has no clear definition but rather it can be described using some core attributes (Cheng, 2023, pp.1-2).

The core attributes presented by Cheng (2023, pp. 1-6) include boundless space, persistence, immersion, decentralization, economic system, and social experiences. Boundless space means that the metaverse has no boundaries on space, number of simultaneous users, number of activities that can be performed or access to different industries, since metaverse is three-dimensional space. Persistence means that metaverse is constantly connectable and is under continuous development by the people using it. Third core attribute, immersion means that everything that can happen in the real world can happen in the metaverse because of its high level of realism. In addition, the environment in metaverse can be tailored to meet the user needs. Decentralization in metaverse means that it is not connected to any platform or company and that its network architecture is also decentralized, meaning that no single server is responsible for the processing but is rather distributed to many devices. Economic system means that in metaverse, users can exchange digital assets similar to exchanging

assets, such as money, in real world. This virtual economic system draws in more and more people towards the metaverse. Lastly, social experiences means that metaverse will expand the boundaries of social networking first changed by the development of internet since in metaverse can create and experience the existing content. (Cheng, 2023, p.1-6)

Metaverse is usually experienced by using immersive interaction technology, such as the most commonly used Virtual Reality (VR), Augmented Reality (AR) and Extended Reality (XR) (Cheng, 2023, p. 47). Virtual reality hijacks all the senses of the user including hearing, sight, and touch in addition to tracking their body movement. Users can fully immerse themselves into the metaverse by using a VR product, usually in the form of a headset, controllers, and cameras. On the other hand, AR is a virtual layer on top of the real world but does not include any interaction from the user (Cheng 2023). Augmented reality can be nowadays seen used for example in photography and art. Lastly, XR combines various technologies such as VR and AR to create a combined environment of real and virtual where humans and machines can interact (Cheng, 2023, p. 53). Even though metaverse can be additionally accessed through the use of mobile devices and computers, this report focuses on experiencing metaverse through these immersive interaction technologies.

2.2 Background on healthcare workforce

While metaverse has been under development and blooming, the healthcare workforce has gone through many recent events, affecting their jobs, and causing high shortages of health and care professionals today. As stated by the World Health Organization (2022), all the countries in the European Region are currently in a situation in which they are facing severe challenges related to their health and care workforce – in addition to having a shortage of health and care workers, countries are also struggling to find, attract and retain health and care specialists, and are having issues related to skills mismatches, inefficient organization of work and e.g., unattractive working conditions. In summary, the challenges faced in the healthcare workforce are complex and multifaceted; some of the factors contributing to the problem include the misalignment of education and lifelong learning with practice requirements, underdevelopment of multiprofessional teamwork, and the underuse of digital health tools and limited integration of services. In addition, it is important to recognize that

there is an imbalance in the geographical distributions of health and care employees, which has led into a situation in which some countries in the European Region have more healthcare professionals, particularly in urban areas, while some other countries, especially in their rural areas, are facing shortages that impact the access to healthcare services and the quality of care (World Health Organization, 2020). As an example of this, according to the OECD (2021), when being compared to the other European countries, Finland has relatively fewer doctors than the EU average, but the country has the highest number of nurses in the EU.

Since the emergence of the global COVID-19 pandemic in December 2019, the pandemic has had a profound impact on the world as it has reshaped the way people, industries, education and communities function (Happonen, Tikka & Usmani, 2021). The already high stress-level healthcare industry was also highly impacted by the pandemic. The healthcare industry has been under enormous stress during the pandemic, since on top of the patients with COVID-19, they have had to treat those with any other diseases. According to research done on the impact of COVID-19 to the mental health of healthcare workers, the presence of anxiety, depression and insomnia can be seen among healthcare workers during the pandemic (Muller et al., 2020). In addition to mental health issues, a survey done on over 43,000 healthcare workers from 206 organizations in the United States, revealed that almost 50% of respondents met criteria for burnout and almost 29% were reporting intentions of leaving their job (Rotenstein, Brown, Sinsky & Linzer, 2023).

In addition to mental health issues combined with a high burnout rate and intentions of leaving one's job, it is worth noting that there was a shortage of health and care workforce present even before the COVID-19 pandemic. In fact, the shortage has been present long enough that it has been taken into consideration in the United Nation's Sustainable Development Goals. In the Sustainable Development Goal 3, the target 3.C is to increase the amount of health finances and recruitment, development, and training of healthcare workforce in developing countries (United Nations, 2023). In addition to the pre-existing workforce shortage in the healthcare industry, there are also concerning projections for the future. In 2020, the World Health Organization presented an estimation that there would be a shortage of 18 million healthcare professionals worldwide by the year 2030. (World Health Organization, 2020). This was however re-estimated by a study in 2022, resulting in a projection of a global healthcare workforce shortage of 12.9 million in 2030 and respective number being 15.4 million in 2020 (Boniol, Kunjumen, Nair, Siyam, Campbell & Diallo,

2022). As mentioned in the study by Boniol et al. (2022), the presence of COVID-19 will alter these numbers as years go.

2.3 Responses to the challenges in the healthcare workforce

To address the shortage of health and care workers and the imbalanced distribution of these employees within the European region and to ultimately maintain essential health services, the World Health Organization (2022) has recommended a set of actions for countries to follow. The proposed actions are equally important, as they highlight the importance of aligning education with a country's population needs and health service requirements, expanding the use of digital tools that support the workforce, strengthen health information systems for better data collection and analysis, developing strategies that will help to both attract and retain employees in rural and remote areas, and e.g., by creating working conditions that promote a healthier work-life balance.

On the other hand, it is very important to acknowledge that the process of digital transformation and the adoption of novel tools and technologies within the healthcare industry is not merely about technical change, as the whole process requires adaptive change in the form of changing people's attitudes and skills, restructuring the way of how the work of health and care employees is organized, and e.g., potentially changing existing legal frameworks. (World Health Organization, 2021). To better understand the extent of the transformation, the challenges and the potential impacts and benefits of utilizing the metaverse in the healthcare industry, especially in the context of supporting healthcare workers in their daily healthcare tasks in the future, are further discussed in Section 4 of the technology report.

3 Current solutions and future opportunities

After shedding light into the concept of metaverse and the challenges we are currently facing in the healthcare industry and especially the health workforce, the next step is to find ways to help and support healthcare professionals in their daily jobs and boost their training opportunities. To understand the status of current solutions to do so, in subchapter 3.1, we have presented three solutions that are currently available in the market. In addition to presenting the existing solutions, in subchapter 3.2, we will present some future opportunities of using metaverse to support the healthcare workforce. Additionally, we will also briefly present a Finnish VR/XR company that has teamed up with various healthcare companies and professionals to showcase different use cases for their devices in the healthcare and medical industry.

3.1 Current solutions

There are currently many solutions that are already in use in the healthcare industry that utilize immersive interaction technologies such as Augmented Reality and Virtual Reality. In this chapter we will go through three of the solutions available, each directed to help different areas of care. The solutions presented in more depth include XRHealth used in telehealth, Proximie utilized in surgeries, and FundamentalVR utilized in medical training.

According to a study by OECD (2021), in Finland the outpatient care is below EU average but the most money is still spent on it compared to other forms of care such as inpatient care or long-term care. Outpatient care means that a patient's condition does not require hospitalization but rather patient is free to leave after a short visit to hospital for procedures such as diagnosis, testing, imaging, or treatment. One solution to both help health and care workers to perform these activities and ease the lives of patients by making trips to hospitals unnecessary is XRHealth. XRHealth utilizes the metaverse in the form of XR, which is explained in more depth in subchapter 2.1, and offers patients a virtual clinic. After consultation and plan with the health and care professional, patient receives the VR Telehealth Kit through mail and then they are ready to start their treatment with the aid of their designated health and care professional (XRHealth, 2023). XRHealth offers virtual

treatment rooms for multiple areas of health such as upper extremity rehabilitation, stress management, therapy, and cognitive training (XRHealth, 2023).

Another pre-existing solution that has the potential to help to address especially the imbalanced distribution of healthcare employees, more specifically surgeons, and support training is a healthcare platform called Proximie. According to Proximie (2023), the platform helps a variety of stakeholders including hospitals, surgeons, and medical device companies to improve patient outcomes and to drive productivity by providing them a solution that enables telepresence through a cloud-based AR platform which allows real-time collaboration between surgeons in different locations by providing a birds-eye view of the operative field. Additionally, Proximie also offers its users content management and data insights. As an example of how Proximie can help to fight the uneven distribution of the healthcare workforce across the world, is to utilize the platform in areas with more limited access to healthcare professionals. In 2016, Proximie was utilized to perform complex reconstructive hand surgery to a patient that had suffered a bomb-blast injury in Gaza, Palestine. As an area of conflict that had limited access to resources and expertise, the procedure on the patient's hand was performed by having the local surgeons in Gaza being guided remotely through Proximie by an assisting surgeon in Lebanon. By using Proximie, the remote surgeon in Beirut was not only "telling" the doctors in Palestine how to perform the surgery, but the surgeon could also "show" them how to carry out the procedure by highlighting important anatomical structures by utilizing Proximie's AR elements (Greenfield et al., 2018).

To help fight the global shortage of health and care professionals, the metaverse can also be utilized to train doctors and nurses through virtual space. One solution already on the market is called FundamentalVR. The platform offers three different kinds of VR solutions to aid health and care professionals in training. HapticVR™ offers ability for surgeons to improve their precision skills with surgical tools and medical devices by offering virtual and safe environment for learning human anatomy and its physical sensations such as bone textures, muscle, and soft tissue (FundamentalVR, 2023). CollaborationVR offers the opportunity to meet other health and care professionals and even customers through virtual space where collaboration, medical procedure and device training and giving feedback can be performed (FundamentalVR, 2023). The last opportunity from FundamentalVR is their StandaloneVR which complements the previous two. Through StandaloneVR, health and care professionals

can rehearse procedures and situational awareness with colleagues through the use of standalone VR device while on the move (FundamentalVR, 2023). According to Greenberg et al. (2021), Proximie can also be utilized to support the hands-on training of surgeons as it provides a platform for virtual telementoring. As an example, during the COVID-19 pandemic, Proximie was utilized in a proof of concept of a virtual at-home hands-on surgical training course in which the participants practiced hernia surgery at the comfort of their own home.

The Finnish VR/XR company Varjo Technologies Oy has also introduced a set of use cases in which their highly advanced VR/XR headsets have been used to help healthcare professionals in their medical training and to prepare and train them to highly challenging real-life scenarios. As an example, Varjo's virtual and mixed reality devices, alongside with Toltech's VH Dissector tool which contains 3D views of over 2,000 anatomical structures, can be utilized by medical personnel and healthcare students to learn faster and more efficiently about anatomical specimens. Varjo's devices can also be used to facilitate healthcare workforce training in the form of medical simulations; the company has co-operated with Laerdal Medical, a leading healthcare solutions provider specialized in training and educational products for lifesaving and emergency medical care (Varjo Technologies Oy, 2023).

3.2 Future opportunities

In addition to the current and continuously evolving solutions presented in previous chapter that aim to help and support health and care professionals in treating patients either through surgeries or virtual spaces, there is a lot of ongoing development for potential future solutions. Whereas many of the currently existing solutions utilize AR and VR, according to Chengoden et al. (2023), the future of metaverse solutions for healthcare will be implementing IoT, blockchain and combining various immersive interaction technologies such as VR, AR, and MR (Chengoden et al., 2023). In a research article by Chengoden et al. (2023) some future opportunities include for example Healthify, which combines both blockchain and metaverse to offer people regardless of race or religion an opportunity to take virtual health trips such as go to gym and shop in online stores using cryptocurrency. Another interesting future project in the article is called HintVR™ which allows surgeons,

doctors, and patients to train and interact together. This way, patients can for example understand their diagnosis and treatment options better, doctors can perform simplified consultation and surgeons can perform surgeries non-invasively (Chengoden et al., 2023). In addition, some of the training materials for healthcare professionals in the HintVR™ are already released including lumbar puncture, IV cannulation and cricothyrotomy while more is constantly under work (8chili, 2023).

Another potential future opportunity of how metaverse could be utilized to support healthcare professionals in their daily jobs and boost their training opportunities is to also consider the possibilities of combining the metaverse and full-body motion. As an example, Infinadeck, which is a patented omnidirectional treadmill that can be combined with the metaverse and VR experiences, could be utilized as a valuable tool when building training simulations in which the healthcare workers are expected to move their body and utilizing situational awareness and to train situations that cannot be trained while a person is standing still. An example of this could for example be a situation in which the healthcare workers such as paramedics arrive at a prehospital scenario, such as a motor vehicle accident. According to Infinadeck (2023) their product offers its user a 360-moving floor which enables natural movement, and Infinadeck is currently being used in the United States and in the United Kingdom to train soldiers in hyper-realistic scenarios, and the product can also be used for medical rehabilitation, testing human performance and for e.g., for collaboration and entertainment. Infinadeck's technology has also been successfully utilized by Khymeia Group to provide a virtual reality enabled healthcare rehabilitation and diagnostic tool called the Moonwalker. The Moonwalker combines virtual reality and Infinadeck's 360-degree omnidirectional platform into a single product, which can be utilized to support patient rehabilitation through a customized and safe rehabilitation routine created by a doctor or remote therapist. (Khymeia Group, 2023).

4 Impacts and benefits of using Metaverse to support the health and care workforce

In this section, we will present and discuss the challenges and the potential impacts and benefits of utilizing the metaverse in the healthcare industry, especially from the perspective of supporting healthcare workers in their daily healthcare tasks in the future. In subsection 4.1. we have presented challenges and potential impacts related to the topic and in subsection 4.2. the potential benefits are further discussed. Additionally, in subsection 4.3. we present a SWOT analysis that aims to present even more insight to the different factors related to the topic.

4.1 Challenges and impacts

Prior to the COVID-19 pandemic, the usage of telemedicine and more specifically remote care was very limited across OECD countries, as many governments had telemedicine specific requirements that effectively made it harder to utilize. In response to the pandemic, many governments and health care providers swiftly introduced new legislation and policies and revised their existing ones, to allow and promote the use of telemedicine. (OECD, 2023). Despite the fact that the wake of telemedicine has opened up wholly new opportunities and avenues in the context of healthcare, the journey towards applying and utilizing the metaverse in the healthcare industry, is characterized by a set of challenges that make such an adoption very complex. Then again, by identifying these challenges, we can gain a clearer understanding of the nature of the challenges and discuss both the negative and positive impacts associated with them.

One of the biggest challenges in utilizing the metaverse in the healthcare industry, whether to support healthcare workers in their daily healthcare or for other related use cases, is the technical challenges and constraints associated with the topic. The metaverse, as it stands, does not yet fully exist but rather exists in a more primitive format where people can roam in virtual spaces (such as Roblox) that mimic the physical world and by using immersive interaction technology such as VR, AR, and haptics to experience and explore virtual spaces. However, to fully realize the metaverse's potential in the future, more advanced versions of

these emerging technologies, e.g., in the format of highly advanced and lightweight VR headsets and powerful hardware and infrastructure, are needed (Raad & Fryad, 2023). In order to facilitate access to these technologies and to also address additional challenges related to e.g., connectivity, latency, and compatibility, the countries or organizations investing in such technology will likely need to make significant financial investments to be able to integrate the metaverse into their healthcare operations. In this scenario the technical constraints and the significant financial investments required for adoption, could lead to adverse impacts such as additional economic burden to countries and organizations or uneven adoption across different regions and institutions due to their limited access to required financial resources and suitable technology.

In addition to possible significant financial investments and costs, integrating the metaverse into the healthcare industry and into the daily tasks and operations of healthcare workers also poses additional challenges that need to be clarified and resolved in order to make the most out of the metaverse and to also minimize potential adverse impacts. As stated by Marzaleh, Peyravi and Shaygani (2022) some of the potential challenges related to applying the metaverse in healthcare services include privacy and security concerns, such as the loss of privacy, potential ethical concerns, and possible disagreements that organizations and healthcare institutions could face when launching such technology in the domain. There are of course other potential challenges and impacts related that should be researched in more detail before any potential considerations of utilizing the metaverse in the healthcare industry go further.

As stated by the World Health Organization (2021), it is also important to acknowledge that digital transformation and the process of adopting novel tools and technologies, such as the metaverse, in the healthcare industry does not only entail technical change, but it also presents potential significant changes into the worker's attitudes and skills, and potentially also restructures the way of how work is approached and organized in the healthcare industry. Thus, as healthcare professionals and organizations would likely have to adapt into completely new ways of working and training in a situation in which the metaverse is utilized in the healthcare industry, it is also highly important to provide proper training and support for healthcare professionals. This could help the healthcare professionals adapt to new tools and technologies and ensure that patient care will always remain the top priority despite digital advancements.

4.2 Benefits

The benefits of using solutions such as the ones presented in third chapter utilizing immersive interaction technology affect both health and care professionals as well as individuals seeking aid for their healthcare related issues. The healthcare industry has been struggling with workforce shortage and mental health issues even pre COVID19, but the situation got worse through the pandemic. With solutions such as XRHealth, Proximie and FundamentalVR, those problems can be alleviated. The first benefit of using metaverse, precisely immersive interaction technology, is the fact that it helps train medical professionals such as nurses and doctors. As presented in third chapter, FundamentalVR, Proximie and Varjo provides many different solutions to train doctors and nurses such as simulation to improve surgeon's tool accuracy and the use of medical devices as well as offer opportunities to learn other real-life situation in virtual space. As mentioned in the research article by Thomason (2021), the use of AR and VR will change the way medical education and training is done as well as changing the processes and procedures. The use of metaverse and immersive interaction technologies provides new opportunities to train medical students as well as maintain the skills of current professionals.

In addition to training, virtual space offers more possibilities for medical professionals to collaborate globally. As seen with Proximie, the remote surgeon in Lebanon assisted with a surgery done in Palestine through remote connection using Proximie. In addition, FundamentalVR offers virtual rooms for collaborative interaction with the possibility to solve medical problems and tasks together from different physical locations. Thomason (2021) also points out that machines and procedures can be tested out safely in virtual environment before carrying it out into the real world. Using the current metaverse solutions, health and care collaboration can be done in many situations, including intense life-threatening surgeries and peaceful medical practice. Therefore, medical professionals, especially doctors and surgeons, can be accessed from different places all around the world, when necessary, without having to fly them out on-site.

The third benefit of metaverse is the wide clinical care opportunities it offers. Even though many of the medical procedures require a visit to a hospital, more and more care can be performed through virtual spaces. As seen with the current solutions, XRHealth offers many virtual options for outpatient care, such as therapy, rehabilitation of upper extremities and

cognitive training. This reduces the visits to the hospital and people can ease their conditions from the comfort of their own home and contact their healthcare professionals remotely when consultation is needed. Since doctors and nurses are contactable remotely, people can find the most suitable professional for their condition from different locations, therefore improving patient experience through more high quality and efficient care. Therefore, the use of metaverse makes both outpatient and preventative care more accessible through the virtual space.

Since metaverse and especially immersive interaction technologies are constantly developed and refined further, the future of healthcare industry utilizing metaverse is full of benefits beyond those listed in this chapter. Future solutions to help health and care professionals will further define the global benefits that the use of metaverse has in providing medical aid to people.

4.3 SWOT analysis

In Table 1., we have presented a SWOT Analysis based on the impacts, challenges and benefits that were discussed in the previous subsections.

<p>Strengths</p> <ul style="list-style-type: none"> • Faster access to healthcare • More collaboration opportunities between medical professionals • Enhanced medical training opportunities 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Technical challenges and constraints • Costs
<p>Opportunities</p> <ul style="list-style-type: none"> • Increased care opportunities • Engaging and educating patients of treatments options 	<p>Threats</p> <ul style="list-style-type: none"> • Limited and uneven adoption due to the related costs • Privacy and security related threats and concerns • Legal and regulatory challenges • Pace of adoption

Table 1. SWOT Analysis

The more positive side of SWOT in a form of strengths include faster access to healthcare and increased collaboration opportunities between medical professionals. The opportunities include increased opportunities to provide care to patients. The weaknesses, on the other hand, include technical challenges and constraints related to the use of metaverse and threats related to limited and uneven adoption, privacy and security related threats and concerns, legal and regulatory challenges, and the pace of adoption.

5 Conclusions

In this report, the impacts and benefits of using metaverse to aid training and daily tasks of health and care workforce is presented. The report mainly focuses on the immersive interaction technology that can be utilized to access metaverse. Some of the impacts include the technological challenges and constraints related to that as well as privacy and security threats. In turn, benefits include faster access to healthcare, increased opportunities to collaborate and enhanced training opportunities. The impacts, challenges, and benefits are also presented in a SWOT analysis. In addition to impacts and benefits, three current solutions using different immersive interaction technologies are introduced, including XRHealth used in telehealth, Proximie utilized in surgeries, and FundamentalVR utilized in medical training. To help the reader understand the concept of metaverse and the current status and problems in healthcare industry, some background has been covered as well.

The purpose of this report was to present the impacts and benefits of the current immersive interaction technology solutions that might potentially become the fundamental building blocks of the metaverse in the future, and to discuss how these kinds of new innovative solutions could be utilized to improve and enhance patient care and provide valuable support to the professionals working in the healthcare industry. While we cannot foresee the future, based on our research on the topic, we firmly believe that the metaverse has a variety of use cases in the healthcare industry and can likely be in the forefront of technologies that will help to solve worldwide challenges related to the health workforce and the healthcare industry in general. Thus, with careful planning and adaptation, the metaverse could become a valuable enabler in improving global healthcare delivery, training, and ultimately – also better patient outcomes. For potential future research, it would be beneficial to research the metaverse from the perspective of digital equity: on one hand, for the patients and their access to relevant technology, but also from the point of view of healthcare students. Potential future research could also explore how e.g. personal brand building, as a skill among digitally talented vs. non-talented young job applicants, could influence employability and career development, potentially leading into unequal opportunities and situations in the job market. (Happonen et al., 2019; Happonen et al., 2021).

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