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Metaverse for Innovation Strategies in the Healthcare Sector: A Qualitative Analysis of Health Professionals' Perceptions

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Chapter 1. Introduction

1.1. Introduction

Up until today, there has been no clear and unique definition of the Metaverse. It has always been difficult to define precisely because the underlying technology is always evolving. The concept of the Metaverse, which was still a hypothetical conception at the time the term was created in the early 1990s, largely borrowed from already-existing online communities (Wang et al., 2022).

Technically, the Metaverse consists in a sort of virtual and parallel world, resulting in a single, shared, immersive, persistent, 3D virtual space where humans experience life in ways they could not in the physical world (Lee, 2022).

The ways in which these online communities behave and operate have vastly changed over time, and so has the definition of Metaverse.

Similarly, also can refer to the Metaverse as a post-reality cosmos that combines physical reality and digital virtuality in a continuous and enduring multiuser experience (Riva, 2009).

The "interreality" of this new concept, which is a personalized immersive e-therapy whose main novelty is the creation of a hybrid, closed-loop, empowering experience bridging both the physical and virtual worlds.

With this comes that our actions in the real world have an impact on our experiences in the metaverse, and vice versa. Thus, this new disruptive combination of technologies resulting in the Metaverse, may produce a more immersive and natural online experience, enabling us to interact with our communities in a more efficient way (Thomason, 2021)

The Metaverse is built on technologies that allow for multimodal interactions with digital people, objects, and settings. Stereoscopic displays that

can transmit the sense of depth enable the representational quality of the XR system. (Thomason, 2021). Distinct and somewhat different displays for each eye that mimic sight in actual situations, and high-resolution XR displays enable a large user field of vision. Compared to 2D systems, XR systems also provide greater aural experiences. The creation of soundscapes that notably improve immersion in AR and VR is made possible by 3D, spatial, or binaural audio. Users may locate themselves and recognize the directions of sound cues because to the spatial dispersion of sound, making it a potent tool for navigation and user attention attraction.

The use of motion controllers in XR systems enables active interaction with virtual objects in addition to the aforementioned passive sensory inputs (Chengoden et al., 2023). Individuals who would like to access the Metaverse should generally have a grip, buttons, triggers, and thumbsticks, and they are portable input devices. Users can touch, grab, move, and control virtual items with the controllers. They become active participants in any educational experience thanks to this capability. On this front, the creation of comprehensive hand tracking will enhance the user interface in the direction of a more natural experience. Moreover, research is being done on touch-responsive wearables such haptics suits and gloves. The focus of additional sensory research is on the digitalization and simulation of smell.

Furthermore, users do not need to be seated to interact with XR environments. They may make their whole body active. In fact, positional and rotational tracking are used to translate physical movement into XR settings and movement can be followed using either external, fixed cameras (outside-in) or built-in headset sensors and cameras that track changes in position in respect to the surrounding environment (inside-out).

The characteristics over exposed briefly summarize those which are the main aspects of the Metaverse. This alternative reality has been hypothesized to have the potential to impact different sectors.

From fashion, to tourisms, futurists and technologists are currently exploring how the Metaverse may play a key role in a multitude of different environments.

However, in the course of this thesis we will pay close attention to how it may be used in the future to change, enhance, and possibly transform the healthcare sector.

As for new technologies, such new digital tools already totally reshaped the healthcare scenario. In fact, the use of medical digital technologies may improve the public's access to and flexibility with healthcare. It includes the accessibility of open data about health, treatment, side effects, and recent advancements in biomedical research.

With the strain of long-term, chronic disease, growing expenses, aging populations, an inadequate health workforce, and finite resources, we have long known that the health care system is unsustainable. Finding models that bring healthcare from hospitals to homes is therefore crucial.

In the metaverse, 3D avatars of healthcare professionals will be able to communicate with tools like digital whiteboards and hold face-to-face meetings without the use of elaborate conferencing technology. Before being used in a real setting, machines, systems, and procedures will be safely tested using digital twins to find flaws and vulnerabilities.

The development, prototyping, assessment, regulation, translation, and improvement of AI-based medical practice, particularly medical imaging-guided diagnosis and therapy can be facilitated by a “medical technology and AI” (MeTAI) metaverse (Briganti and Le Moine, 2020)

Idealistically, the MeTAI metaverse should make it easier to enhance and incorporate disparate, standalone systems into a cohesive healthcare infrastructure. The metaverse's new features will reshape society and biomedicine as the technologies supporting it develop. We see the advantages of a biological metaverse as being comparable to those offered by computer-

aided design software in aerospace system engineering, where virtual representations of airplanes and spacecraft are thoroughly examined and improved before being built in the real world.

According to futurist Bernard Marr, the combination of three of the current most significant technical trends—telepresence, digital twinning, and blockchain—, has the potential to have a great impact on healthcare. These three ideas might be used to produce a completely new method of providing healthcare, which may result in cheaper costs and significantly better patient results.

1.2. Purpose of this research

The main objective of the proposed research is to analyze doctors' perception of digital technologies in healthcare and their propensity to use the Metaverse as a work tool in the future.

Findings shed the light on six promising topics, namely:

1) New technologies as enabler factors to reshape the healthcare services.
2) Metaverse and medical fields.
3) Metaverse and doctors-patients relationship maintaining.
4) Metaverse as a booster for telemedicine purposes.
5) Lack of knowledge and new medical skills.
6) Metaverse future issues and opportunities

Each one of these topics will be further analyzed and discussed in order to better understand the future impact of digital technologies, and in particular the Metaverse

1.3. Thesis structure

The thesis is organized as follows. In the next section (Chapter 2) we provide an overview of the study by focusing on the current opportunities of Metaverse for healthcare purpose, and by shedding light on the role of new technologies. After a brief introduction on the Metaverse's potential uses in the healthcare sector, we focused on medical staff and doctors' antecedent to use new technologies.

Afterwards, we report the methodology by which data was collected and reported (Chapter 3), introducing the topic of qualitative research analysis and then primarily focusing on the way in which the open questions were formulated and exposed to participants, following a series of standard rules for qualitative research purposes.

Once concluded the methodology, the next section (Chapter 4) reports all results of the research. Participants' answers were reported and summarized in a specific table and then analyzed in more detail.

Moving on then to the last part of the thesis, Chapter 5 discusses all results by analyzing different topic that came to light from participants' responses to the questionnaire. The section hopes to shed light on some interesting insights and reflections that ultimately emerged from the study.

Finally, the last section (Chapter 6) will conclude the thesis by giving a general overview of the study and focusing on limitation and future auspices of the research.

Chapter 2. Overview of the study

2.1. Digital-based healthcare services: The Metaverse opportunity for the healthcare sector competitiveness

The healthcare industry has been known to grow increasingly quickly in the last decades as a result of the rapid advancements in digitalization and automation, which have produced new models that have been opening up new avenues for providing treatment at a lower cost (Wiederhold and Riva, 2022).

It is hypothesized that the current consumer culture, which prioritized face-to-face interactions, will be replaced by a zero-contact corporate culture, as internet commerce is becoming increasingly prevalent across all company sectors, such as luxury, tourism, education etc., as well as in the healthcare sector. (Petrigna and Musumeci, 2022). Among these sectors, the use of smart technologies - consisting in IoT-based technologies which uses big data analysis, machine learning, and artificial intelligence to provide cognitive awareness to the objects which were in the past considered as inanimate - in healthcare in particular has grown significantly. It is clear that the zero-contact corporate culture has had a significant impact on the healthcare sector as the range of smart service apps has increased and their use has skyrocketed Sestino et al., 2020)

Among the other new possible technological integrations, and by considering the current technological frontier, the Metaverse has enormous potential for the healthcare industry by enabling both patients and medical professionals to have realistic experiences. It is an intersection of many enabling technologies, through which novel approaches to delivering high-quality healthcare treatments and services can be investigated. The combination of these technologies guarantees individualized, close-knit patient

care. Additionally, it offers clever adaptive solutions that break down boundaries between healthcare professionals and recipients. As part of future research paths, the problems with the Metaverse's adaption for healthcare applications are also emphasized, along with some likely fixes. (Chengoden et al., 2022)

Applications of metaverse services have started to emerge, and they are now a substantial and growing promising sector of the healthcare sector (Ter-Akopov et al., 2019). As a result, it is crucial that the healthcare sector understand the values and dedication to the metaverse services as a crucial component of strategic planning for the long-term vision in the sector. Although there is promise for metaverse services in the healthcare sector, there are also a number of complex and competing opportunities. Without a systematic method for assessing the possible evolution of business opportunities, it is very challenging to appropriately balance the current metaverse service requirements of a business model and its applicable technology. (Lee, 2022)

In order to monitor the patient's physical and emotional responses, the healthcare sector needs to maintain continual human touch with them (Sestino & D'Angelo, 2023): Indeed, by considering the basis of doctors-patients relationship, such kind of connections does not consist only in doctors' professionalism, but also in their non-verbal, empathic, and social behavior.

By considering such connection, the doctor-patient relationship is crucial for providing quality healthcare and achieving positive health outcomes. Here are some key factors that are important in building a strong doctor-patient relationship (Goold and Lipkin, 1999)

- Communication: Effective communication between the doctor and patient is essential. The doctor must be able to listen carefully to the patient's concerns and explain medical information in a way that is easy to understand (Ha and Longnecker, 2010)
- Trust: Patients need to feel that they can trust their doctors. Trust is built by demonstrating competence, honesty, and respect for the patient's beliefs and values (Ward, 2018)
- Empathy: Doctors must be able to empathize with their patients and understand their feelings and concerns. This involves acknowledging their fears and anxieties and providing emotional support (Ha and Longnecker, 2010)
- Shared decision-making: Patients should be involved in decisions about their own care. Doctors should provide information about the available options, the risks and benefits of each, and the patient's preferences (Ha and Longnecker, 2010)
- Respect for privacy: Doctors should respect their patients' privacy and maintain confidentiality (Ha and Longnecker, 2010)
- Continuity of care: Patients benefit from having a consistent relationship with their doctors over time. This allows the doctor to develop a deep understanding of the patient's medical history, needs, and preferences (Ha and Longnecker, 2010)

Overall, the doctor-patient relationship should be based on mutual respect, trust, and open communication. When these elements are present, patients are more likely to feel satisfied with their care, adhere to treatment recommendations, and achieve better health outcomes. Thus, even by considering the current new technologies this kind of characteristics should remain unaltered.

This process has been boosted by the pandemic, thus there is a push for the use of remote care technologies like telehealth, which employs digital information and communication technologies to access medical services remotely. According to, by 2020, 95% of healthcare facilities in the United States would be able to offer telehealth, up from 43% prior to the COVID-19 pandemic (Demeke et al, 2020). Using technology to communicate while not physically present, patient and doctor interactions are referred to as "telemedicine" in general. It comprises of text messages, emails, video chats, and phone calls. Digital medicine, telehealth, and e-health are other terms for telemedicine.

Patients and physicians will be able to meet in a 3D clinic or wherever it is done thanks to Metaverse's ability to supplement these meetings with a virtual office. Figure 1 shows a case study of how the metaverse might connect people from remote places to medical facilities at the touch of a finger. A patient who has been identified as suffering from conditions like "eczema" may visit a local clinic. The clinic doesn't have a treatment for such a situation. Using metaverse, consulting doctors can video conference with several panel doctors located in district hospitals and multi-specialty hospitals throughout the world to get their thoughts and suggestions.

This would facilitate the patient's rapid access to medical care. Second, it would lessen the improvement in doctor-to-doctor communication and consultation. Thirdly, there is less of a need for big multi-specialty hospitals everywhere. (Bansal et al., 2022)

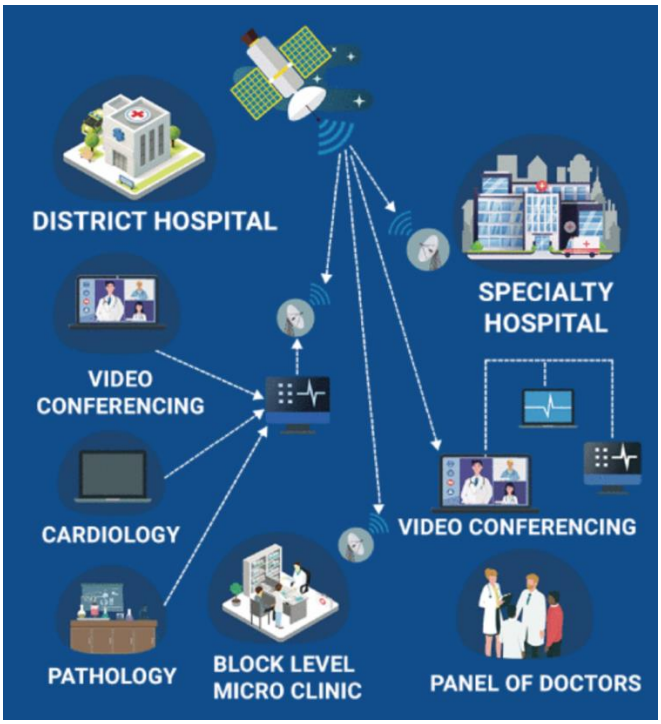

Figure 1. A telemedicine case study application in India.
Source: Bansal et al., 2022

The Metaverse, one of the newest digital technologies, is now altering the world of business opportunities and boosting the chances for consumers to access services like medical and healthcare services globally. The healthcare Metaverse was in fact valued at USD 6.85 billion in 2021, and by 2030, it is anticipated to reach USD 72.10 billion, expanding at a CAGR of 29.89% from 2022 to 2030 (Forbes 2022).

In order to ensure that doctors, nurses, and staff have a virtual presence online, Latus Healthcare in the United Kingdom (https://latushealth.co.uk/) has created a "virtual hospital" that consists of virtual reality medical surroundings and virtual agents. These services include a virtual hospital setting that may be accessed with a headset, with a focus on counseling and physical therapy services. Computer vision is used in physical treatment, for instance, when

cameras are used to examine the range of motion in injured joints and the advancements patients make during rehabilitation. The first hospital foundation to ever be established in the Metaverse, or directly in the virtual world without a "twin" in the actual world, is iMining. This is a second, more complicated example (Sestino et al, 2022)

From final users' perspective (i.e., the patients), the convergence of the aforementioned new technologies activating the Metaverse may allow healthcare professionals to provide a range of highly integrated, intentional, and individualized care, unrestricted by the siloed nature of current healthcare models in a "parallel" setting of everyday life (Sun et al., 2022). With the introduction of new technologies and their combined use, healthcare facilities and medical services could undergo a complete transformation. For this, the doctor-patient relationship may need to be rethought (Córdova, 2022). By taking the experience to the next level, the metaverse may promote both doctor-patient and doctor-doctor communication, enabling hitherto unheard-of levels of sophistication in prevention, diagnosis, and treatment.

Thus, by bridging the gap between the patient and the doctor, the metaverse can revolutionize the healthcare sector. Many people find going to a hospital or doctor's office uncomfortable; thus, while maintaining patient convenience, Metaverse helps patients and healthcare professionals communicate. Additionally, telemedicine allows for the secure transmission of medical data and reports from one place to another. Therefore, people can have faith in this system and confidently ask for its help.

Moreover, the lack of reliable healthcare infrastructure in rural areas, remote locations, and post-disaster circumstances causes problems. To provide emergency medical care in such locations or situations, telemedicine may employ the metaverse. Patients can receive clinical care at home without making the difficult trip to the hospital.

Additionally, the sharing and discussion of crucial medical case information among healthcare professionals in many locations has been made possible by contemporary information technology breakthroughs like mobile collaboration (Winter et al., 2018)

And lastly, since telemedicine has made it possible to monitor patients via phone, tablet, and computer technology, healthcare costs have decreased. Doctors can now verify prescriptions and supervise medication monitoring.

The risk of infectious disease transmission between patients and medical professionals is also decreased through telemedicine. (Bansal et al., 2022)

A healthcare center, health center, or community health center is one of a network of clinics run by a team of general practitioners and registered nurses that offer medical care to locals in a certain area. A health center may offer pediatric, women's, family planning, pharmacy, orthopedic, and other services. In this part, we show how the metaverse might offer fully immersive experiences that might offer real-time direction right in front of the doctor. Figure 2 summarizes the domains of health facilities taken into consideration.

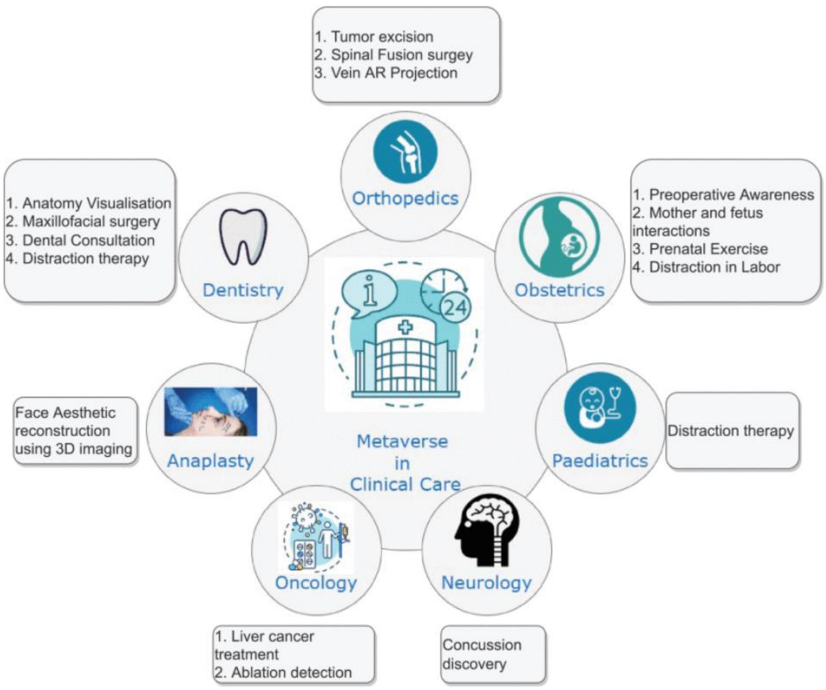

Figure 2: Overview of metaverse applications in different divisions of clinical care. *Source: Bansal et al., 2022*

2.2 Digital twins in the Metaverse: A view on personal healthcare with Digital Technologies

Interoperable electronic health records have significantly improved patient outcomes, access to patients' medical records, and the rate of medical errors ever since the US passed the Health Information Technology for Economic and Clinical Act (HITECH) in 2009. As of 2021, office-based doctors adopted certified electronic health records systems at a rate of roughly 72.3%.

Patients can typically access some of their own medical records in hospitals, including appointment schedules, lab test results, and more. But when it comes to personal healthcare, those records might not be enough because the data is frequently stale, disjointed, and doesn't offer any advice or an accurate depiction of the state of the patient's health at the time. Clinicians lack awareness of patients' current health conditions because they lack access to the most recent patient generated health data because patients have no ability to contribute to their own EHRs.

There will be problems with measurement accuracy and reliability even if they have access to patient-generated health data. In such a scenario, electronic health records and data generated by patients might be combined using a digital twin.

The first thing that the general public should be concerned about is their own health risk factors in order to maintain their own health. Various data sources, including behavioral aspects, family history, their own medical history, sensor readings, and self-reported health issues like chest pain, can reveal that different people have varied sets of risk factors.

As the Metaverse is synced with numerous personal data sources, which may be used to analyze risk factors and provide insight based on the provided data, it can be utilized as a digital technology able to manage risk factors. A general thorough questionnaire that doctors' offices and hospitals generally use for a new patient can be used to identify health risk factors directly, and synchronized data analysis can be used to identify them implicitly. (Song et al., 2022)

Digital twins of actual items, settings, and assets might be made to show How the physical and virtual worlds are converging. A digital twin is a representation of a physical asset that replicates the behavior and interactions of the real item through its data model. It serves as a virtual representation of the actual thing or process it represents, allowing for remote monitoring and assessment in close to real time. Through the use of digital tracking, simulations, and improved human body modeling, the use of digital twins in healthcare can change clinical procedures and hospital administration.

A health care provider can evaluate the capacity, staffing capabilities, and care models of its facilities to determine what actions to take and develop plans for future difficulties by establishing a digital twin of the hospital, operational strategies, or medical processes. By simulating a person's biological traits, genetic make-up, and lifestyle, the technology can also be applied in personalized medicine to create a digital twin of the human body. The goal of digitizing the human body and creating an exact reproduction of its internal systems is to advance the idea of the "virtual patient" and enable the provision of specialized, targeted medical care and treatment.

(Tan et al., 2022)

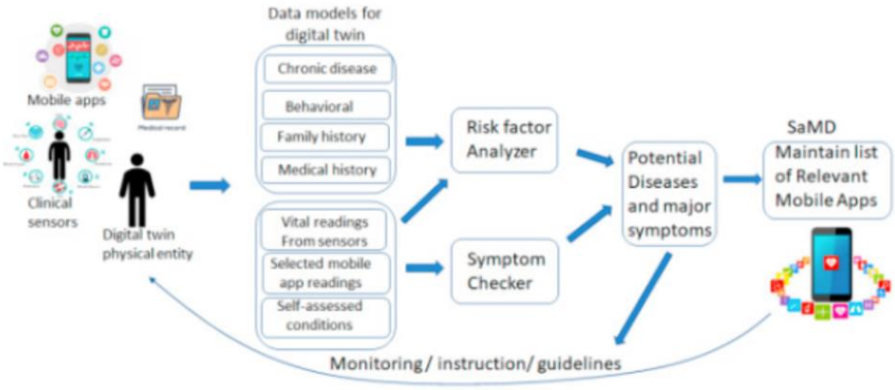

Figure 3: Digital twin for potential disease monitoring.

Source: Tan et al., 2022

2.3. Digital technologies acceptance in the healthcare settings. Focusing on the medical staff perspective.

The last ten years, in particular, have seen substantial research into the factors that influence how healthcare technologies are used. Various models and theories of technology acceptability were used to study these aspects.

Technology acceptance is characterized as the choice to adopt a novel solution, as opposed to technology rejection. Technology acceptance refers to a person's psychological state with reference to their intention to employ a particular technology (Marangunić and Granić, 2015). The adoption of technology by a user is important at all times, not just during the design stage or right after installation. The information systems' architectures, working environments, and potential consumers will all undergo continuous modification. Due to these modifications as well as other social or cultural difficulties, users' needs may also vary.

Technology acceptance is a term used to describe the extent to which individuals are willing to adopt and use a new technology. The concept of technology acceptance is based on the Technology Acceptance Model (TAM), which was first introduced by Davis in 1989. According to the TAM, technology acceptance is influenced by two main factors: perceived usefulness and perceived ease of use.

Perceived usefulness refers to the extent to which individuals believe that a technology will help them to accomplish their tasks or goals. Perceived ease of use refers to the degree to which individuals believe that a technology is easy to use and understand. Both of these factors have been found to significantly affect an individual's willingness to adopt and use a new technology. Research has shown that there are several other factors that can also influence technology acceptance (Rogers, 2003). For example, social influence can play a significant role in an individual's decision to adopt a new technology (Davis, 1989, Venkatesh et al., 2003). This can include factors such as peer pressure, social norms, and the opinions of influential individuals.

Another important factor in technology acceptance is perceived risk. Individuals may be hesitant to adopt a new technology if they perceive that there is a high level of risk associated with its use (Venkatesh et al., 2003). This can include concerns about privacy, security, or potential negative consequences of using the technology.

Overall, technology acceptance is a complex process that is influenced by a variety of factors. Researchers continue to explore this topic in order to better understand how individuals make decisions about adopting and using new technologies, and to develop strategies for promoting technology acceptance.

There is no denying the growth of digital technologies in the healthcare industry. Additionally, the staff's use of technology in the healthcare industry

is a crucial concern because information technologies are crucial in boosting their productivity and effectiveness at work. Determining and comprehending how people respond to the development of new technology is vital for this reason. The failure or delay in implementing a certain technology can be caused by the low levels of acceptance for that technology. Furthermore, the absence of technological adoption in the healthcare industry may harm some of its main goals.

E-health services are becoming more and more widely available and used. In those with greater medical demands, these services are particularly important. Scientific methods can be a crucial tool for identifying trends in medical research that would not be obvious using conventional approaches to analyzing the medical literature (Fang, 2015). Digital medical technology includes, but is not limited to, teleradiology, telediagnosis, electronic health records, and computer-aided diagnosis (CAD). France is an example of a country that invests in and pioneers' electronic health records (Manard et al.) However, the availability of equipment and new technical services in various or specialized healthcare areas reflects the impact of technological progress.

In order to estimate the acceptance of new technologies by healthcare workers, different models have been used throughout the years. Even though it goes back several years and wasn't initially designed to be applied in the context of remote care technologies, the Technology Acceptance Model (TAM) is nevertheless useful and utilized to forecast the adoption behavior of remote care technologies by health professionals. However, the results of recent research indicate that TAM's predictive potential in the healthcare industry may be less than it has been in other fields. Holden and Karsh suggest that the issues may stem from the various definitions and interpretations of TAM constructs used in health IT studies, particularly the attempts to replace

the TAM construct of personal productivity as a measure of usefulness with the quality of care.

2.4. Doctors' perceptions of new technologies in healthcare

By considering the rapid development and expansion of digital technologies and the ever-growing technological integrations in the healthcare sectors, previous literature longly investigate both doctors' and patients' perception of such advances. By focusing on doctors' perception, literature tried to shed light on how the technological-related changes in healthcare workers' influenced their attitudes, and consequent behaviors. Most of these studies focused on doctors' and medical students' knowledge, experience, attitude and beliefs related to AI and aimed to determine whether these characteristics are required and whether they can be sufficiently configured to be related with behavioral goals to apply AI in future medical practice.

Many of these results demonstrate that the intention to when doctors have a strong individual belief in the role of technology (individually necessary condition). Combinations of knowledge and experience, attitudes and beliefs, academic level and gender, are always associated with high intentions to use artificial intelligence and digital technologies (equifinal and sufficient configurations) but can be associated with nonhigh intentions profiles as well.

By analyzing different qualitative and quantitative researches that aimed to determine doctor's intention to use digital technologies in healthcare, the first thing that was observed was the similarity in the variables used. It was confirmed that the two explanatory variables that had the greatest influence on the likelihood of using telemedicine were "perceived usefulness for reducing

costs associated with clinical practice" and "the interest of the medical staff in using telemedicine.

According to the different studies that utilized said variables, the statistical significance of these two driving elements highlights the significance of perceived utility when justification for technology use is required. The doctors at the healthcare facility specifically valued telemedicine's ability to lower costs and its value to the medical industry.

The importance of lowering costs connected with clinical practice may be explained by the necessity to optimize costs in a context of economic crisis, healthcare cost containment, and health service cuts. Network effects, which are essential for the adoption of any technology, may also be responsible for the finding regarding the interest of the medical personnel in telemedicine.

However, other common variables between the studies have been demonstrated to not be as influential. In fact, neither the "perceived value of telemedicine in raising the standard of clinical practice" nor the "perceived usability of ICTs in clinical practice" were discovered to be statistically significant.

In this regard, telemedicine was seen as a technology that lowers expenses rather than raising standards. It is possible to hypothesize some plausible argumentations for this particular result.

Possibly, aging population and an increase in the prevalence of long-term diseases are currently placing a strain on health systems. These elements work together to significantly raise the demand for care and put increasing pressure on the limited healthcare resources, together with rising healthcare expectations in a political environment of reduced healthcare funding.

It is also important to note that in the studies analyzed, many of the doctors had expertise using ICTs because they were under 40 years old on average and had been in their positions for an average of 13 years. Since

telemedicine has a favorable effect on service quality, they were specialists in respect to the prospective use of ICTs.

Moreover, increasing the use of telemedicine should go beyond the strictly technological aspect, according to empirical research. Instead, it is important to take into account contextual, organizational, professional, and social variables.

However, beyond these preliminary findings resulting from the combination of results of various researches, it is essential that future research be compared with other samples of doctors who use telemedicine, particularly a comparative study of the public and private sectors, and should also extend the ex-ante model to an ex-post model to examine how the determinants of telemedicine use affect clinical practice outcomes.

Source	**Healthcare setting**	**Method (sample)**	**Variables involved in the study**	**Main findings**
Saigi-Rubió et al. (2016)	Determinants of the intention to use telemedicine: evidence from primary care physicians	Quantitative (398 medical professionals)	Perceived usefulness; Perceived ease-of-use; Physician's perception of telemedicine; Subjective norm; Physician's relationship	The findings showed that the doctors at the healthcare facility gave more weight to telemedicine's potential to lower costs and its value to the medical profession. The second explanatory factor, in terms of

			with ICTs as a user in his or her personal life	relevance, was the patients' propensity for telemedicine and their perceptions of medical information security and confidentiality. A third set of moderating effects would seem to support the significance of the doctors' personal judgments.
Wrzosek et al. (2020)	Doctors' Perceptions of E-Prescribing upon Its Mandatory Adoption in Poland	Quantitative (144 participants)	Performance expectancy; Effort expectancy; Social influence; Facilitating conditions; Gender, sex and experience as external determinants likely to influence their response	The survey's findings show that physicians do not think e-prescribing increases the effectiveness of their profession. Additionally, the participant's age has no bearing on this attitude. Regarding the impact of societal attitudes, we also discovered that doctors hardly ever take other people's perspectives into

				account when performing their duties.
Melas et al. (2011)	Modeling the acceptance of clinical information systems among hospital medical staff	Quantitative (604 medical staff)	ICT feature demands; ICT knowledge; Perceived usefulness; Perceived ease of use; Attitude towards use; Behavioral Intention to use	The results show that TAM predicts a substantial proportion of the intention to use clinical information systems.
Saigí-Rubió et al. (2021)	Primary care professionals' intention to use digital clinical consultations (eConsulta) in the post-COVID-19 context	Mixed qualitative and quantitative research (questionnaire)	Perceived benefits; Environmental pressure; Experience of technology; Degree of eConsulta implementation	The COVID-19 pandemic had considerably enhanced the adoption and use of eConsulta, and the majority of healthcare professionals were happy with its use in practice and intended to adopt it into their practices in the post-COVID-19 environment.

lhashmi et al. (2019)	Implementing Artificial Intelligence (AI) Projects in the Health Sector	Quantitative (53 participants)	Perceived ease of use; Perceived usefulness	The outcome of this questionnaire illustrated that managerial, organizational, operational and IT infrastructure factors have a positive impact on (AI) project implementation
Wagner et al. (2023)	Understanding Prospective Physicians' Intention to Use Artificial Intelligence in Their Future Medical Practice AIHTs: Artificial technology-based health technologies	Quantitative (322 participants)	Individual background (gender, academic level); Knowledge of and experience with AI (familiarity with AIHTs and experimentation with AIHTs); Behavioral Intention with regards to AI (intention to use AIHTs in future	The results demonstrate that the intention to use artificial intelligence (AI) is only observed when students have a strong belief in the role of AI (individually necessary condition); specific AI profiles are always associated with high intentions to use artificial intelligence (equifinal and sufficient

			medical practices); Attitudes and beliefs in regards to AI (importance of AIHTs in medical curriculum and role of AIHTs in future medical tasks) (Figure 4)	configurations); and profiles associated with nonhigh intentions can be identified by a combination of knowledge and experience, attitudes and beliefs, and academic level and gender.

Table 1: The table summarized six different studies analyzed in order to better grasp doctors' current intention to use digital technologies in healthcare, as well as to give a general idea on the perception's development in recent years.

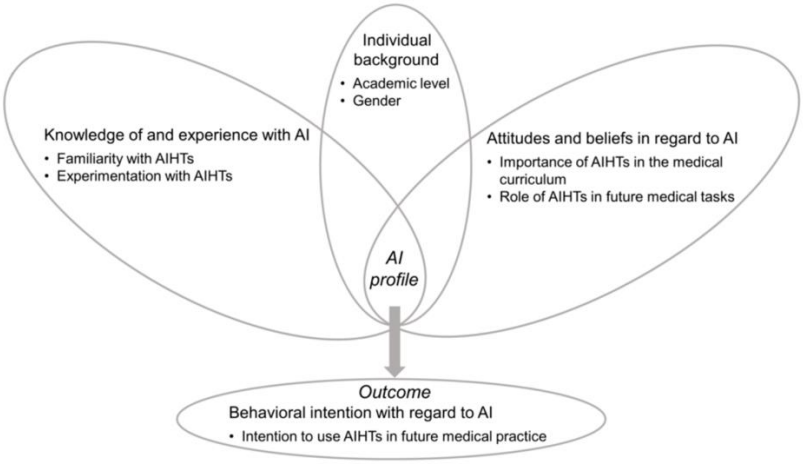

Figure 4: Configurational model of prospective physicians' behavioral intention with regards to artificial intelligence (AI).

Source: Wagner et al., 2023

After a close analysis of these previous studies we are now concerned on how doctors are today perceiving the Metaverse in the healthcare sector. We intend to gather our information through a thorough investigation conducting a qualitative research.

Chapter 3. Methodology

3.1. Qualitative Research

This study explores the unrealized potential of metaverse applications in healthcare from a clinician's perspective: More specifically, in the attempt to answer to the RQ1, we would like to shed light on doctors' perception of the current opportunities enabled by the Metaverse (as a technology) in the healthcare sector.

Thus, we would like to capture their perceptions in terms of benefits, drawbacks, restrictions, and difficulties associated with the implementation of the metaverse in actual clinical practice in the outside world, as the study draws attention to the area's exponential transformation.

The study will follow a qualitative research imprint. In a qualitative study, "research design should be a reflexive process operating through every stage of a project" (Hammersley & Atkinson, 1995, p. 24). The process consists of gathering and evaluating data, creating and revising theories, expanding or refocusing research topics, and recognizing and addressing validity risks typically occur more or less concurrently, each activity having an impact on the others (Belk et al., 2003).

A qualitative research looks at actual issues and offers more in-depth understandings. It aids in the generation of hypotheses as well as the further investigation and understanding of quantitative data, as opposed to gathering numerical data points or intervening or introducing treatments as in quantitative research. In qualitative research, participants' experiences, viewpoints, and

actions are gathered. Instead of addressing “how many”s or “how much”s, it addresses “how”s and “why”s. It might be set up as an independent study that just uses qualitative data, or it might be a component of mixed-methods research that uses both qualitative and quantitative data.

There is no doubt that qualitative data can be quantified, but at its core, qualitative data seeks themes and patterns that can be challenging to quantify. It is crucial to avoid losing the context and narrative of qualitative work by attempting to quantify unsuitable data.

3.2. Structure of the Research

The investigated sample consisted of 20 participants (specifically ten resident medical doctors, and ten young medical doctors)., In particular, the reasoning behind the selection of the candidates is to have a wide enough range of individuals in terms of age, gender and medical specialization in order to comprehend exactly how the Metaverse, as well as other digital technologies, are today viewed by different categories of healthcare workers.

By interviewing both doctors and interns we hope to identify some differences in the responses given that will allow us to have a general understanding on how the approach to digital technologies will evolve in the near future as well as how it is perceived today.

3.3. Methodology for Data Collection and Analysis and Sample

We used semi-structured one-on-one interviews as a component of us exploratory research design in order to gather perspectives, meanings, and recommendations from the participating participants (Daymon and Holloway,

2011). In order to better understand a specific and constrained phenomenon in its context and to identify current problems and opportunities, the research was conducted using the case study methodology (Corbin and Strauss, 1990). As a case study, we specifically investigate medical doctors' perception of Metaverse-based healthcare services. Finally, by exposing the case to additional research, this strategy helped to develop a theoretical framework that is relevant to other circumstances.

Purposive sampling, in line with the phenomenological approach, was employed to select the participants after earlier study (Teddlie and Yu, 2007). According to participants' prior exposure to the topic under study, participants were chosen (Groenewald, 2004). In fact, the study participants had a history relevant to the subject at hand. To shed light on present problems and opportunities resulting from such a revolutionary process, we used in-depth qualitative analysis to examine doctors' opinions of the digital shift. According to the principles of qualitative research, we found the use of in-depth interviews to be beneficial because it allowed us to thoroughly examine a contemporary phenomenon in its actual setting (Belk et al., 2012), particularly when the distinctions between phenomenon and context may not be obvious (Yin, 2014).

Since it is helpful to concentrate on questions, themes, and lines of inquiry to pursue, the method based on semi-structured interviews was chosen in particular (Daymon and Holloway, 2010). In this method, the questions are asked in a random order that depends on the participants' responses, revealing itself to be highly flexible and capable of generating previously unconsidered insights.

Twenty semi-structured face-to-face interviews with twenty Italian doctors working at various hospitals were used to gather the data, according to Martin and Eisenhardt (2010). The interviews were planned in accordance with

a defined protocol that consistently changed throughout the investigation. The English translation and exact transcription of each interview.

Specifically to take note about the interviews, we built a survey by using the Qualtrics platforms: The interview consists into two sections. The first one (consisting of three questions), was aimed to collect participants' personal information concerning the candidate (related to the basic sociodemographic data in terms of age and sex, together with their specialization in the medical field); The second one (consisting of eight questions), was aimed to capture the insights useful to answer the proposed research questions.

All questions of the survey are open-ended questions, therefore there will be no multiple-choice answers (except for 1 question), but instead it will be up to the candidate to answer as in-depth as they feel. By giving candidates the freedom to answer with as many details as possible and as sincerely as they can, we hope to not limit the possibilities of answers and views on the subject proposed.

Potential informant bias was prevented in a several ways, including anonymizing the involved managers to encourage them to speak openly and honestly (Eisenhardt, 1989a, 1989b), collecting extensive archival and observational data to supplement the participants (Leonard-Barton, 1990; Ozcan and Eisenhardt, 2009), and collecting longitudinal data in real time and retrospectively in multiple waves. Last but not least, in keeping with the methodology used (Belk et al., 2012), the questions were left open-ended (Koriat et al., 2000).

After compiling the responses from all of the chosen participants, we assigned a random progressive code to each participant (from 1 to 20) to each statement, along with a letter to denote the participant's gender ("M" = Male;

"F" = Female), age, and gender. Finally, the emergent findings have been organized coherently and comprehensively (Bansal et al., 2001).

From the emerging constructs and themes, tentative relationships between constructs were formed, in the attempt to systematize the emerging contents in a coherent manner: Then these initial relationships were refined via replication logic-frequently revising each case to compare and verify occurrence of specific construct, relationships, and logics (Ozcan and Eisenhardt, 2009).

Thus, as a part of our analysis, researchers cycled among the emergent theory, case data, and literature to further refine the emerging construct definitions, to finally converge on a parsimonious set of insights, focusingly only on the most robust findings (Andriopoulos and Lewis, 2009).

Chapter 4. Results

The study has proven to be significant in terms of recognizing doctors' perception of digital technologies in the workplace nowadays.

The first interesting result was observed in regards to what doctors perceive the role of technologies to be in healthcare. All participants to the questionnaire answered extremely similarly, emphasizing how technologies cover a crucial and fundamental role in the healthcare sector. In the opinion of the entirety of participants, healthcare and technology should proceed hand in hand, as technologies help facilitate diagnoses and enhance the efficiency of clinical treatments.

However, this extremely significant result was interestingly contrasted by a second observation. When asked if they had ever used new technologies in the workplace, almost 50% of participants answered that they had never been first hand users of technologies for work purposes.

After introducing digital technologies in general, a brief description of the Metaverse was given and participants were then asked if they had heard of the term before. The answers given were mostly positive, in fact 75% of doctors stated they had previously come into contact with the word, while only 25% said they had not heard of the term before.

Subsequently, the idea of a virtual hospital was proposed to the participants, who were asked how they imagined it to function. The answers in this matter were particularly heterogeneous. Some doctors reveled to be extremely open-minded and optimist on the proposed subject, hypothesizing that a virtual hospital would help reduce timing as well as to better the quality of life of patients that need continuous checkups. On the other hand, the other

half of the participants were highly reluctant, mostly stating that they were not able to imagine or hypothesize a functioning virtual hospital.

After exposing the participants to the idea of a virtual healthcare service, they were asked to state their general perception in regards to how the Metaverse could fit in the healthcare sector. While a small percentage of doctors answered positively, a larger number of participants expressed some concerns. Interestingly, no doctor openly stated they had a negative perception per se of the Metaverse in healthcare, however many affirmed they knew too little on the matter to express a definitive opinion. Some stated that the idea was still too distant to be considered concretely and that the knowledge on the subject was too limited among doctors, therefore they were unable to gather enough information to answer properly. The questionnaire then proceeded to ask participants whether they imagined a way in which the Metaverse could contribute to the delivering of healthcare services. During this particular part of the study, some interesting results were observed. Most doctors were not only able to answer, but proceeded to hypothesize different and rather variegated uses for the Metaverse in healthcare. A theme commonly proposed was the fact that the Metaverse would enhance faster and more complete interactions between clinics, diagnostics and therapeutic application, as well as help in surgical formation and simulations. Different doctors also envisioned the Metaverse as a way to monitor intake and correct dosage according to the patient's needs. Lastly, the idea of overcoming issues related to physical distance emerged in several answers, as doctors stated that the Metaverse could be a useful tool to help patients reach healthcare services while in geographically challenging areas.

Subsequently, participants were asked to predict what should be some of the most useful skills for future doctors to have and extremely curious answers were observed. In fact, all participants answered rather similarly, however none of them reported any “emotional” skills, but rather focused on digital skills and stated that future doctors should be able to capably manage new technologies.

To conclude the open answered questions, doctors were then asked to hypothesize how the doctor-patient relationship would be effected by the advent of the Metaverse and other digital technologies, and how they thought such relationship might change. Once again, answers varied and were rather equally divided between positive and negative perceptions. For those who answered positively, the relationship between doctor and patient could become more “personal” in some ways, as the Metaverse would be a means to better connect individuals. For those however who answered negatively, the concern lies around the fact that a good relationship between doctor and patient is already quite difficult to obtain, therefore they have reason to believe that interacting through digital platforms such as the Metaverse could make the building of such a relationship even more difficult. A doctor's work is considered very "human" in many aspects, made up of perceptions and based on a continuous and constructive dialogue useful for both diagnosis and therapy. This is why some doctors’ main preoccupation is that the metaverse might create more detachment and take away an important part of their work.

The table below reports all answers given by participants, who were coded from R1 (respondent 1) to R16 (respondent 16).

	What role do technologies hold in healthcare?	**Has the participant used technologies in the workplace before? If so, which ones?**	**Before this brief description, had you ever heard of the Metaverse?**	**How does the participant imagine a functioning virtual hospital or the delivering of a healthcare service based on the Metaverse?**
R1	Fundamental and constantly updated	Advanced imaging, teleconsult	yes	Rather positively
R2	Technology and healthcare must go hand in hand	Not in first person, I have seen telemedicine visits made by other colleges	no	It allows to reduce timing, improve the quality of life of patients who have to carry out repeated checks, even if they are used to having patients live, it could make them lose sight of something
R3	Fundamental (and growing) in the prevention, diagnosis and treatment of pathologies.	No	yes	At the moment, worrying
R4	priority	only computer programs for the pc	yes	to improve diagnostics and subsequent timely intervention

R5	Facilitate procedures and make them more accurate and faster, improve the clinical efficacy of treatments.	I take 3D intraoral scans at every visit treatment plans are imposed with digital workflow for orthodontics and prosthetics	yes	Effective only in a few cases and with strong limitations
R6	They play a pivotal role in the clinical-diagnostic evaluation	no	yes	I can't imagine it
R7	essential, they serve to help in the diagnosis and to reduce waiting times	in general medicine the new technologies would be in the field of telemedicine, e.g. an ecg reported online by a cardiologist, without necessarily being present. unfortunately to date nothing like this still exists, at least in the region where I live	no	a set of instruments that the patient may have available at his or her home or in a residential or semi-residential facility, where they are adequately educated in the correct use of the instrument which will then be interpreted and evaluated by the doctor remotely with the possibility of interfacing with other colleagues specialists
R8	Central	Yes. Intraoral scanner, 3D CT, digital orthopantomograph, CAD-CAM technology	yes	I would not know

R9	Technologies are the future of the healthcare profession	Telemedicine	yes	allow the patient to be evaluated and monitored without having him moved from the territory of residence
R 10	Important	no	yes	I can't imagine it because I don't understand how the virtual dimension can allow for visits or examinations (instrumental, laboratory, etc.), or diagnostic or therapeutic maneuvers
R 11	They play an essential role, as they are able to enhance and sometimes allow the implementation of otherwise impracticable rehabilitation strategies from scratch	In the rehabilitation of deafness	no	Like a world full of potential, but at the moment of imminent implementation not conceivable
R 12	Fundamental	Telemedicine	yes	Not very effective
R 13	Increased diagnostic sensitivity and specificity, reduced diagnostic times, increased	I've never had a chance to use them.	yes	I imagine the possibility of remote patient assistance; exercises in the surgical field

	precision and reduced invasiveness of surgical procedures, improved learning curve when used in teaching			for the doctor in training.
R 14	Relevant as it shortens working times	Digitization, 3d printers	yes	Interesting hypothesis
R 15	Very relevant	Yes, especially for the medical diagnostic phase	yes	I imagine it with admiration but also with concern
R 16	Fundamental	no	yes	I imagine the possibility of providing healthcare services, even of a high level, even in areas that are difficult to reach

	What is the participant's perception of the Metaverse as a technology used in the healthcare sector?	**How could the Metaverse contribute to deliver treatment?**	**Which are some of the new skills that will be required from future doctors considering the technological development?**	**How does the participant imagine the doctor-patient relationship might change with the advent of the Meaverse and other virtual reality technologies?**
R1	positive	especially in training and surgical simulation	Advanced familiarity with digital methodologies.	Reduction, maybe in a negative way, of the relationship and possibile difficulties in managing patients in terns of diagnosis and cure.
R2		It seems a reality that is still very distant, perhaps even difficult to accept		We need to be open to new technologies... I find that getting used to this new reality is difficult both for us and for the patient but that good results can be obtained with collaboration
R3	To be explored	At the moment I don't see any applications, considering the human relationship fundamental in laying the foundations for an effective therapy	Greater technological skills (possible introduction of specific lessons in the degree course)	Getting worse, as taught by the advent of Doctor Google
R4	still far behind in implementation	through faster and more complete interactions between clinics, diagnostics and therapeutic application	application in all medical fields	for the better, speeding up and completing all the data for possible

				medical-surgical solutions
R5	Something very innovative that could only have real use if perfected	Facilitating them by shortening the distance between clinician and patient whenever possible	Experience with video games, understanding and regular use of computers and smartphones, knowledge of the internet	It could become (sometimes too much) more personal and less formal
R6	I am very wary. I find it useless in some respects, helpful in others	I don't know how it could help	Knowing how to help and involve patients in the use of new technologies.	Nowadays it is really difficult to create a good doctor-patient relationship. I believe that the metaverse understood as a virtual world made up of avatars can make the construction of this relationship even more difficult. The doctor's work is very "human" also made up of perceptions and based on a continuous and constructive dialogue useful for both diagnosis and therapy. I'm afraid the metaverse might create more detachment and take away an important part of our work

R7	that it is essential to ensure effective and adequate care at home for the patient given the large amount of work that awaits us in the health sector due to the aging of the population	through a reminder system for the patient about taking the therapy	a good knowledge of the computer, but having almost modernized the old system in medicine, let's say that it is now difficult to find doctors who do not know how to use a PC or a tablet or a smartphone	unfortunately there will no longer be that vis-a-vis relationship to which we were used to, but it is the only way to guarantee everyone the necessary care in the shortest possible time, where obviously televisitation is possible
R8	It doesn't convince me much	I would not know	Telematic visits	I would not know
R9	positive	ensure intake and correct dosage according to the patient's needs	familiarity with technology, knowing how to communicate with the patient in a functional way with the virtual tool	it should provide greater guarantees to both the patient and the operator
R 10	I don't have a perception about it, because I can't think of concrete examples of use in healthcare	I would not know. I can't imagine a different modality from the one already existing with whatsapp, that is to say from the therapies provided by telephone	Critical thinking, because the risk is that it will be replaced by the "thinking" of Artificial Intelligence	I fear the "human" dimension of the doctor-patient relationship may be lost in favor of a "depersonalized" relationship
R 11	As a tool at the service of the doctor, who however must continue to master the	Through the possibility of reaching patients in distant realities and allowing greater adherence/compliance to the proposed treatments	Skills in biomedical engineering and programming	The goal of technology is to assist and implement, not replace, the direct doctor-

	"hands on" skills			patient relationship
R 12	Not very effective	Not in surgery	I would not know	Positively only in some clinical areas
R 13	positive	By increasing the availability of treatments even at a distance, therapeutic adherence to treatments would increase	Use of computer software	Better compliance with therapies
R 14	I don't know enough to make a judgment	I would not know	A capacity for vision that includes physical psychological health and overall well-being of the patient! Digital skills	For the better
R 15	Probably useful	I don't imagine how	Advanced skills in the digital world	I fear it could get worse
R 16	Like a fundamental help to the medical profession	If used with caution, very useful	I think the study and use of new technologies should be taught in the university curriculum	It would certainly bring the doctor much closer to the patient

Chapter 5. Discussions and Implications

This study attempts to provide a somewhat accurate prediction on the how the Metaverse can contribute to telemedicine and other healthcare activities. Specifically, this paper focuses on doctors' perception of digital technologies in the healthcare sector. Previous studies acknowledge that, provided the overall growing technological development, the healthcare sector has been increasingly adapting to digital technologies used in the workspace. However, the attempt of this research is not only to analyze how the healthcare sector is evolving in terms of new technologies, but also to get a clearer view on how medical staff, in particular doctors, perceive this development. To do so, a series of in person interviews have been sent into place, in order to allow doctors to express both opinions and concerns from which the study hopes to revel future trends of technological adaption in healthcare.

As per the results previously discussed, some interesting topics of discussion have emerged from the answers given by the medical staff interviewed. These topics are the result of combining different answers as well as giving personal inputs on the possible motivations behind each answer.

5.1. New technologies as enabler factors to reshape the healthcare services.

The first topic of discussion concerns the general perception of technologies in healthcare. The study has provided some significant insights concerning the current view that doctors hold in regards to technologies. Interestingly enough, all participants answered that technologies hold a central role in healthcare.

For instance, one participant stated that: "They play a pivotal role in the clinical-diagnostic evaluation" (R6, M, 28 years old), while another reported:

"Fundamental (and growing) in the prevention, diagnosis and treatment of pathologies." (R3, F, 37 years old)

From what the study was able to gather from participants' answers to the questionnaire, it is safe to state that technologies play a fundamental part in the practice of medical professions. All participants agreed on the importance of new technologies in the workplace and affirmed that the development of healthcare is most likely to go hand in hand with the development and emerging of new technologies. In fact one respondent affirmed that: "Technology and healthcare must go hand in hand" (R2, F, 42 years old)

This implies that new technologies can be seen and considered as enabling factors to transform and reshape healthcare services. With the growth and continuous expansion of digital based technologies, the healthcare sector is predicted to evolve consequently, increasingly revolutionizing the way services are delivered, as technologies often facilitate procedures and make them faster and more accurate, improving the clinical efficacy of treatments. Technologies also play an essential role as they are viewed in the healthcare sector as a way to enhance the implementation of rehabilitation strategies, as stated by another respondent: "They play an essential role, as they are able to enhance and sometimes allow the implementation of otherwise impracticable rehabilitation strategies from scratch" (R11, F, 42 years old)

5.2. Metaverse and medical fields.

The second topic of discussion that emerged from observing results of the research was related to the relationship between responses and medical fields. To better explain, an interesting observation was made in regards to the fact

that doctors belonging to the same field of specialization did not necessarily give similar answers nor did they state similar concerns.

While first conducing the research, a hypothesis was made in terms of possible similarities in answers solely based on previous studies and common sense, and a relationship was predicted to exist between respondent's medical field of specialization and their propensity to adopt new technologies in the workplace. However, results ultimately denied such hypothesis, since several doctors from the same medical field often answered rather differently in terms of perception of the Metaverse and, more in general, propension to the use of digital technologies. For example, multiple doctors that participated to the questionnaire were specialized in otolaryngology, however their responses in regards to the Metaverse were divergent and often incompatible. In particular, when asked about their general perception of the Metaverse in healthcare, a few participants resulted reluctant, stating that they were still diffident on the matter. For instance, one respondent affirmed: "At the moment, worrying" (R3, F, 37 years old) while another stated: "not very effective" (R12, M, 67 years old).

On the other hand, others resulted optimists and affirmed that they had an overall positive perception of the Metaverse. For example, one doctor stated: "I imagine the possibility of providing healthcare services, even of a high level, even in areas that are difficult to reach" (R16, M, 63 years old) and another said: "I imagine the possibility of remote patient assistance; exercises in the surgical field for the doctor in training" (R13, F, 35 years old)

This result was particularly interesting as it shed light on the fact that perception does not depend on specialization but more so on the personal approach of the single doctor to technologies. This bring us to believe that there is no one medical field which is likely to be more propense to the adoption of the Metaverse than others.

However, by analyzing results, another interesting observation concerning medical fields was made. In fact, it is now our general understanding that doctors mostly agree on the fact that the Metaverse will be less useful in surgical than in clinical cases. This was confirmed by the fact that surgeons were observed to be the most reluctant on the topic, while other specialists such as pediatricians or radiologists were clearly more propense to the idea of partially transferring their work on digital platforms.

5.3. Metaverse and doctors-patients relationship maintaining.

Another particular topic of discussion that came to light after analyzing results of the questionnaire concerned the doctor-patient relationship in the Metaverse. Such relationship is considered to be particularly difficult to create and maintain. The medical profession is in some ways a rather "human" profession, as it requires a great amount of compassion and empathy, as well as the technical skills. The doctor-patient interaction is also impacted by a variety of organizational or system elements. Along with appropriate waiting periods and attention to individual comfort, the accessibility of staff members, both administrative and clinical, and their level of civility give patients the impression that they are valued and appreciated. A sense of security is aided by the availability of covering nurses and medical professionals. A caring and concerned atmosphere is created via reminders and user-friendly teaching materials.

Introducing such relationship to the Metaverse could surely have an important impact on its balance, and not everyone is equally optimist on the possible outcomes. Some participants were partially reluctant on the matter, stating that getting used to this new reality would be difficult both for the doctors and for the patient. One participant stated that: "We need to be open to new

technologies... I find that getting used to this new reality is difficult both for us and for the patient but that good results can be obtained with collaboration" (R2, F, 42 years old). Some even reported that they imagine the relationship to worsen. One participant affirmed: "Reduction, maybe in a negative way, of the relationship and possibile difficulties in managing patients in terns of diagnosis and cure." (R1, M, 55 years old).

Other doctors resulted more optimist, hypothesizing that the relationship might evolve for the better. Someone stated: "The goal of technology is to assist and implement, not replace, the direct doctor-patient relationship" (R11, F, 42 years old).

Other particpicants affirm that new technologies such as the Metaverse might be helpful in terms of accelerating timing and tata processing. One participant reported: "It would change for the better, speeding up and completing all the data for possible medical-surgical solutions" (R4, F, 60 years old)

In the opinion of some interviewed professionals, transferring the relationship into the virtual world would certainly bring the doctor much closer to the patient. In fact, one participant responded that: "it should provide greater guarantees to both the patient and the operator." (R9, M, 65 years old)

These results are particularly interesting as they highlight the fact that technology does not necessarily mean greater distance from one another, but in contrary it could also be a helpful tool to help people connect, and this goes for doctors and patients as well.

5.4. Metaverse as a booster for telemedicine purposes.

Any medical practice including a distance component falls under the broad definition of telemedicine. It dates at least as far as the usage of ship to shore radio for providing medical advice to sea captains in its popularly accepted definition, in which a doctor-patient contact involves telecommunication. In order to replace direct face-to-face interaction between a healthcare provider and a patient, telemedicine is thought of as an integrated system of healthcare delivery. It has the ability to solve issues with healthcare that seem insurmountable, such as limited access to care for certain populations, especially those who are geographically disadvantaged, uneven care quality, and cost inflation. Its true merit has yet to be discovered through methodical empirical research. However, results from our analysis demonstrated that more than a few medical professionals have already interacted with telemedicine and are familiar with the topic.

"Telemedice" (R9, M, 65 years old; R12, M, 67 yeard old)

This has led us to believe that the Metaverse could also be considered as an implementation tool, acting like a booster to enforce the use of telemedicine and other digital based health services.

5.5. Lack of knowledge and new medical skills.

The fifth topic of discussion worth mentioning concerns the lack of knowledge in terms of technologies in the current healthcare sector. An interesting link between lack of knowledge and skepticism was found in observing results. Most participants who answered negatively on the general perception of the Metaverse, then stated that they were not able to imagine concrete application of the virtual platform in healthcare. For example, one

participant reported: “I can't imagine it because I don't understand how the virtual dimension can allow for visits or examinations (instrumental, laboratory, etc.), or diagnostic or therapeutic maneuvers” (R10, M , 41 years old)

Therefore, a plausible hypothesis is that the general hesitation could be a consequence of simply not being well informed on the subjects.

In general, the adoption of new technologies by older persons lags behind that of younger ones, although they will do so if they seem to have value, such as preserving their quality of life (Heinz et al., 2013). The results of previous studies have already connected the low propensity to adopt technologies to a lack of information (Vaportzis et al., 2017), and, as shown by our research, this goes for doctors as well.

In fact, with the growing development of digitalization in all work areas, all participants agreed on the fact that future doctors should be able to capably manage technologies and have necessary skills to adapt to such a development. All medical professionals in the future should know how to help and involve patients in the use of new technologies. They will be required to have familiarity with technology, and to know how to communicate with the patient in a functional way through the virtual tool.

When asked what are the skills that future doctors will be required to ask, one participant answered: “Advanced familiarity with digital methodologies (R1, M, 55 years old) while another stated: “Knowing how to help and involve patients in the use of new technologies. (R6, M, 68 years old).

5.6. Metaverse future issues and opportunities

The last topic of discussion concerns the future opportunities and limits that the Metaverse could encounter in the healthcare sector. By observing results, a common theme was repeatedly encountered: the Metaverse as a way to reduce distance and accelerate timing. In the opinion of most of the participants, the use of the Metaverse in healthcare would help to reduce timing and allow the patient to be evaluated and monitored without having him moved from the territory of residence. It would mean having faster and more complete interactions between clinics, diagnostics and therapeutic application.

One participant affirmed that: “By increasing the availability of treatments even at a distance, therapeutic adherence to treatments would increase (R13, F, 35 years old), while another stated: “ Through the possibility of reaching patients in distant realities and allowing greater adherence/compliance to the proposed treatments” (R11, M, 42 years old).

Furthermore, by increasing the availability of treatments even at a distance, therapeutic adherence to treatments would increase.

Another significant observation concerned a new way in which the Metaverse was thought to be useful at the eyes of some doctors. A few participants in fact stated that they believe the virtual platform could be an essential tool of monitorization. For instance, one doctors stated: “through a reminder system for the patient about taking the therapy” (R7, M, 38 years old)

It would give doctors the possibility to ensure intake and correct dosage according to the patient's needs, as well as to easily monitor patients who have to carry out repeated checks.

The table below reports and summarizes the different topics discussed, providing proof through “quotas” given by doctors during the interviews, for the considerations that were made during the discussion. For each topic, a series of answers belonging to different questions were clustered and classified to fit the topic.

Topic 1. New technologies as enabler factors to reshape the healthcare services.	**Topic 2. Metaverse and medical fields.**	**Topic 3. Metaverse and doctors-patients relationship maintaining.**	**Topic 4. Metaverse as a booster for telemedicine purposes.**	**Topic 5. Lack of knowledge and new medical skills.**	**Topic 6. Metaverse future issues and opportunities**
"Fundamental and constantly updated”		“Reduction, perhaps even negative, in the doctor-patient relationship and possible difficulty in managing the patient in terms of diagnosis and treatment”	“Not in first person, I have seen telemedicine visits made by other colleges”	“At the moment I don't see any applications, considering the human relationship fundamental in laying the foundations for an effective therapy”	“It allows to reduce timing, improve the quality of life of patients who have to carry out repeated checks, even if they are used to having patients live, it could make them lose sight of something”
“Technology and healthcare must go hand in hand”		“We need to be open to new technologies. .. I find that getting used to this new reality is	“In general medicine the new technologies would be in th field of telemedicine, e.g. an ecg	“I don't know how it could help”	“Allow the patient to be evaluated and monitored without having him moved from the territory of residence”

		difficult both for us and for the patient but that good results can be obtained with collaboration ”	reported onlin by a cardiologist, without necessarily being present. unfortunately to date nothin like this still exists, at least in the region where I live”		
“Fundament al (and growing) in the prevention, diagnosis and treatment of pathologies. ”		“Getting worse, as taught by the advent of Doctor Google”	“Telemedici ne”	“I would not know”	“I imagine the possibility of remote patient assistance; exercises in the surgical field for the doctor in training.”
“Priority”		“For the better, speeding up and completing all the data for possible medical-surgical solutions”	“Telemedici ne”	“I would not know. I can't imagine a different modality from the one already existing with whatsapp, that is to say from the therapies provided by telephone”	“I imagine the possibility of providing healthcare services, even of a high level, even in areas that are difficult to reach”
“Facilitate procedures and make them more accurate and faster,		“It could become (sometimes too much) more	“Not in first person, I have seen telemedicine visits made	“I don't imagine how”	“Especially in training and surgical simulation”

improve the clinical efficacy of treatments".		personal and less formal"	by other colleges"		
"They play a pivotal role in the clinical-diagnostic evaluation"		"Nowadays it is really difficult to create a good doctor-patient relationship. I believe that the metaverse understood as a virtual world made up of avatars can make the construction of this relationship even more difficult. The doctor's work is very "human" also made up of perceptions and based on a continuous and constructive dialogue useful for both diagnosis and therapy. I'm afraid the metaverse might create more detachment and take away an important part of our work"	"In general medicine the new technologies would be in the field of telemedicine, e.g. an ecg reported online by a cardiologist, without necessarily being present. unfortunately to date nothing like this still exists, at least in the region where I live"	"I can't imagine it because I don't understand how the virtual dimension can allow for visits or examinations (instrumental, laboratory, etc.), or diagnostic or therapeutic maneuvers"	"Through faster and more complete interactions between clinics, diagnostics and therapeutic application"

“Essential, they serve to help in the diagnosis and to reduce waiting times”		“Unfortunately there will no longer be that vis-a-vis relationship to which we were used to, but it is the only way to guarantee everyone the necessary care in the shortest possible time, where obviously televisitation is possible”	“Telemedicine”	“At the moment I don't see any applications, considering the human relationship fundamental in laying the foundations for an effective therapy”	“Facilitating them by shortening the distance between clinician and patient whenever possible”
“Central”		“I would not know”	“Telemedicine”	“I don't know how it could help”	“Through a reminder system for the patient about taking the therapy”
“They are the future of the healthcare profession”		“It should provide greater guarantees to both the patient and the operator”	“Not in first person, I have seen telemedicine visits made by other colleges”	“I would not know”	“Ensure intake and correct dosage according to the patient's needs”
“Important”		“I fear the "human" dimension of the doctor-patient relationship may be lost in favor of a "depersonalized" relationship”	“In general medicine the new technologies would be in the field of telemedicine, e.g. an ecg reported online by a cardiologist, without necessarily being present. unfortunatel	“I would not know. I can't imagine a different modality from the one already existing with whatsapp, that is to say from the therapies	“Through the possibility of reaching patients in distant realities and allowing greater adherence/compliance to the proposed treatments”

			y to date nothing like this still exists, at least in the region where I live”	provided by telephone”	
“They play an essential role, as they are able to enhance and sometimes allow the implementation of otherwise impracticable rehabilitation strategies from scratch”		“The goal of technology is to assist and implement, not replace, the direct doctor-patient relationship”	“Telemedicine”	“I don't imagine how”	“By increasing the availability of treatments even at a distance, therapeutic adherence to treatments would increase”
“Fundamental”		“Positively only in some clinical areas”	“Telemedicine”	“I can't imagine it because I don't understand how the virtual dimension can allow for visits or examinations (instrumental, laboratory, etc.), or diagnostic or therapeutic maneuvers”	“It allows to reduce timing, improve the quality of life of patients who have to carry out repeated checks, even if they are used to having patients live, it could make them lose sight of something”

“Increased diagnostic sensitivity and specificity, reduced diagnostic times, increased precision and reduced invasiveness of surgical procedures, improved learning curve when used in teaching”		“Better compliance with therapies”	“Not in first person, I have seen telemedicine visits made by other colleges”	“At the moment I don't see any applications, considering the human relationship fundamental in laying the foundations for an effective therapy”	“Allow the patient to be evaluated and monitored without having him moved from the territory of residence”
“Relevant as it shortens working times”		“For the better”	“In general medicine the new technologies would be in the field of telemedicine, e.g. an ecg reported online by a cardiologist, without necessarily being present. unfortunately to date nothing like this still exists, at least in the region where I live”	“I don't know how it could help”	“I imagine the possibility of remote patient assistance; exercises in the surgical field for the doctor in training.”
“Very relevant”		“I fear it could get worse”	“Telemedicine”	“I would not know”	“I imagine the possibility of providing healthcare services, even of

					a high level, even in areas that are difficult to reach”
“Fundamental”		“It would certainly bring the doctor much closer to the patient”	“Telemedicine”	“I would not know. I can't imagine a different modality from the one already existing with whatsapp, that is to say from the therapies provided by telephone”	“Especially in training and surgical simulation”

Chapter 6. Conclusions

The healthcare industry has grown more quickly as a result of the rapid advancements in digitalization and automation, which have produced new models that are opening up new avenues for providing treatment at a lower cost. The Metaverse has enormous potential for the healthcare industry by enabling both patients and medical professionals to have realistic experiences.

Through this study it has been asserted that medical professionals have differing opinions on the future and the impact that the Metaverse will have in the healthcare sector, however the possibility of an advancement of new and digital technologies in the practice of sanitary services is certain. The conducted research has had its limitations, bringing attention to the fact that even individuals who are familiar with the use of current technologies frequently experience a steep learning curve as each new model is released due to such a rapid advancement. Many future doctors will need some tech know-how to successfully handle daily activities as the metaverse continues to play an increasingly significant part in healthcare. As a result, it will be crucial to create supports for those who require them, helping individuals cross this new terrain.

Furthermore, while it is commendable that advances in digital healthcare have made it simpler for a larger spectrum of people to get care, it is crucial to take into account the ethical issues they raise. The mere fact that treatment is being delivered virtually does not make issues with public safety, privacy invasion, or prejudice go away. In addition, there have previously been a number of significant lapses in online security and patient privacy. Although the potential for home-based healthcare is encouraging, we must also make sure that technology keeps getting more reasonably priced, that apps are thoroughly examined, and that doctors are expertly educated. As the metaverse develops,

collaboration between service providers, consumers, and lawmakers will be crucial to building a virtual environment that safely engages users all around the world.

For these reasons, our hope for future researches is that they be able to take into account all of the current issues and problematics that the Metaverse yet has to overcome in order to fully develop and make its way into healthcare, as well as any other aspect of our lives.

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