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The integration of metaverse technology in healthcare: a comprehensive review and future research directions

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ABSTRACT

The impact of using the metaverse in healthcare is investigated in this research work. Emerging technologies are essential to enhancing medical consultants' care, especially in developing countries like India. The study filters and reviews the pertinent literature using the scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR) methodology. The initial search yielded 180 articles. Forty-four articles were considered for the study after screening the papers in light of the research questions and relevant literature. The theory-context-characteristics-methodology (TCCM) framework is used in this study to assess future metaverse research trends. This study also used the context, intervention, mechanism, and outcome (CIMO) logic for planning and decision-making. This study examines the development of metaverse research over the past ten years and supports research findings published in peer-reviewed journals. Based on the TCCM framework, recommendations have been made for additional research.

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1. INTRODUCTION

Services related to healthcare have become an essential component in the process of preserving the psychological, bodily, and social well-being of the whole population of the world. This is the primary factor that underlines the vital relevance of this kind of service: healthcare services can lessen the detrimental effects of sickness, damage, and illness while fostering well-being and lifespan. Due to the implementation of digital health services, made possible by the technologies of the internet and digital platforms, significant changes have been brought about in the dynamics of the contact between patients and physicians.

Various transitions occurred, such as augmented reality (AR), Blockchain, and virtual reality (VR) [1]. Even considering the technological progress, different sections like the healthcare industry and other challenges are considered. This different trail includes the burden of various long-lasting health issues, population ageing, insufficient health care persons and the availability of resources. The noteworthy commonness of these concerns has impelled the necessity to afford healthcare amenities straight to individuals within the cosines of their particular living universes.

Interoperability is among the most challenging issues to surmount in healthcare. According to healthcare mandates, an organization must maintain patient data security while sharing it rapidly with different teams [2]. This means that your healthcare organization can share patient information with other healthcare providers around the globe. An outdated information technology (IT) infrastructure is what holds you back in surmounting the challenges of interoperability and data security. Healthcare systems are already straining under the growing burden of bandwidth-intense, connected devices [3].

Experts are optimistic about the emerging trend of the metaverse in the healthcare industry, which is occurring against the backdrop of an increasing demand for digital care in the era following coronavirus disease (COVID). Technology companies, healthcare providers, insurance companies, and makers of pharmaceuticals and medical equipment are among the major stakeholders in the value chain that have already begun driving activities centered on adopting the metaverse. In today's world, medical pictures are visualized on two-dimensional screens slice by slice during the diagnostic process of radiology. Providing better visualization in medical imaging has the potential to increase the value of the study of diseases and the planning of surgical procedures. A more participatory and realistic experience in medicine may be possible because of the capabilities of the metaverse, which include visualization and immersion. The capacity of hospitals to provide treatment for patients is being put in jeopardy due to a need for more nursing assistants, laboratory technicians, and technicians. Using extended reality (XR) capabilities, the metaverse presents a potential answer for telehealth [4]. Health workers' services could be provided from a distance using AR headsets and wearable devices for diagnosis, treatment, monitoring, and care [5]. Immersive therapies refer to the use of AR, VR, or mixed reality to treat, manage, or prevent any medical condition. Cognitive therapy, support groups, psychiatric examinations, and rehabilitation are some of the applications feasible in the metaverse. With the assistance of haptic sensors, physical treatment will also promote the metaverse's development [6], [7].

A digital upheaval is now a pleasing habitation in healthcare production, which is present in the overview of Industry 4.0. This conversion is a captivating place due to embracing technology-based innovations to replace traditional healthcare products. During the COVID-19 period, the healthcare system has advanced the edges of its systems and has faced a few problems that have never been seen before. There is a significant variation in the need for troublesome technologies such as telemedicine and other health units by organizations [8]. During COVID-19, technological advancements have taken so all needs can be fulfilled by using meta-verse. The word meta verse was coined with the addition of various technologies like artificial intelligence (AI) and XR, which provided a significant boon to the virtual environment of the treatment and services. These met-averse technologies provide digital change in the health industry [1].

Several cutting-edge technologies, which have the potential to change digital healthcare practices and improve the quality of virtual healthcare services, are principally responsible for this. These technologies have been included in the system. A decrease in human engagement and online communication has occurred due to the expansion of the metaverse. Various new trends and technologies have emerged daily, including the metaverse.

RQ1: what is the research trend and context of past studies?

Ahmad *et al.* [9] analyzed that the convergence of emerging technologies will affect healthcare systems. One of the sectors most susceptible to technological change is the healthcare sector. The literature review thoroughly analyses how big data analytics and healthcare systems have employed XR and 6G technologies to enable efficient and expandable delivery of healthcare services.

RQ2: what changes can be witnessed in the healthcare sector due to the fusion of emerging technologies?

Robots combined with AI, VR, AR, Web 3.0, intelligent clouds, edge computing, and quantum computing-all possible with metaverse- can transform the healthcare industry substantially. Blockchain, telepresence, and digital twinning are three significant technical advancements merging in the metaverse. VR helps doctors teach other doctors how to improve patient outcomes. Fourth industrial revolution (4IR) technologies, which help remove fundamental barriers to equal digital healthcare access, advance the metaverse [10].

RQ3: how will technological developments help curb the barriers to digital healthcare?

It provides advanced training to medical practitioners using metaverse technologies, and surgical simulations could be done with an up-to-date version of the latest medical advancements. These also introduce new concepts of therapy for patients, such as treating anxiety or phobias with VR therapy [11]. Besides, it offers metaverse healthcare to researchers worldwide, collaborative research in virtual labs on drug discovery, medical studies, or other innovative healthcare solutions. In medicine, one of the most remarkable applications of the metaverse is found in surgery. When surgeons perform intricate surgeries anywhere in the world, they may now receive real-time assistance, which has allowed them to share their expertise across international borders. Education in medicine has never been more fascinating than now, thanks to the virtual medical simulations that the metaverse can showcase. Such simulations offer the training of realistic scenarios without jeopardizing patient safety among students and other professionals in the medical field [12].

The scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR) method has been used in this study to review the relevant peer-reviewed articles. The influence of metaverse integration in the healthcare sector will add value to the existing literature. This study aims to identify research trends in healthcare by applying the context, intervention, mechanism, and outcome (CIMO) logic. It uses the theory-context-characteristics-methodology (TCCM) framework to identify research gaps in the existing literature, providing scope for future research. A literature review of metaverse in the healthcare sector was essential to understand the research work undertaken in the past to achieve the study's objective. Also, future research propositions will be provided to the researchers, which will help advance the current research domain.

2. LITERATURE REVIEW

The research of [1] showed that VR administered through the metaverse seemed safe. Upon collection of data using various measures, it was found that neck pain disorders (NPD) resulted in a substantial reduction in disability of 23.2%. In contrast, non-specific low back pain (NS-LBP) caused a significant decrease of 17.8%. Letafati and Otoum [13] investigated the privacy and security of healthcare in the metaverse from several perspectives. The authors concentrated their efforts on ensuring the safety of data gathering and communication inside the access layer of the metaverse. A discussion is held on the privacy and security issues involved with using clinical machine learning for intelligent e-health and the obstacles linked with privacy and security inside the metaverse.

Gandi *et al.* [14] looked through the metaverse services and applications to see which ones could be most usefully developed for the urology area. The metaverse's convergence and integration of technologies will contribute to reimagining laboratory medical services through enhanced offerings, improved user experiences, increased efficiency, and customized care [15]. Musamih *et al.* [16] discussed the application of nonfungible tokens (NFTs) in healthcare and outlined the essential elements of NFTs, their salient characteristics, their advantages, and the potential benefits of NFTs in many healthcare fields, including supply chain (SC) management, patient-centric data management, digital twins, clinical trial management, and genomics.

Telementoring surgery and impalpable tumor are two instances that could succeed if improvements in data transformation and infrastructure can overcome the current obstacles and limits [17]. A few challenges that must be considered when implementing this policy are cybersecurity breaches, privacy issues, ethical concerns, and the exacerbation of healthcare disparities. NeuroVerse holds great promise for improving neurosurgical and interventional procedures while advancing neurology [18].

Digital twinning is a rapid, simple, and suitable solution for doctors and other medical experts because of its low latency and processing expenses. Additionally, it makes the move to the internet of medical things (IoMT) easier. The real-time measurement strategy of deep learning (DL)-based computer vision, which does away with the requirement for additional sensors in the suggested digital twin, is one crucial advance. A comprehensive conceptual framework for creating digital twins of cervical vertebral maturation (CVM) within a blockchain environment has been established and implemented. This framework is based on MobileNetV2. This research presents a multi-server attribute-based encryption (ABE) metaverse healthcare data-sharing strategy that maintains constant encryption computation overhead. Furthermore, this study includes a multitude of features. This solution also provides equivalence detection and encrypted text validity for metaverse healthcare. This technology aims to accomplish safe deduplication while lowering the number of incorrect ciphertexts. After deduplication is finished, it is advised that an entirely new attribute-based re-encryption be put into place to facilitate authority delegation. Ultimately, the PBC library simulation experiment shows that the suggested method works effectively [19].

The older adults who had utilized the virtual social centre had much improved mental health compared to those who had not. Therefore, older persons' feelings of loneliness and sadness were lessened by virtual social centers. When the worldwide epidemic subsides and the population ages, virtual social centers can assist the elderly in overcoming loneliness and sadness [20]. Solaiman [21] examined the ethical and legal issues surrounding healthcare delivery in the metaverse. It suggests that the metaverse problems are more complicated than those in the telehealth and virtual health sectors. It makes the case that international cooperation between legislators, researchers, and policymakers is necessary to control this area and promote meta-medicine's secure and efficient advancement. When it comes to protecting the privacy and confidentiality of healthcare data, swarm learning is a solution that has been proposed after integrating distributed machine learning with blockchain technology.

On the other hand, the current swarm learning architecture may face new security issues due to multiple anonymous avatars and an unequal distribution of data quality. Swarm learning in the metaverse can facilitate the integration of partial model parameters with the global model for privacy protection. In light of the disparity in healthcare resource data, the decentralized autonomous organization blockchain network has been suggested to guarantee the equity of model-sharing profits further [22]. This study also focused on the components of the self-determination theory for the metaverse in United Arab Emirates diagnostics and healthcare. Two critical factors impacting the virtual simulation and perceived usefulness of metaverse technology for medical purposes are autonomy and relatedness [23]. VR has the potential to be a handy tool for pain relief and rehabilitation, as well as for reducing stress and anxiety and boosting therapeutic compliance. Virtual consultations can lower costs and increase access to care while minimizing travel time. Metaverse has the most potential in urologic surgery because of its capacity to transform AI, AR, and operation planning through 3D modelling and virtual procedures. The virtual world made the distance and cost of the individual's therapy possible. These transform AR, AI, and 3D modelling for various surgical procedures, including urology. Advanced technologies, such as metaverse learning, are used to establish several healthcare schools that offer lectures. Individual can use the version for study in their place [18]. One of community strength's most exciting difficulties is serum hesitancy, which can be discussed worldwide using the metaverse. This area initiates the improvement of the interdisciplinary healthcare sector in a resourceful way to increase the technical aspect of the digital world. This work tries to make the metaverse that virtually provides a helpful healthcare community, teaches about the vaccine principles and boosts vaccination [19].

The AR/VR technology offered by metaverse can help patients and healthcare professionals by enabling remote medical consultations and training. To better manage their health and make more informed decisions, people can also use health-related technologies and information [12]. Gupta *et al.* [24] assessed the patient's behavior about the possible metaverse application in the healthcare industry. Offering patients individualized medical treatments through the metaverse can be a substantial alternative. AI-powered medicine can be developed, prototyped, evaluated, regulated, translated, and improved using a metaverse of medical technology and AI [25].

3. METHOD

Systematic literature reviews are a method of conducting secondary research that is both scientific and rigorous, and they are frequently employed in management. To produce results that are accurate and valid, systematic reviews use a methodical approach that has been predetermined and a stringent methodology. The method known as SPAR-4-SLR, which is depicted in Figure 1, is utilized in this systematic literature review of the low carbon or carbon neutrality for increasing firm/organizational and SC performance. This method was developed by [26] and has been utilized in numerous review studies [27]–[36]. In Figure 1, the technique for selecting articles is depicted. The many steps are broken down into the following categories:

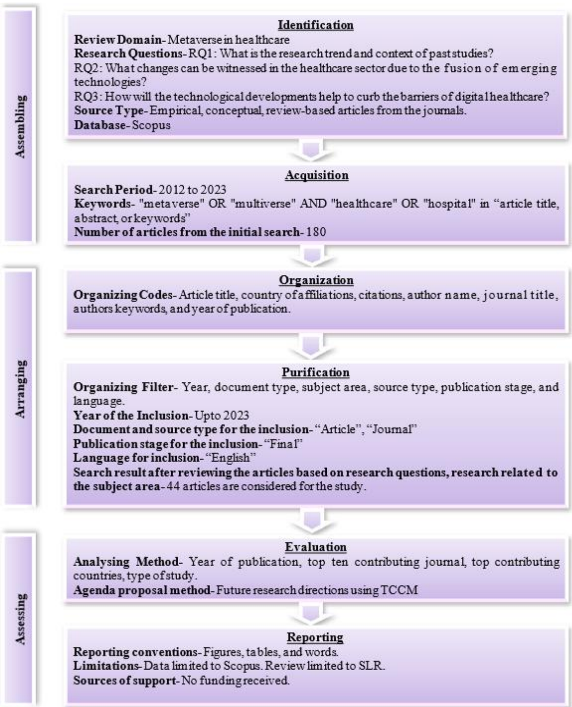

Figure 1. SPAR-4-SLR framework [26]

3.1. Assembling

To complete the SPAR-4-SLR process, it is necessary to locate and collect articles for evaluation. Regarding identification, the evaluation is primarily concerned with low carbon or carbon neutrality as its primary focus. RQ1, RQ2, and RQ3 are focused with the question of "what" constitutes the SLR for low-carbon or carbon-neutrality in order to improve the performance of firms and organizations as well as SC. Because conceptual and empirical "papers" published in "journals" are the only sources of academic literature that have been subjected to rigorous peer review, these are the only forms of "papers" that these journals publish. The Scopus database was utilized as both the search engine and the method for obtaining the content because it is capable of delivering the necessary information. The search was carried out between 2012 and 2023. (10 years). In Scopus, the "article title, abstract, or keywords" criterion, "metaverse" OR "multiverse" AND "healthcare" OR "hospital" were the search terms. In total, 180 articles appeared from the initial search.

3.2. Arranging

Using the code, SPAR-4-SLR can organize and tidy up search results. Scopus's category tool was utilized in this study to classify the 180 papers that were received throughout the designated assembly time. The total number of articles and review papers that were reviewed was reduced from 180 to 162. English was selected because the investigation was written in English, which resulted in 159 articles being left. By its research questions and objectives, this study examined a total of 44 articles.

3.3. Assessing

A study of the article and a report on its strengths, shortcomings, and support are presented after the conclusion of the SPAR-4-SLR technique. They are presented after the conclusion of the procedure. The year of publication, the top ten publications that were cited, the top ten journals that contributed, the nations, the type of study, and the methods that were used to collect data were all factors that were taken into consideration throughout the evaluation. This document contains a further examination of the topic matter and suggestions for additional research. To present the findings of the review, a combination of illustrations, tables, and text is utilized. Towards the end of the essay, both the limitations of the article and the sources of financing are discussed. Because the review made use of secondary data that was available to the general public, there was no need for ethical approval.

4. FINDINGS AND FUTURE RESEARCH DIRECTIONS

4.1. Thematic analysis

The study's thematic analysis, which considers acceptance, difficulties, and target audiences where metaverse research has been conducted in recent years, is presented in Table 1. AI, mixed reality (MR), AR, VR, and other elements influenced how customers adopted new technology. Our analysis of peer-reviewed academic papers on metaverse research showed that the writers needed help conducting their studies. This study was undertaken with the participation of both healthcare professionals and patients. Researchers are gradually undertaking various research projects in several sectors to generate new research findings and opportunities for further study.

Table 1. Thematic analysis

Themes	Sub-themes	Discussion	Reference
Adoption	Factors:		[37]
	VR	Healthcare workers and patients can use VR technologies to interact with simulated surroundings.	
	AR	3D modelling and visualization are utilized to diagnose patient symptoms, medical imaging, and vital signs.	
	MR	Healthcare providers can more easily simplify medical procedures by utilizing MR technology.	
	AI	AI can improve patient outcomes, enhance quality of life and preventive care, and generate more accurate diagnosis and treatment plans.	
Challenges	Metaverse adoption in the healthcare sector is facing many challenges	The medical metaverse faces the following challenges – Data privacy issues – Data volume problem – Interaction device issues – Technology cost issues	[38]
Target audience	Patients	Improving patients' well-being by providing timely and efficient medical care	[39]

4.2. Future research directions using TCCM framework

This study employed the SPAR-4-SLR approach developed by [26]. Utilizing the TCCM framework crafted by and used by [35], further research avenues are suggested based on this synthesis. Its popularity can be attributed to its ability to assist researchers in classifying their findings into four categories, allowing them to identify overlap areas and possible future research directions. Initially, the theoretical frameworks that were employed in literary works. Next, the previously covered context and those that have not been examined well. The literature is categorized thirdly based on the features of the major issues explored and fourthly on the approaches discussed. To better understand the current trends and possible future research directions, the authors of this study used the TCCM framework to help them identify the research gaps in the body of existing literature across the four categories [39]. Table 2 shows the future research questions for metaverse in healthcare.

Table 2. Potential future research areas and questions in metaverse

Themes	Research gap identified	Future research questions
	Future direction – theory	
Theory–driven research	Research should focus on missing connections between various theories that apply to healthcare.	What SC, operations or organizational theories can be applied to metaverse research? How may conceptual and empirical research aid theoretical development in metaverse research? What are the prospects and challenges that metaverse research faces?
	Future direction – context	
Industry/sector	Expanding the context to include other medical specialties is necessary.	What are the barriers to metaverse adoption across various interdisciplinary healthcare sector fields?
	Comparative research could be undertaken.	What are the obstacles smaller hospitals face in implementing metaverse compared to larger hospitals?
Geographical area	In developing countries, research should be undertaken.	What makes medical practitioners in developing nations different when utilizing the metaverse under clinical and moral standards?
	Need for a practical metaverse research methodology in developing nations.	How does the adoption of the metaverse affect the conduct of research in healthcare domains that have yet to be explored?
	Future directions – characteristics	
Ethical and legal issues	Research in this area has mostly been conceptual. One may also view empirical research work as a potential area for more investigation.	How much fresh insight will be gained from stakeholder interviews and in-depth research?
Risk	Adoption of the metaverse in healthcare can be unpredictable and dangerous.	After implementing the metaverse, how much risk and uncertainty will be there in the healthcare sector?
Decision-making process	Decision-making procedures could be used to resolve several healthcare-related difficulties.	Will decision-making procedures be able to address the problems facing the healthcare industry?
Disease diagnosis and treatment	The amount of time needed to diagnose a condition and start treatment.	Will implementing metaverse in healthcare enable prompt and effective disease diagnosis and treatment?
	Future directions – methodology	
Data collection techniques	Expansion of data collection sources is essential.	How effective will the mixed data collection methods evaluate the obstacles to adopting the metaverse? What value can grounded theory, focus groups, Delphi, and fuzzy Delphi methodologies offer to the existing literature?
Data source	Studies that use primary data should be the main emphasis of research.	How does triangulation of data improve the validity of study findings and facilitate a more profound comprehension?

4.2.1. Future directions-theory development

The results of the systematic review of the literature indicate that the technology acceptance model (TAM), theory of planned behavior (TPB), technology readiness index (TRI), theory of reasoned action (TRA), and unified theory of acceptance and use of technology (UTAUT), UTAUT2, are the most frequently used theories and models in metaverse research. These theories and models mainly concentrated on e-commerce websites, metaverse shopping, beauty product shopping, and e-retailing. Consequently, there are many opportunities for applying other theories and models in metaverse studies across different fields.

The existing literature does not employ organization, operations, or SC theories. As a result, a wide range of theories can be used to explain the adoption of the metaverse in healthcare. TPB explains why healthcare providers intend to follow clinical guidelines [40]. IT advancements in healthcare can provide improved medical results, which can be explained by actor networks [41]. Jensen *et al.* [42], institutional theory can also serve as a foundation for investigating the decision to adopt metaverse technology and the expansion of innovations in the medical field.

4.2.2. Future directions-context

Most metaverse research over the past ten years has been undertaken in China (21.43%), followed by India (14.28%), according to the most recent SPAR-4-SLR data. Regarding research output, the following two countries are the United Arab Emirates and Italy (11.90% each). The United States of America and Korea each contributed 7.14% to the study project, while the Czech Republic made up just 4.76% of the total research initiative. Notably, 78.57% of metaverse research papers used data from seven distinct countries: China, India, Italy, the United Arab Emirates, Korea, the United States of America, and the Czech Republic. As a result, the results' generalizability will not be discussed. Thus, additional studies should be conducted in different countries.

The authors did a contextual analysis to determine the current literature's disciplinary, regional, and industry foci. Orthopedic is the primary subject matter in academic publications. The authors thus urge further research in less-studied areas such as dentistry implants, veterinary medicine, ophthalmology, gastroenterology, and pulmonology. According to the findings, research in developing and underdeveloped economies also showed a need. Dwivedi *et al.* [43], this could result from the government's lack of involvement in encouraging the adoption of innovative technology. Future studies may examine this to learn more about how government intervention varies in developing economies compared to industrialized ones. It was also noted that there was not much multidisciplinary and multinational research. A robust comparative examination of the subject may be possible with the aid of these studies.

4.2.3. Future directions-characteristics

This section suggests directions for further research on adopting metaverse in healthcare, considering different aspects. Numerous gaps in the themes and features of these studies were also found after thoroughly examining the body of extant research. The ethical and legal issues of metaverse applications in this sector are broad. Though some research has addressed these issues, the focus of these studies has been primarily conceptual. New perspectives on the subject might emerge via a more in-depth investigation and stakeholder interviews. It is also unknown how much risk and uncertainty the healthcare industry will face due to the metaverse. Another area of further research is how SC configuration, stakeholder collaboration, and metaverse adoption are affected. Multi-criteria decision-making (MCDM) methodologies can be used to investigate the factors that promote or inhibit the adoption of metaverse. The SC issues related to the industry's adoption of the metaverse can also be analyzed using MCDM. There is also a need for more literature on developing customized medications in the metaverse. Patients may benefit significantly from these; more research is needed to determine this.

4.2.4. Future directions-methodology

Research employing mixed methods may help investigate the obstacles to adoption encountered by industry participants. It can also be used to determine how simple or complex pre-operative planning and medical intervention will be. Another option is examining a long-term study that uses 3D medical models to describe medical students' learning curves. The grounded theory technique can be applied to comprehend stakeholders' adoption behavior and intentions in various healthcare domains. Prospective investigators may also utilize targeted focus groups, Delphi, and fuzzy Delphi techniques to gather data from subjects entirely missing from existing studies. There is also a lack of an interview-based study in the literature to comprehend the barriers to metaverse adoption in the field.

4.3. Abilities of metaverse based on CIMO logic

Denyer *et al.* [44] implemented design science approach and CIMO as shown in Figure 2 logic to comprehend the advantages of the metaverse to the healthcare industry. Intervention (I) is used in this case to attain the outcome (O) in context (C). [45] state that mechanism (M) produces the desired result when an intervention is used. This review uses the CIMO logic to provide information about enlightening the excellence of healthcare services provided to patients (context) through intervention. The study also covers successfully adopting and implementing metaverse (mechanism) to achieve the intended result.

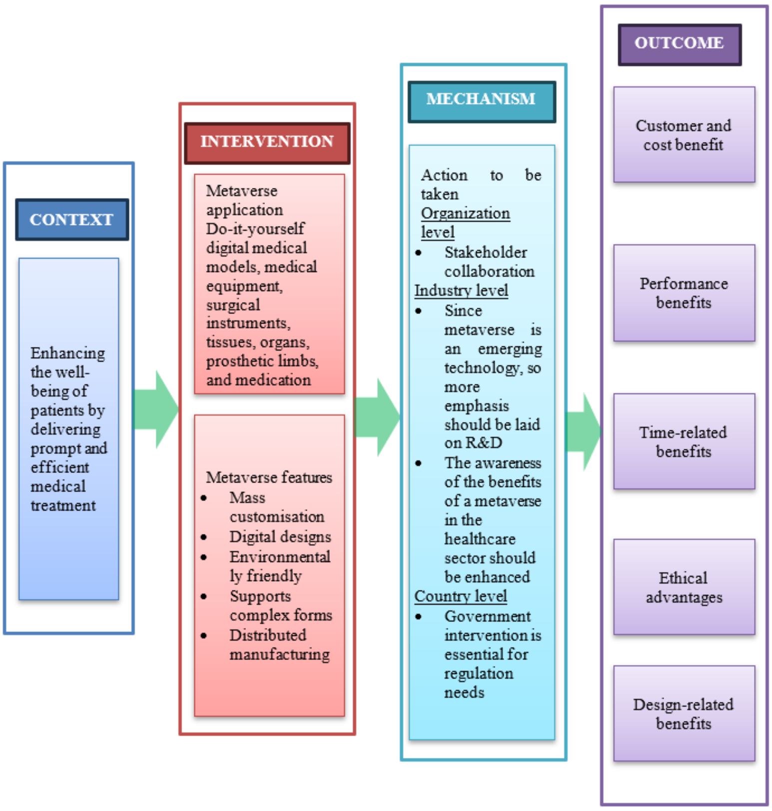

Figure 2. Abilities of metaverse based on CIMO logic

4.3.1. Context

Colicchia and Strozzi [46], the study subjects may include people, relationships, institutional contexts, or larger systems. Giving patients access to higher-quality, timely, and individualized healthcare treatments aims to enhance their quality of life. This study will set the context for future research in the domain of metaverse in healthcare. Also, this research will set the context for the healthcare industries to adopt the metaverse.

4.3.2. Intervention

Colicchia and Strozzi [46] examined the occurrences or behaviors that have an impact. Metaverse intervention can be used to achieve the goal or context. Reaching this goal is made more accessible by the metaverse's distinct characteristics. Yadav *et al.* [47], layer-on-layer linking reduces material waste and energy usage. Priyadarshini *et al.* [48], [49] state that digital designs facilitate the production of numerous product iterations without physical printing, hence improving market response. Huang *et al.* [50], the implementation of a distributed manufacturing system results in a reduction of logistics requirements, an increase in customer involvement, and the ability to facilitate mass customization.

4.3.3. Mechanism

The mechanism is how an intervention produces a particular effect [47]. Only the successful implementation of metaverse will make it valuable in the healthcare sector. First, more field research and development are needed to maximize the environmental benefits [48], economic [51], and social benefits of the technology [52]. Next, more involvement from stakeholders is required. This includes trained and skilled workers [53] and proactive top management [54]. All of these groups need to be motivated by innovation. The effectiveness of the process depends on stakeholder collaboration [55]. Based on the discussion above, the following research proposal can be provided for upcoming investigations.

Proposition 1: the metaverse adoption rate positively correlates with increased government participation in the regulatory needs of medical devices, bio-printed tissues, and additively made pharmaceuticals.

4.3.4. Outcome

The term "outcome" refers to the results or consequences that are brought about by an intervention that is carried out via the utilization of a mechanism [47]. It is possible to achieve the aim by conquering the challenges the metaverse presents. These results symbolize the potential of the metaverse, which may be utilized to its fullest extent after it has been implemented. Personalized medications may be acquired using the metaverse to define a patient's biological, physiological, social, and economic uniqueness. This allows for customizing the patient's size, dose, presentation, and the pace at which they are administered [56]. Noël *et al.* [57], these advantages contribute to better patient care at a reduced expense. Aquino *et al.* [58] suggest that a patient's distinct genetic profile, physiology, and metabolism may enable the accurate selection of a medication and its dosage, reducing adverse drug responses and waste. The following study proposal can be provided for upcoming investigations based on the discussion above.

Proposition 2: using metaverse to deliver timely, individualized healthcare services at a reduced cost improves patients' quality of life.

Magnetic resonance imaging (MRI) and computed tomography (CT) data can be electronically stored, allowing for rapid and affordable manufacturing. Tacher *et al.* [59], this would allow for long-term use and reduce the number of animals needed for training. Gibbs *et al.* [60], printed tissue, such as bone, will likely replace some animal research in the pharmaceutical industry. Singh and Jonnalagadda [61], 3D-printed organs and models may eventually take the role of animal testing in scientific research. Based on the discussion above, the following study proposal can be provided for upcoming investigations.

Proposition 3: large-scale adoption of the metaverse reduces the frequency of animal drug testing by university labs and pharmaceutical businesses.

In addition to creating local jobs and providing social security, the metaverse can foster social inclusion by providing various benefits to individuals with physical disabilities [62]. The process becomes autonomous, the equipment becomes noiseless, and the metaverse can reduce the requirement for continual human-machine interaction, all of which can reduce the likelihood of accidents. Community members can benefit from additional product customization depending on local needs. Based on the discussion above, the following study idea can be suggested for upcoming investigations.

Proposition 4: adopting the metaverse improves life ability, health, and social well-being by enabling the social inclusion of those with disabilities.

A thorough review of the healthcare industry's metaverse literature led to the framework development shown in Figure 2. The advantages have been discussed. The obstacles and the steps needed to overcome them have been thoroughly explained. Several advantageous results that can be attained with metaverse's assistance are also mentioned in the framework. The research community has, however, given less consideration to a few crucial features of the framework. Therefore, these framework components have been put forth as potential areas for further investigation.

5. DISCUSSION AND IMPLICATION OF THE RESEARCH

In this scenario, metaverse could prove to be a game changer. It includes the integration of cutting-edge technologies, such as AR, VR, AI, blockchain, quantum computing, robotics, internet of medical devices, and many others. Opening doors to many exciting areas of exploration in innovative solutions with superior quality treatments and healthcare services, being leverageable with these advanced technologies unfolds further. Providing life-like experiences to patients and healthcare providers, the metaverse will unlock new opportunities for better healthcare outcomes. The study comprehensively reviews all the academic discussions and research concerning the metaverse, the healthcare industry, and associated emerging technologies. Other than that, the COVID-19 pandemic has been a significant leading cause of the current disorder.

This has been behind the accelerating rapid change across the healthcare ecosystem, forcing all stakeholders to rethink their approach toward this industry and compelling everyone to the unavoidable adoption of technologies in order to cope with the changes. This paper looks at how the metaverse might be a game-changer for healthcare in the future. It lays the groundwork by going over the basics of the metaverse and its potential applications across various medical fields. These encompass broad-scale changes such as improved medical education and training, through to providing immersive clinical care, performing surgical procedures, assisting in obstetrics, and much more. In essence, this study presents four propositions on the future using the CIMO framework. The first proposition relates to the fact that the adoption rate of metaverse will increase if the government intervenes. The government could assist hospitals with respect to necessary technology transfer and funding. The government could actively become involved in awareness creation about the metaverse in the healthcare domain. The second proposition involves the delivery of healthcare services through the metaverse. They consider that, in fact, the quality of the patients will increase due to a lesser expense, and there will be better treatment facilities for the patients as well as higher patient satisfaction. Third, the proposition is that there will be high-quality drug testing such as metaverse. It will also aid the universities and labs. Lastly, it proposes the improvement in social life of disabled people. That reflected a shift in attitude, illustrated by increased embracing of telehealth and the place that gaming occupies in the younger population, toward increasingly open embraces of technology in healthcare.

Similar to VR, blockchain, and digital twins, other new technologies moving at breakneck speeds toward proactive healthcare transform the very idea of healthcare itself at its core. Even if the metaverse is undoubtedly a technology that has tremendous potential for improving healthcare, its proper integration should not only be made keeping in consideration the quality of care but also the patients' safety additionally, the impact on the human dimension. Meanwhile, these issues of including technology need to be recognized but suppressed. Any functional systems of metaverse call for a striking balance between ethical and practical concerns concerning data security and privacy, interoperability concerns, and legal concerns about ownership and distribution of data. Taking proactive actions towards meeting these challenges, we will ensure that systems of metaverse align with the principles of quality care and safety in their implementation. As much as we would take the advantage of metaverse with the benefit in the healthcare arena through applying the patient-centric approach and taking an overview of possible risks and benefits, care and thought have to be implemented where technology acts more like an enabler than a disruptor. It is in this way that benefits about better healthcare outcomes from the metaverse can be maximized while at the same time taking care of the welfare and interests of patients. Current trends in technology within the healthcare industry have efficiently and effectively adopted remote patient monitoring to ensure the best service to patients with modern telemedicine techniques.

Metaverse is the latest buzzword of today, which expects transformative changes in many strata of life. But with the introduction of the metaverse, healthcare will also experience change in the near future through upgrading the current service of monitoring patient health, changing the way people interact with the healthcare system by adding more interactive features in a virtual world with technologies such as VR for medical training and AR in surgical procedures. It elaborates quite clearly on the potential applications of the Metaverse in health care.

More precisely, it emphasizes the possibilities of implementation of the metaverse in medical diagnosis, monitoring of patients, healthcare training, surgeries, and medical therapeutics and theragnostic. In addition, some of the recent and upcoming projects regarding the metaverse in the context of healthcare, including blockchain, digital twins, and telemedicine, are identified. It critically analyses the challenges and open issues if metaverse is to realize its full potential for healthcare and further recommends relevant future scope directions which would enable confident implementation of the metaverse in healthcare.

6. CONCLUSION

The healthcare industry was the focus of this study, which utilized innovative metaverse research approaches. The study aims to determine how implementing metaverse technology will benefit the healthcare industry. To search the Scopus database for pertinent papers on metaverse, we utilized keywords. Within the scope of this investigation, the SPAR-4-SLR approach was employed to select, screen, and review the publications. This research study includes the most prominent authors, works, publications, countries, theories, and approaches in this particular topic. As can be observed from the published data on metaverse research, the healthcare research field has undergone significant development over the past ten years. In addition, this study included a listing of the top ten journals in terms of the number of papers published in those journals. Based on the findings of this study, which examined the countries that have contributed to metaverse research during the past ten years, it was discovered that China has made the most significant contribution. Despite this, the researchers encountered a few challenges during their earlier scientific investigations. High-quality research that is carried out using effective methods is required in developing countries. The limitation of the study is that the authors used only one peer reviewed database, namely, SCOPUS, so in the future, other databases will be included, like Web of Science and Google Scholar.

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