Challenges in Metaverse Adoption on People, Process, and Technology Perspectives: A Review from the Five past Years

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Abstract: The Metaverse represents a virtual world intrinsically connected to reality. Its essence lies in constructing a digital space encompassing different media types, merging uniquely with the real world. This environment's innovation and its potential users' attraction to immersive experiences bring countless opportunities for individuals and organizations, as highlighted in the Gartner Group Report on the "Top Strategic Technology Trends for 2023." However, significant opportunities also bring significant challenges. So, in this context, this paper presents the results of a Systematic Literature Review (SLR) study focusing on the challenges of using the Metaverse from the perspective of people, processes, and technology. Following Kitchenham and Charters (2007) guidelines, we analysed 55 studies from relevant sources to understand the intricate interaction between human elements, procedures involved, and technology within the context of the Metaverse. This review made it possible to present a comprehensive view of the challenges and obstacles in this field of investigation, offering insights into the quantity and quality of available evidence. The challenges identified in this study summarize the main academic contributions related to using the Metaverse in the last five years.

1 INTRODUCTION

This study sought to investigate the "Metaverse" trend based on understanding the challenges of Information and Communication Technology (ICT) and the multidisciplinary aspects that technological innovation can cause in people's lives.

The motivation for the study on Metaverse originated from the analysis of the report "*Top Strategic Technology Trends for 2023*," published by the Gartner Group and available at (Gartner, 2023). This report presents ten trends, nine of which are grouped into three categories: *Optimize* (Digital Immune System, Applied Observability, and AI Trust, Risk, and Security Management), *Scale* (Industry Cloud Platforms, Platform Engineering, and Wireless-Value Realization), and *Pioneer* (Superapps, Adaptive AI, and Metaverse). The tenth trend refers to sustainable technology, presented as a transversal trend to the previous nine trends.

The systematic study of technological trends is conducted in a discipline part of the undergraduate curriculum in Information Systems (IS) at Federal University of Pernambuco (Brazil), called "IS Trends and Challenges". This course aims to discuss and investigate technological trends and their impacts on the IS area from people, processes, and technology perspectives. The choice of the Pioneer category, in which the Metaverse falls, was based on classroom debates about the challenges that impede the use of the Metaverse more broadly by organizations, combined with the quote from Gartner (2023), which states: "*By 2027, over 40% of large organizations worldwide will be using a combination of Web3, spatial computing, and digital twins in metaverse-based projects aimed at increasing revenue*."

The Metaverse represents a virtual world intrinsically connected to reality. A recent work investigated the terms linked to the metaverse through a literature review, obtaining 28 definitions and descriptions of the metaverse (Ritterbusch and

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Teichmann, 2023). Using the most common terms, Ritterbusch and Teichmann (2023) point out: *Metaverse, a crossword of "meta" (meaning transcendency) and "universe," describes a three-dimensional online environment in which users represented by avatars interact with each other in virtual spaces decoupled from the real physical world.* Its essence lies in constructing a digital space encompassing different types of media, merging in a unique way with the real world. Lin et al. (2022) highlight that this convergence between the real and virtual worlds implies that virtuality can influence reality, directly affecting everyday activities and economic life. In practice, the Metaverse is a digital creation that transcends the barriers of entertainment and is tangibly inserted into everyday life, introducing new paradigms in areas such as education, work, leisure, and social interactions. However, this real-world and virtual convergence also brings complex and multifaceted challenges to organizations and users. In this context, this article addresses the challenges of using the Metaverse, exploring its implications from diverse perspectives, as pointed out in the following research question: RQ) *What are the challenges of metaverse adoption from people, processes, and technology perspectives?*

To carry out this study, we adopted the Systematic Literature Review (SLR) method described by Kitchenham & Charters (2007). From applying this method in the primary research bases in computing in the last five years, we examined 55 relevant studies selected to understand the intricate relationship between human elements, the processes involved, and technology within the context of the Metaverse. Analysis of the studies revealed several significant challenges associated with using the Metaverse, providing a comprehensive overview of the topic and offering insights from the available evidence.

To tell this history, this paper is organized into six sections. After this brief introduction, Section 2 contextualizes the Metaverse and its influence on everyday life. Section 3 describes the methodology applied based on the Systematic Literature Review method (Kitchenham & Charters, 2007). Section 4 presents the results found, discussed in Section 5. Finally, Section 6 presents the conclusions of this study and future work.

2 CONTEXT

In recent years, the business world has undergone significant transformations driven by technological advancement and the need to adapt to new realities, such as the COVID-19 pandemic. As noted by Park et al. (2023), the pandemic forced companies and their employees to adopt remote work on an unprecedented scale. While some organizations have begun calling employees back to the physical office as the threat of the pandemic eases, many employees have been reluctant to return. This scenario has driven the emergence of a new work paradigm: using the Metaverse as an alternative workspace that can complement the limitations of remote work or even offline work.

On the other hand, Handoko et al. (2023) highlight that the rise of the Metaverse also brought specific challenges to corporate accounting and auditing. With companies acquiring digital assets in the Metaverse, such as land and virtual properties, and investing in cryptocurrencies, traditional accounting and auditing have new territories to explore and regulate. In parallel, Jansen et al. (2023) highlight the importance of the consistent performance of metaverse-related systems, emphasizing the need to understand the performance characteristics of extended reality (XR) devices. This is essential to ensure that the user experience in the Metaverse is satisfactory and efficient.

As the Metaverse emerges as a field of great interest and potential, it is crucial to reflect on the various challenges that arise in its adoption and implementation. It represents fertile ground for innovation and an arena where several obstacles must be overcome. By exploring these challenges from the perspectives of people, processes, and technology, this article provides a comprehensive look at the constantly evolving landscape of the Metaverse.

3 RESEARCH METHOD

This study used the Systematic Literature Review (SLR) method to investigate the challenges of the Metaverse. As defined by Kitchenham and Charters (2007), SLR is a rigorous and structured approach that allows you to systematically explore, analyse, and synthesize the evidence available in a given field of research. It consists of three main stages: 1) *planning the review*, identifying the motivation, and defining the protocol to be followed; 2) *conducting the review*, following the defined protocol, extracting, and synthesizing the data; 3) *Reporting analysis and synthesis*, based on the answers found for the research questions. Fig. 1 illustrates the RSL process by Kitchenham and Charters (2007).
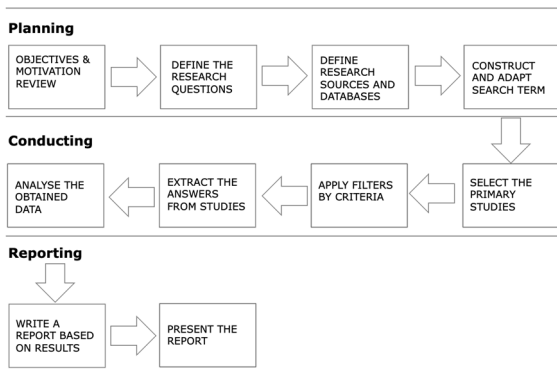
Figure 1: RSL process.

3.1 Planning

Research planning involved carefully defining all the key elements needed to conduct RSL effectively. The main steps first included formulating the central research question, representing the study's objective; investigating the different sectors in which the Metaverse can be applied, identifying the challenges; understanding the potentials of the Metaverse, and, finally, analysing the obstacles related to integrating the Metaverse with information systems.

In addition to the main question, secondary questions were defined to deepen the analysis and address specific aspects related to the topic:

- Q1) What are the main **human challenges** faced in adopting the Metaverse?
- Q2) What are the main **technological obstacles**?
- Q3) What **process challenges** arise when using the Metaverse?

Considering the sustainable technology aspect, treated as transversal to all trends highlighted by the Gartner Group's Top 10 Trends report, a fifth question was formulated on the selected studies:

- **Meta Question:** Did the studies comment on any Metaverse challenge related to sustainability?

Defining the research protocol was crucial to ensure the consistency and transparency of the study selection process. Relevant keywords that covered the main concepts of the study were identified. This includes terms related to the interest of the study, such as "Metaverse," "Practice," and "Challenge." The keywords, synonyms, and search string were defined to broadly capture studies on the Metaverse and its challenges, as shown in Table 1.

Table 1: The string used in search tools.

Search String
(Metaverse) AND (Challenge OR Barriers OR Obstacles) AND (Practice OR Experience OR Case)

Additionally, primary research sources such as ACM DL, IEEE Xplore, Scopus, Emerald, and Science Direct were selected to ensure the quality and relevance of the data collected. The established research plan and protocol provide a solid foundation for conducting a rigorous and comprehensive systematic literature review.

3.2 Conducting

To ensure the selection of the most relevant and high-quality articles for our study, inclusion and exclusion criteria were established according to the RSL method. For this, the following exclusion criteria were defined:

- Articles outside the period chosen for research (2018 to 2023).
- Secondary studies (other RSL or MS).
- Articles unavailable for viewing.
- Articles with less than four pages.
- Duplicate or highly similar articles.

As inclusion criteria, the following were defined:

- Articles related to the topic and research questions.
- Publications in conference proceedings and journals.

These criteria were applied in two distinct stages, first in filter 1, composed of the information contained in the titles and abstracts of the articles, and later, in filter 2, in case of doubts regarding the selection, considering the introductions and conclusions of the articles for an evaluation more complete.

The inclusion and exclusion criteria were rigorously applied to the articles collected from all selected research sources. This application resulted in categorizing articles into three groups: approved in filter 1, approved in filter 2 (when necessary), and rejected. In addition to the inclusion and exclusion criteria, the quality of the selected articles was assessed based on specific criteria:

- Clear context.
- Well-defined methodology.
- Practical application.
- Relevant and consistent discussion.
- Presentation of research limitations and threats.

Each criterion was evaluated concerning each article, assigning a score of 0 (does not meet), 0.5 (partially meets), and 1 (completely meets) for each criterion, adding up to a maximum total of 5 points for the overall quality assessment of each article. To conduct this research stage, four senior students from the Information Systems undergraduate course participated, working in pairs, as well as a professor with a doctorate in Computer Science.

3.3 Reporting

After completing the analysis stage, in which the articles were subjected to filters based on strict inclusion, exclusion, and quality assessment criteria, we proceeded to select the qualified studies that would integrate the final list of articles to be considered for synthesizing responses to the research questions.

As a cut-off metric for qualifying studies, a percentage equal to or greater than 50% of the maximum quality grade awarded was defined according to the specified criteria (Clear Context, Well-defined Methodology, Practical Application, Relevant and consistent discussions, Limitations, and threats of the commented research), totalizing 5 points. Thus, the classified studies present a qualification greater than or equal to 2.5 points. This approach ensured the inclusion of articles demonstrating a good-quality standard according to pre-established criteria.

Furthermore, the selected studies were ordered by year of publication, in ascending order, to provide a chronological view of the research development related to the topic of the Metaverse and its challenges. To further enrich the analysis of the results, each selected article had its answers to the research questions recorded according to the evidence collected in excerpts from the articles themselves, using electronic spreadsheets shared between the evaluators. The responses were classified according to the following value scale:

- 1: Answers - When the article provides a complete answer to the research question,
- 0.5: Partially answers - When the article offered a partial answer to the research question.
- 0: Does not answer - When the article does not adequately address the research question.

This classification of responses allowed a more precise and objective analysis of the contributions of each selected study concerning the research questions defined in the initial phase of the study.

The detailed analysis and synthesis of the results will be presented in the discussion section of this article. From the information collected and the ratings of the responses, it was possible to have a clear and in-depth view of the challenges of using the Metaverse from the perspectives of people, processes, and technology, providing valuable insights and a comprehensive view of the current research landscape on this topic.

4 RESULTS

The selection of articles that underlie the current study followed the research method described in Section 3 systematically and rigorously.

Initially, a broad search was carried out across the selected research sources, resulting in an initial set of results with the first numbers per research source. After obtaining the initial results, the next step ensured that the inclusion and exclusion criteria were applied in the first filter, which was based on analysing the titles and abstracts of the articles.

A second filtering, which consists of a more in-depth analysis of the studies by reading the introductions and conclusions of the articles, was applied when it was impossible to decide the validity of an article based on the first filtering. Finally, the articles qualified in the previous stages were subjected to evaluation of the predefined quality criteria. At the end of this process, 55 articles were selected. Fig. 2 summarizes the article selection process according to the PRISMA model.
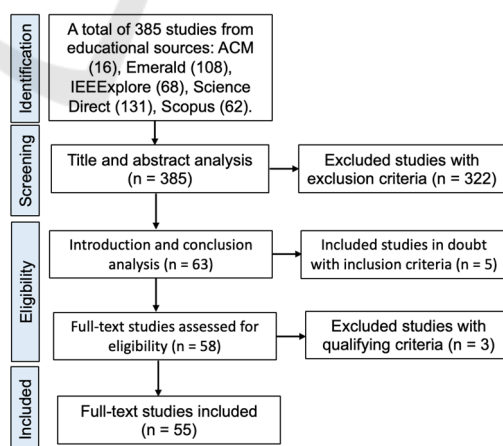

Figure 2: PRISMA flow chart of section process.

The selected articles came from different research sources, having more excellent representation in the IEEE, Scopus, and ACM databases. Only the

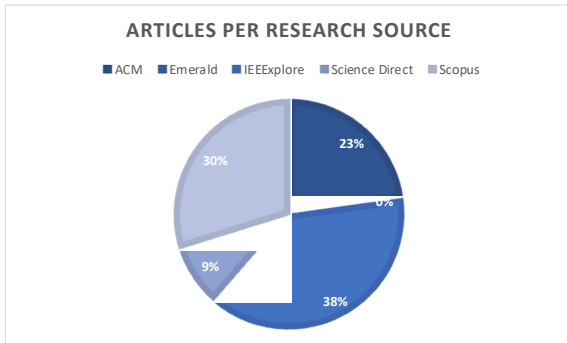Emerald base was not represented in this result, as shown in Fig. 3.

Figure 3: Number of studies per research source.

Fig. 4 presents an overview of the number of articles selected depending on their year of publication, where it is possible to attest that the Metaverse is indeed a trend, considering that most selected articles were published in 2022 and 2023. It is important to emphasize that a detailed list of studies is available in Appendix A.
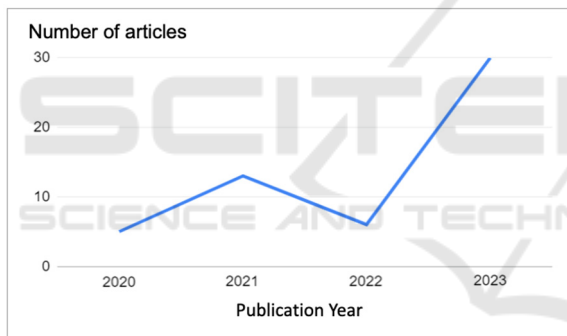

Figure 4: Number of studies in the timeline.

Analysing the first authors of the studies to identify the countries that are involved with research in the context of Metaverse, it was possible to identify a greater predominance in China (27%), the USA (20%), and India (15%). Fig. 5 shows the list of countries involved with the respective numbers of studies.

Regarding the type of study, the results were balanced, with 57% of studies of the conference paper/proceedings type and 43% of the journals/periodicals type, as shown in Fig. 6.

Most studies still achieved a high level of quality, considering the defined criteria and research questions, with more than 50% higher than value 4, as shown in Fig. 7.
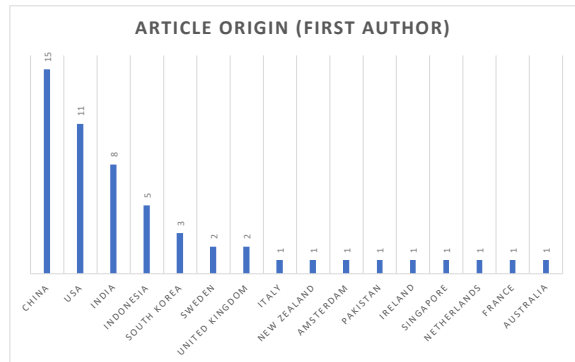

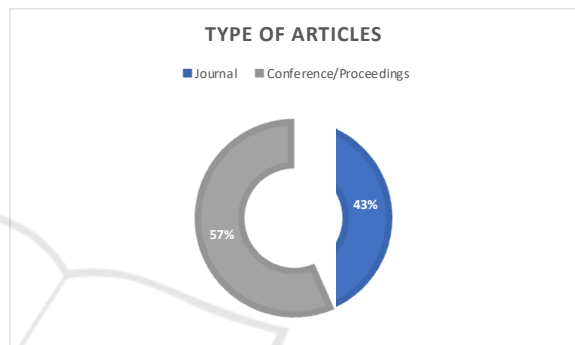Figure 5: Number of studies per origin (first author).
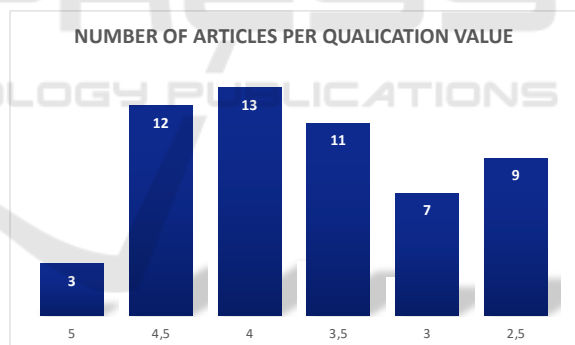

Figure 6: Type of studies.

Figure 7: Number of studies in the timeline.

Finally, regarding the application contexts of the Metaverse found, the studies were diverse within the domain of applications for Education (EP10, EP21, EP22, EP39, EP, 41, EP47), Work Environments (EP28, EP44, EP48), Health (EP18, EP34), Commerce (EP15, EP48, EP49), Games/NFT (Non-Fungible Token) (EP1), Social Media (EP5, EP8), and other studies focused on the technological aspect of platforms, considering computer network resources/assets (EP4, EP52), use of blockchain (EP28), virtual reality (VR)(EP2), augmented reality (AR) (EP13), and artificial intelligence (AI) (EP43).

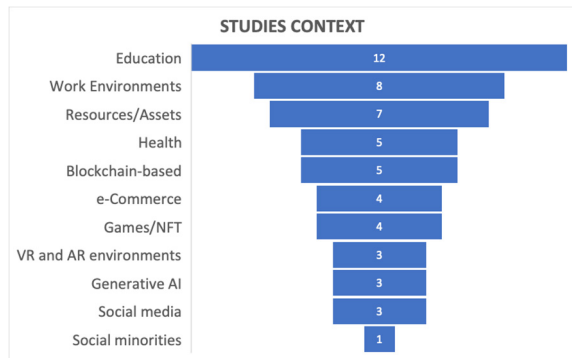Fig. 8 shows the themes related to the context of studies.

Figure 8: Context of studies.

The results also indicate that most authors focused their research on specific contexts, with a notable emphasis on the educational domain, where Metaverse applications ranged from integration in virtual classrooms to initiatives aimed at training employees in organizational environments. The use of the Metaverse as a pedagogical tool emerged as a central theme, exploring the potential of the virtual environment to enrich learning experiences, provide realistic simulations, and promote collaboration between students and educators.

In addition to the educational context, research that explored the Metaverse in the health field also stood out. Applications have ranged from advanced medical simulations to innovative virtual reality-based therapies. The Metaverse has shown promise in creating immersive medical training environments and offering innovative therapeutic solutions, combining education and work environment.

Another aspect to point out is the intersection of the Metaverse with disruptive technologies, such as artificial intelligence and blockchain. The integration of these complementary technologies has been explored in different contexts, revealing potential synergies to drive innovation. Artificial intelligence, for example, has played a crucial role in creating more intelligent and personalized interactions within the Metaverse. At the same time, blockchain has been applied to ensure secure and transparent transactions in virtual environments.

Furthermore, the combinations between application domains and the intersection of the Metaverse with technologies such as artificial intelligence and blockchain highlight the interdisciplinary nature of research in the area. The advancement of these contexts suggests a dynamic and promising future for the Metaverse, with

significant implications for education, health, and technological innovation.

5 DISCUSSIONS

In recent years, the business world has undergone significant transformations driven by technological advancement and the need to adapt to new realities, such as the COVID-19 pandemic. As noted by Park et al. (2023).

Please note that the name of each author must start with its first name.

5.1 What Are the Main Human Challenges Faced in Adopting the Metaverse?

Any technological novelty has as one of its first challenges and, perhaps the most important, human adoption. In this question, we study the different perspectives concerning people's adoption challenges. Among these challenges, some evidence was found, such as the need to maintain accessibility and inclusion of people in this environment, including older age groups, the dangers associated with maintaining privacy and preserving ethics among human relationships in the virtual environment, and care for the mental health and well-being of those inserted in this often-addictive environment. Fig. 9 shows the primary found evidence.
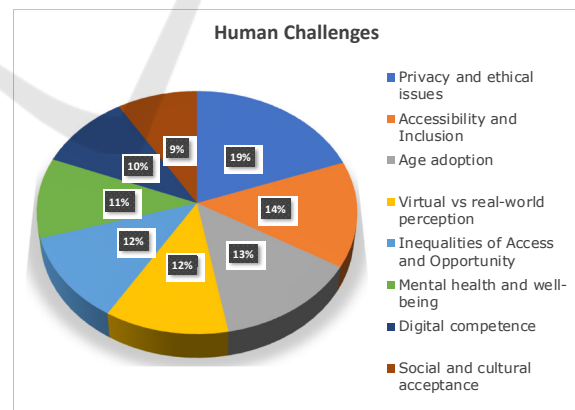

Figure 9: Human challenges in Metaverse adoption.

EP22 discusses a Metaverse proposal in the educational context, highlighting the importance of encouraging more people to use this environment through an inclusive virtual environment that considers as many different participant requirements as possible. On the other hand, this environment may

not attract all audiences due to its more prominent characteristics and applications. In EP45, the authors highlight the risks associated with the prior perception of users who, for example, may associate training activities using Metaverse with games and, therefore, generate prejudices that reduce the credibility of the training. EP18 also highlights that using the Metaverse is quite challenging to implement for older people, who have several limitations in accessing this information.

EP48 points out the dangers of using the Metaverse through avatars in an environment where everything is permitted. When two individuals have a disagreement that amounts to a violation of law in the real world, such incidents may constitute a violation of tort law or criminal law, which goes unpunished in the virtual environment. As it is an engaging and stimulating environment for user interactions, EP11 highlights that it is more complex and complicated for governments to deal with ethical, privacy, and security issues in the virtual space due to the influence on people's privacy and business information in the Metaverse.

Health and relationship challenges are also among the main Metaverse adoption challenges. EP50 highlights the impact of using Metaverse on its users' mental health and well-being, underlining that there is a high cognitive overload and mental fatigue compared to using other technologies because users need to simultaneously process their perception of the physical world and the virtual world. EP7 also highlights that staying in the Metaverse for a long time can create some movement imbalance due to devices mounted on the head and eyes. This study highlights that users may experience some symptoms (e.g., cybersickness, blurred vision, or dizziness) or even fall to the ground after wearing wearable devices for some time, which may pose a potential risk to users' physical safety. EP50 also highlights the risks of Metaverse addiction, "Cyber Addiction," and the destruction of our sense of humanity. EP10 also highlights that the higher the quality of immersive interaction, the easier it will be for users to be immersed, ultimately leading to physical, social, and mental disorders that affect human beings due to excessive interaction with cyberspace.

5.2 What Are the Main Technological Obstacles?

The main technological challenges indicated in the studies are shown in Fig. 10.
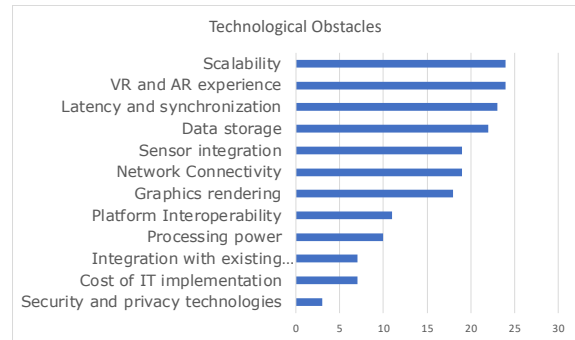

Figure 10: Technological obstacles in Metaverse adoption.

Analysing the technological tools necessary for developing this new mode of interaction on the internet, that is, the Metaverse, these tools exist, but they need to evolve over a long period. The current technologies and tools are already used to build the embryos of what the Metaverse can become.

EP45 comments that the adoption of the metaverse presents inherent challenges such as the lack of familiarity that participants may have with its technologies, especially VR. EP44 also highlights the difficulty of using high-technology devices (for example, VR), due to the premature stage of their commercialization and high investment costs.

When looking at the scalability aspect, we realize that the current technologies do not support many users (EP5).

As for connectivity, EP8 highlights that 5G has a data transfer rate ranging from 10 to 20 Gbps. However, this transfer rate would not support this transfer rate for rendering the Metaverse's high-resolution frames and transferring the metadata generated by the different sensors.

As EP8 talks about the need to expand data transfer, EP11 talks about expanding an infrastructure network such as data centres, computing centres, communication infrastructure, and energy supply to scale virtual reality. EP16 and EP8 highlight the need to expand data transmission. Still, beyond that, they emphasize that big data storage and more reliable network infrastructure are crucial for the broad adoption of the Metaverse.

EP7 highlights the need to generate a good quality of experience (QoE). The authors emphasize that high-speed internet and the absence of crashes are essential to promote continuity and play a fundamental role in social interaction. EP8 reinforces this aspect when it states that building a secure, reliable, and scalable system aligned with QoE is crucial to the success of the Metaverse.

EP48 highlights the results of interviews with adopters and non-adopters of the Metaverse,

highlighting those interviewees identified "technology adoption and implementation," "lack of worker skills," "implementation cost," and "security" as the main challenges associated with the Metaverse.

5.3 What Process Challenges Arise when Using the Metaverse?

The systematic analysis of the literature on the Metaverse revealed a significant consensus among scholars regarding the main process challenges associated with its adoption. The results highlight three critical areas that the authors have consistently identified as fundamental obstacles to successfully integrating the Metaverse in diverse contexts.

In Fig. 11, it is possible to observe that the issue of regulation and ethics in the Metaverse, which has been widely explored in the literature, is emerging as one of the main challenges. The complexity inherent in virtual interactions, the collection of personal data, and privacy issues stood out as prominent concerns (EP21, EP22). The lack of clear regulatory frameworks and uniform ethical approaches to guide behavior in the Metaverse has been identified as a substantial barrier (EP48). The authors emphasized the pressing need to develop specific ethical guidelines and regulations to ensure responsible and safe use of the Metaverse (EP50).
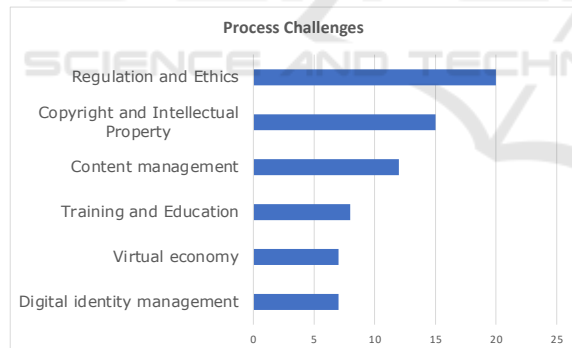

Figure 11: Process challenges in Metaverse adoption.

Another significant challenge that the authors highlighted concerns copyright and the protection of intellectual property in the virtual environment (EP16). With the proliferation of digital creations within the Metaverse, copyright definition and effective enforcement have become complex issues. The absence of adequate frameworks to protect and assign copyright in virtual environments raises concerns about the unauthorized reproduction and distribution of digital content. Resolving these issues has become crucial to encourage creation and

innovation without compromising the rights of creators (EP50).

Efficient content management in the Metaverse emerged as a practical challenge ranging from creating to distributing and archiving digital assets (EP12). The diversity of content formats (EP13), the need for adequate curation, and the need to ensure accessibility and continuous updating were highlighted as critical areas (EP20). The lack of uniform standards for organizing and presenting content in the Metaverse hinders user experience and effective interactions.

These results provide valuable insights for those interested in implementing and continuing the Metaverse development. Mitigating these process challenges will require multidisciplinary collaboration between stakeholders, policymakers, and the technology community. As the Metaverse evolves, facing these issues becomes imperative to ensure its ethical, legal, and functional development in various spheres of society.

5.4 Relevance and Future Works

For several reasons, investigating the metaverse's challenges from diverse perspectives—human, process, and technology—is essential for future practical initiatives.

Firstly, understanding human perspectives helps address user experience, accessibility, the digital divide, and ethical considerations. By considering human factors, developers can create more inclusive, engaging, and ethically responsible metaverse environments that cater to a broader range of users.

Secondly, examining process perspectives favours that metaverse platforms' development, implementation, and governance are efficient, scalable, and secure. This includes the integration of agile methodologies, privacy regulations, and interoperability standards to facilitate seamless experiences across different virtual environments.

Lastly, exploring technological challenges is essential for overcoming limitations related to hardware, software, and network capabilities. This involves advancing virtual and augmented reality technologies, improving data processing and storage solutions, and enhancing cybersecurity measures to support the complex demands of the metaverse. Addressing these challenges collectively from diverse perspectives is crucial for future metaverse initiatives. Future works, considering the analysis of metaverse challenges, might include:

- *Developing More Inclusive and Accessible Metaverse Environments*: Research and

development projects aim to create platforms accessible to users with various abilities, backgrounds, and technological access levels.

- *Enhancing User Experience through Ethical Design*: Initiatives focused on ethical considerations in the metaverse, ensuring user privacy and security and fostering a safe, engaging community.
- *Implementing Agile and Scalable Development Processes*: Studies or projects that explore integrating agile methodologies for the dynamic development of metaverse platforms, ensuring they are scalable and can evolve with user needs.
- *Establishing Governance and Regulatory Frameworks*: Develop comprehensive governance structures and regulatory frameworks that address privacy, data protection, and interoperability standards within the metaverse.
- *Advancing Hardware and Software Technologies*: Research into improving virtual and augmented reality devices, processing power, and storage solutions to support the high demands of metaverse environments.
- *Enhancing Cybersecurity Measures*: Projects aimed at bolstering the security of metaverse platforms, protecting users from potential cyber threats, and ensuring a safe virtual space for interaction.
- *Interoperability and Standards Development*: Efforts to develop and implement standards that ensure seamless experiences across different virtual environments, facilitating interoperability between various metaverse platforms.
- *Addressing the Digital Divide*: Initiatives focused on making the metaverse accessible to all, bridging the gap between those with ready access to digital technologies and those without, ensuring equitable participation.

These future works would address current limitations and challenges within the metaverse and lay the groundwork for a more immersive, inclusive, and sustainable digital future.

6 CONCLUSIONS

From the analysis of 55 studies on the Metaverse, it was possible to find evidence that we are in the early stages of understanding and effectively implementing this revolutionary technology. Most of the studies examined revealed a notable pattern: controlled environments simulations, where the potential and challenges of the Metaverse are explored in carefully designed scenarios. However, the lack of successful, long-term implementations of the Metaverse in real-world environments is a recurring finding. The current limitations lie in the lack of practical cases that have developed enough to generate robust artifacts for analysis. Most investigations are based on prototypes, experiments, and controlled environments that offer promising glimpses but do not fully reflect the dynamic, multifaceted challenges of a full-scale implementation.

It is imperative to recognize that, at its current stage, the Metaverse remains a developing area, dependent on substantial advances in several dimensions (human, technological, and procedural). From a technical perspective, it is necessary to improve the infrastructure to offer more immersive, accessible, and functional virtual environments. From a process perspective, regulation, ethics, copyright, and content management challenges demand innovative approaches and practical solutions. From a human perspective, social formation and acceptance play critical roles, as the interaction and widespread adoption of the Metaverse require shared understanding and cultural change. The need for education and awareness among both users and developers is a crucial area of attention.

We conclude, therefore, that the path to full use of the Metaverse is complex and multifaceted. As we explore its potential, it is vital to recognize the gaps and challenges presented in this study. Continued collaboration between researchers, developers, policymakers, and society is essential to pushing the Metaverse toward broader and more effective implementation. This is just the beginning of a journey that will require continued innovation and a collective commitment to the ethical and responsible development of the next frontier of digital experience.

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APPENDIX A

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