Literature Review on Metaverse Use Cases

Seminar paper

Behr, Lina Maria, FH Wedel, Wedel, Germany, stud106361@fh-wedel.de

Abstract

This literature review examines the state of the art on Metaverse use cases in different industries and business sectors. To elaborate this overview, a systematic literature review was carried out and the application-oriented development of the Metaverse discussed. The literature analysis based on 38 research studies shows that the Metaverse is revolutionizing industries such as art, business, education, finance, healthcare, manufacturing, entertainment, tourism, and transportation through its integration of recent technologies like virtual and augmented reality. It enhances the user experience, promotes teamwork and drives creativity. Collaboration between stakeholders provides the opportunity to overcome barriers, minimize risks and fully realize the potential of the Metaverse, leading to a new era of connected virtual experiences across all industries.

Keywords: Metaverse, industry, sector, systematic literature review

Table of Contents

1 Introduction to the Metaverse

Imagine starting a new role within a company but instead of the traditional introduction processes via video calls or in-person meetings, you are asked to join the enterprise Metaverse - a virtual space in which users move with the help of avatars and in which they can interact with and use virtual artifacts (Bendel, 2024). Correspondingly, you can directly connect with your new colleagues, get to know the corporate culture, and even meet coworkers across the globe for a coffee break in a completely virtual environment.

An onboarding process like this might seem like a distant concept taking into consideration that in a Bitkom-study in Germany 55% of the respondents stated that they were not familiar with the term "Metaverse" (Rabe, 2024).

Yet, the concept of a Metaverse, surges the interest of companies as well as academic research.

The multinational consulting company *Accenture*, for example, has already created its own Metaverse, called the *Nth floor*. Among other applications, *Accenture* currently uses this Metaverse for the onboarding procedure. In 2022 150,000 new employees experienced their first day at *Accenture* in this enterprise Metaverse, leveraging avatars, and Virtual Reality to engage with their new work environment (Accenture, 2022).

Metaverse related academic interest surged around the year 2020, resulting in numerous scholarly publications exploring its implications, chances, and risks (Rejeb et al., 2023).

Generally, the Metaverse is envisioned as a unified environment facilitating virtual commerce, digital asset transactions and diverse business interactions. It promises decentralized, collaborative ecosystems across various sectors (Gupta, 2022). While still in early stage, the Metaverse is seen as the Internet's next evolution (Weinberger and Gross, 2023). Projections by Gartner forecast significant user engagement by 2026, while J.P. Morgan is foreseeing a $1 trillion market opportunity (Resnick and Wiles, 2022). The whole evolution of the Metaverse is expected to progress through emerging, advanced, and mature phases, with full maturity anticipated after 2030 (Nguyen et al., 2022).

Subsequently, recognizing the early development stage of the Metaverse, this research paper aims to answer the question, what specific Metaverse use cases in business environments are currently (2024) being discussed in academic literature. Starting with a definition of key concepts regarding the Metaverse, a systematic literature review on the state of the art of specific Metaverse use cases will be provided. After that, the findings will be summarized and discussed. At last, broader implications will be presented and further research directions suggested.

This literature review introduces the Metaverse and its chances for specific business contexts. It does not address technical, legal, or ethical issues related to hardware, software, governance, or cultural implications. It excludes discussing general topics like the value of digital currencies, technical standardization, sustainability aspects, national laws, usability considerations, Metaverse classification and detailed discussions about generally applicable definitions.

2 Background Information

The following sections present an overview of the historical development of the Internet, and fundamental technologies enabling the Metaverse.

Historical development: Web 3.0

The Internet has already gone through three stages of development: Web 1.0 and Web 2.0; the third stage, Web 3.0, now significantly changes the way people interact with the Internet.

Static websites, passive consumers and open-source standards as well as technology constituted the characteristics of Web 1.0. User-driven content and engagement defined the Web 2.0 era. Real-time collaboration and interaction have been promoted by social networking, mobile access, and dynamic

content. Blockchain, semantic understanding, and decentralization are some of the main technologies that now make the transition to Web 3.0 possible. Its focus on decentralized data networks that create an environment without intermediaries, deploying artificial intelligence (AI) and edge computing form the foundation for developing the Metaverse (Cheng, 2023).

Blockchain

Unlike conventional methods managed by a central authority, Distributed Ledger Technology (DLT) enables a decentralized documentation of transactions. Blockchain technology is an effective implementation of DLT. It enables data storage by several parties with equal rights. Each party owns an identical ledger copy. New transactions are recorded in all copies. Consensus on the state of the ledger is achieved through smart contracts, and consensus algorithms. This decentralized approach reduces the need for trusted third parties, such as banks for financial transactions. Each participant can verify transactions independently (Urban, 2020).

Smart Contracts and NFTs

A smart contract is a programmable code deployed on a blockchain. Once predefined conditions are met, it executes the predetermined actions. It can create and manipulate different types of data or tokens within blockchain ecosystems. Smart contracts allow users to set rules for transactions without having to rely on intermediaries. A smart contract can facilitate the creation of unique assets with specific functions. They offer the potential to transfer many aspects of traditional business agreements to a blockchain by providing an algorithmic way to not only enumerate clauses, but also to enforce them (Harvey et al., 2021).

A non-fungible token (NFT) is a unique digital asset with exclusive characteristics within a framework. It cannot be exchanged on a one-to-one basis, like for example cryptocurrencies (Hartwich et al., 2022).

Digital Twin

A digital twin is an exact virtual representation of a product, system, component, or process. It consists of a semantically linked set of relevant digital artifacts such as design and operational data. Digital twins continue to mature throughout the lifecycle of the physical system and continuously integrate the available and required data and knowledge (Boschert and Rosen, 2018).

Virtual and Augmented Reality

Virtual Reality (VR) uses advanced computer graphics, motion sensors, and display technologies to allow users to immerse themselves in realistic simulations of real or imaginary worlds (Kamińska et al., 2019). Augmented Reality (AR) enables a real-time view of the physical world enhanced by overlaying computer-generated virtual information. This can be a direct or indirect augmentation. Interactivity, three-dimensional spatial integration and the ability to seamlessly merge virtual and real objects characterize AR resulting in an enriched user experience (Carmigniani and Furht, 2011). VR and AR may seem similar but both technologies serve different purposes. VR allows users to dive into a completely digital environment and experience it interactively by wearing headsets or glasses. AR, however, enhances the physical environment by overlaying digital objects with additional information and functions (Abdullah et al., 2023).

3 Literature Review

A systematic approach was used to generate a comprehensive literature review. As a result, the relevant literature was categorized in three stages: Literature Search, Literature Selection and Qualitative Analysis.

Literature Search

The initial literature search followed the methodology proposed by Webster and Watson (2002). Using a systematic approach, a significant amount of relevant literature on the Metaverse has been identified. The recherche was conducted using three databases: EBSCO, AISeL, and Emerald Insight. The entire search focused on the phrase "Metaverse".

To further narrow the EBSCO-search, I added the terms "sector" and "industry" to be mentioned in the abstract. Subsequently, *TI Metaverse AND AB (sector or industry)* formed the search query. After that, I restricted the results to peer-reviewed literature released within the last 12 months (as of April 2024). This led to the identification of 89 relevant journal articles.

In AISeL I searched the database using the phrase *TITLE: Metaverse*. Afterwards I applied the filters peer-reviewed articles and published in 2023 or 2024 resulting in three relevant publications. I used the same keywords and filters as in AISeL to identify literature in the Emerald Insight database (search phrase *TITLE: Metaverse*, filter: published in 2023 or 2024). In this database I identified 12 relevant publications. Thus, during this first phase, I identified 104 relevant journal articles.

Literature Selection

To narrow the literature collection to the most relevant publications, I applied more filters. Initially, duplicates have been identified and eliminated. After that, the remaining publications' titles and abstracts were examined for focus and relevance. Articles that did not contribute to the development of specific Metaverse use cases or lacked a research focus on them were removed. The remaining 38 articles have been included in the literature analysis.

Literature Analysis

During the selection and analysis process, an article by Tukur et al. (2024) published in the Journal of King Sau University - Computer and Information Sciences was identified. This article also provides a literature review regarding potential (general and specific) applications, techniques, and technologies of the Metaverse. Because of that, it forms the basis for the following overview of research paper regarding use cases, clustered by sectors (see Table 1). The table shows the number of articles published regarding Metaverse use cases in the respective sectors. It was further modified to include the literature discussed in the present study, yielding a total of 62 reviewed publications that address specific Metaverse use cases. The literature analysis itself focused on the article's contribution to the development of the Metaverse (for results see Table 2) and the key findings regarding the use cases themselves.

Sector	# of publications reviewed	
	Tukur et al. (2024)	Own contribution
Art	0	2
Business	1	2
Construction & Facility Management	0	2
Education	6	12
Finance	1	2
Healthcare	4	5
Manufacturing	5	7
Military	1	0
Real Estate	2	0
Entertainment	1	2
Sports	1	0
Food industry	0	1
Tourism	1	2
Transportation	1	1
∑ of publications	**24**	**38**

Table 1. Overview: number of publications regarding Metaverse use cases

So, based on the findings of Tukur et al. (2024) and the databases I used, it can be said that in the fields of education, followed by manufacturing in industry 4.0/5.0 and healthcare, most scientific literature regarding the Metaverse has recently been published.

4 Results

To develop a broader understanding of what a Metaverse is and what its key characteristics are, the following section briefly discusses two Metaverse definitions. After that, potential Metaverse use cases in specific business sectors are pointed out, firstly as an overview using the format of a table and secondly by giving a more detailed running text overview. Additionally, the last paragraph discusses some general concerns regarding the Metaverse.

Weinberger (2022) defines the Metaverse as "an interconnected web of ubiquitous virtual worlds partly overlapping with and enhancing the physical world. These virtual worlds enable users who are represented by avatars to connect and interact with each other, and to experience and consume user-generated content in an immersive, scalable, synchronous, and persistent environment. An economic system provides incentives for contributing to the Metaverse."
Mystakidis (2022) offers a similar definition, describing the Metaverse as "the post-reality universe, a perpetual and persistent multiuser environment merging physical reality with digital virtuality." It is formed by the convergence of technologies such as VR and AR, enabling multisensory interactions with virtual environments, digital objects and people. It functions as a networked web of immersive environments where users can communicate and interact with digital artifacts in real-time (Mystakidis, 2022).

In general, it is difficult to provide one universal definition as the Metaverse is a complex concept and still at an early stage of development. Different research groups pursue different approaches without reaching a common understanding. However, two major streams can be identified. Understanding the Metaverse as an advancement of internet platforms augmented by new attributes like three-dimensional communication and the direct trade of digital goods through NFTs is one method of approaching a definition. Another option is to see the Metaverse as an immersive environment where technological innovations like VR and AR allow for realistic experiences without requiring NFTs or persistence. Identifying the Metaverse's fundamental objective that unifies the many components and technologies and creates a unified vision is one of its challenges (Tingelhoff and Marga, 2023).

4.1 Use cases

Research studies are currently discussing possible applications in different environments to better comprehend the possibilities the Metaverse entails. An outline of the sectors and industries with the potential to benefit from the Metaverse can be seen in Table 2. The authors and their contributions to the development of the Metaverse are listed accordingly.

Sector	**Reference**	**Contribution**
Art	Xinyi (2023)	Creation of a framework for improving visual art quality in the Metaverse through innovative subjective analysis; qualitative & quantitative research
	Hu (2023)	Development of methods to evaluate visual quality; ranking of nine key indicators influencing art quality including targeted suggestions; integration of six core Metaverse technologies into digital design

Business	Erik et al. (2023)	Examination of workplace design challenges in Metaverse-based workplaces; introducing a new decision-making method addressing uncertainty
	Li and Ismail (2024)	Discussion of a multi-person collaborative virtual conference system using VR, enhancing engagement, collaboration and synchronization (e.g. XDreamer)
Construction & Facility Management	Waqar et al. (2023)	Identification of success factors for Metaverse integration into the Architecture, Engineering and Construction industry; practical insights
	El Jaouhari et al. (2023)	Examination of Metaverse techniques significantly advancing facility management and blockchain usage for proactive, daily property and asset management
Education	Rahman et al. (2023)	Description of virtual campus creation and 3D simulations; proposition of using Mozilla Hubs to revolutionize classrooms
	Bizel (2023)	Performance of a bibliometric analysis identifying trends, gaps and future directions; showing influential countries & researchers and possible improvements
	Pradana and Hanifah Putri (2023)	Discussion of benefits, challenges and implications for traditional educational systems; showing capabilities which emphasize transformative learning experiences
	Lee (2023a)	Focus on *Gather.Town*; addressing virtual learning programs engaging user at heritage sites, sustainability challenges and the strategic use of hybrid platforms
	Mitra (2023)	Proposition of a Metaverse Education and Training Platform blending physical and online participation (for professionals, academics, disadvantaged students)
	Hussain (2023)	Discussion of virtual classrooms & AI-driven personalized learning overcoming cultural barriers and addressing technical, ethical and social challenges
	Hanandita et al. (2024)	Discussion of Metaverse use in science education offering engaging and effective learning experiences
	Lee and Kim (2023)	Examination of AI-integration into the Metaverse enhancing educational experience; addressing leaners' difficulties in navigating the Metaverse
	Almeida et al. (2023)	Creation of a method for developing immersive Metaverses for industrial training; focus on creating cross-platform VR environments; address challenges
	De Felice et al. (2023)	Development of user-friendly VR environments to improve problem-solving and training; practical benefits for industry professionals for all technical skill levels
	Tella et al. (2023)	Emphasis on the role of metaliteracy skills for librarians and users; addressing need for ongoing training, critical thinking and collaboration
	Mitchell (2024)	Focus on teaching project management concepts; examining student perceptions of presence and collaboration; offers practical insights
Finance	Mohamed and Faisal (2024)	Focus on integration of technologies into banking operations within the Metaverse; highlight its transformative potential
	Radanliev (2024)	Exploration of blockchain technologies´ impact examining opportunities and risks in terms of finance and society; interdisciplinary approach
Food industry	Kulova et al. (2024)	Discussion of integrating sustainability-focused strategies into the Metaverse and the importance of sustainability, equity and environmental responsibility

Healthcare	Qian et al. (2023)	Introduction of a non-drug treatment for Alzheimer's disease utilizing Brain-Computer Interfaces and VR to create a virtual Memory Metaverse
	Kim et al. (2023)	Focus on integration of advanced wearable devices into the Metaverse to revolutionize healthcare; show challenges and opportunities
	Wang et al. (2023)	Discussion of immersive training for surgical procedures and medical practices; shows benefits of telemedicine and remote surgery improving healthcare access
	Lee (2023b)	Creation of a framework for Metaverse usage as therapeutic spaces in mental health care emphasizing human-centered aspects
	Mozumder et al. (2023)	Discussion of Metaverse supporting digital anti-aging in healthcare and personalized care delivery including remote treatment options and telepresence
Manufacturing	Piccarozzi (2024)	Emphasis on contribution of Metaverse to sustainability; discusses challenges & opportunities; shows need for effective regulation, policies and professional skills
	Kaigom (2024)	Discussion of robotized applications in Industry 4.0/ 5.0; addresses shared control between humans and robots using VR/AR, AI and digital twins
	Mourtzis (2023a)	Creation of a conceptual framework for integrating a human-centric approach; discusses personalized design system bridging digital and physical realms
	Hosseini et al. (2024)	Discussion of immersive interaction within a digital factory environment; uses a systematic methodology for creating a digital twin-based factory
	Salminen and Aromaa (2024)	Emphasis on potential applications for industrial settings and challenges; offer insights for developers to overcome obstacles in Metaverse development
	Mourtzis (2023b)	Emphasis on Digital Twins integration with Cyber-Physical Systems; proposes a service-oriented digital twin architecture with Metaverse-enabled platforms
	Khalaj et al. (2023)	Focus on digital twin technology; discusses how digital twins with cyber-physical systems and advanced sensors allow real-time data capture and analysis
Entertainment	Mohammed et al. (2024)	Focus on experiences and the changing landscape of virtual worlds and their relationship with gaming; emphasizes benefits and risks
	Oh et al. (2023)	Proposition of a framework to enhance interaction data communication in virtual concerts on Metaverse platforms, providing a solution for large audiences
Tourism	Kouroupi and Metaxas (2023)	Discussion of how Metaverse can combat overtourism by offering virtual experiences resembling real-world destinations; show the need for further research
	Florido-Benítez (2024)	Emphasis on interoperability standards ensuring seamless user experiences and accessibility; shows potential to enhance quality of life for residents and tourists
Transportation	Bag et al. (2023)	Examination of barriers to Metaverse integration into supply chain management and challenges for successful implementation

Table 2. Clustered overview: authors and their contribution to the development of the Metaverse

Metaverse and Art

The use of VR and AR in visual art can enhance the viewing experience and allow human-machine collaboration during art production, increasing user engagement. A large amount of information about artwork, visual traits, creators, and audience perceptions can be found in the Metaverse. Thus, by incorporating hearing, touch, and smell, it broadens creative possibilities, and enhances sensory experiences (Xinyi, 2023). In addition, the Metaverse provides an environment for assessing and improving digital art. Through the dynamic interaction of technology innovation and artistic advancement, it smoothly incorporates art evaluation and reshapes the digital art experience (Hu, 2023).

Metaverse and Business (in general)

Erik et al. (2023) propose a framework for a workplace design decision-making process, which is based on the assessment of five Metaverse environments. It considers factors like user experience, size, individualization, privacy, security, and communication. Thereby it reduces subjective bias while assisting in navigating complexity. Li and Ismail (2024) offer useful insights on the benefits of incorporating the Metaverse into virtual conferences. They emphasize enhanced collaboration via immersive environments, fostering creativity, and innovation in interaction techniques while minimizing expenses by keeping away with the need for a physical venue.

Metaverse, Construction and Facility Management

The Metaverse can facilitate immediate design modifications, interface with digital twins, and enhance safety training in the fields of construction and facility management. It allows architectural modifications, remote inspections, team communication, and predictive maintenance. This improves teamwork, communication, and project productivity (Waqar et al., 2023). Key elements of facility management, such movement tracking and device control, can enhance operations, while immersive simulations can increase staff engagement (El Jaouhari et al., 2023).

Metaverse and Education

According to Rahman et al. (2023), the incorporation of the Metaverse into educational environments provides real-time collaboration through global connectivity, while maintaining privacy, and security. Accessibility and engagement are encouraged by its immersive environment, tailored learning tools and the integration of conventional techniques (Bizel, 2023). In addition to this, the Metaverse gives students the opportunity to engage in simulations and experiments, what enhances their comprehension of scientific ideas and promotes lifelong learning (Hanandita et al., 2024). As stated by Pradana and Hanifah Putri (2023), the Metaverse's dynamic learning environment is more beneficial than traditional classrooms as it promotes critical thinking, teamwork and community development. These immersive learning environments are created using VR and AR technology, which also improve comprehension of difficult subjects and promote inclusive social interactions (Hussain, 2023). In terms of learning about project management principles, the Metaverse supports collaboration and risk-free problem-solving while meeting a variety of learning demands and preparing students for virtual work environments (Mitchell, 2024).

As indicated by Lee and Kim (2023), the incorporation of VR into the Metaverse aligns with educational theories such as constructivism. It also increases student learning efficiency and knowledge of topics like environmental conservation. The Metaverse enhances participation and information retention in professional training by providing practical experiences and real-life knowledge simulations (Mitra, 2023; Almeida et al., 2023). It acts as a platform for mentorship, encouraging cooperation and knowledge sharing between instructors, trainers, and learners. Furthermore, with the help of AI-driven avatars, the Metaverse provides immersive online learning opportunities in fields like astronomy and history (De Felice et al., 2023). But in this case, it is essential to also address ethical issues, such as data privacy (Lee, 2023a; Tella et al., 2023).

Metaverse and Finance

Mohameda and Faisal's (2024) research demonstrates, how the Metaverse impacts banking operations. In this sector, benefits include increased transaction security, advanced customer service and accelerated mortgage procedures caused by the integration of blockchain technology allowing for example the deployment of smart contracts. Using NFTs can also improve customer engagement and transactional flexibility. In general, the banking sector can profit from the Metaverse through improved customer satisfaction, developing innovative products like green loans, and optimizing operations.

The integration of cryptocurrencies in the Metaverse is examined by Radanliev (2024). He highlights the social and economic implications of this development. The study emphasizes a multidisciplinary approach to provide insights on the relationship between fintech, blockchain, and the Metaverse. By addressing the financial and cybersecurity issues associated with blockchain use in the Metaverse, it closes a gap in current research. It anticipates how blockchain technology and cryptocurrencies will affect the socioeconomic landscape in the future. This analysis highlights the dynamic role that cryptocurrencies play in shaping the evolving Metaverse ecosystem.

Metaverse and the Food Industry

According to Kulova et al. (2024), the Metaverse has a significant impact on the food industry. It is transforming customer experiences and advancing sustainability. Large companies like KFC, Starbucks, and Domino's Pizza are utilizing virtual platforms to offer individualized experiences that merge virtual and physical worlds by utilizing AR, VR, and Artificial Intelligence. While contextual support improves the customer journey and increases sales and brand loyalty, avatars make it easier for customers to interact with virtual offerings while creating sustainable decisions. Brands attract eco-aware customers by incorporating sustainability into their virtual activities, which possibly increases profitability.

Metaverse and Healthcare

There is growing interest in the application of innovative technology, especially the Metaverse, to healthcare. Its advantages for surgical precision, medical education, remote healthcare, and medical imaging are discussed by Qian et al. (2023). They highlight its potential for managing chronic illnesses and provide insights into a Metaverse therapy concept for Alzheimer's patients. This approach involves creating customized virtual settings to trigger memories, with the potential to improve cognitive function and emotional well-being.

In a similar way, Kim et al. (2023) investigate the revolutionary developments in several healthcare sectors generated by the Metaverse. They demonstrate immersive digital healthcare applications that improve patient outcomes, surgical performance and therapeutic impacts across biomedical imaging, training, and surgery. Through 3D volumetric microscopic imaging, XR technology is renowned for its capacity to offer interactive visualization for bio/medical applications, strengthening our understanding of intricate biological structures. Additionally, Kim et al. (2023) discuss wearables that are part of the Metaverse, like avatar-based rehabilitation and smart rehabilitation systems, which provide real-time feedback and reduced patient heterogeneity. Yet, optimizing interactions in the Metaverse, offering customized feedback and enabling real-time patient data monitoring essentially relies on the combination of Artificial Intelligence, machine learning, Internet of Things and 5G connectivity.

Wang et al. (2023) concentrate on how the Metaverse might improve telemedicine and remote therapy. They describe the availability of health monitoring and online consultations, which are particularly helpful in remote areas. By providing 3D schematics and virtual simulations for medical training, the Metaverse enhances learning in a risk-free setting, hence facilitating training and instruction. Furthermore, they emphasize how the Metaverse aids with surgical precision by improving surgical planning using AR technology for comprehensive anatomical images.

Additionally, they discuss the usage of VR tools for mental health treatment, stressing the issues, such as data security and network reliability, that need to be resolved. Yet, the Metaverse offers ways of immersive therapy for disorders like anxiety and phobias.

With the objective to demonstrate how the Metaverse might enhance patient outcomes and accessibility to healthcare, Lee (2023b) examines its uses in professional training, stress management and mental health therapy. Benefits include more effective stress and pain management strategies, improved data management, innovative research and treatment approaches, increased access to medical services, virtual therapy sessions and professional healthcare training. Moreover, there are intriguing opportunities for improving patient outcomes and healthcare delivery leveraging the Metaverse.

In their investigation into the Metaverse's applications in healthcare, Mozumder et al. (2023) emphasize the Metaverse's potential to enable remote medical treatment for patients, especially those with mobility limitations. Furthermore, it provides real-time data to surgeons during complex procedures, thereby improving outcomes. It is underlined that AR can improve accessibility by enabling remote patient assessments. It appears that medical professionals sharpen their skills using Metaverse simulations, and that innovation is driven by digital anti-aging procedures and the integration of AI, blockchain, and Internet of Things.

Metaverse and Manufacturing

Research on the intersection of Industry 4.0 and 5.0 with the Metaverse highlights how revolutionary this technology can be for production (Piccarozzi, 2024). Although the authors agree on its potential, they all present different angles on its use cases, advantages, and difficulties. Piccarozzi (2024) demonstrates how the Metaverse might improve teamwork, and sustainability by mentioning application cases such as remote equipment monitoring and virtual prototyping. In a similar way, Kaigom (2024) highlights the increase in productivity enabled through artificial intelligence, and virtual workspaces. Mourtzis (2023a) expands on this topic by mentioning advantages including a blockchain-secured transaction system, gamification for employee engagement, a human-centric approach to value generation, and increased productivity through real-time contact.

Hosseini et al. (2024) explore the Metaverse's immersive experiences in further detail, focusing on digital factories and their use of VR and digital twins. Their emphasis on real-time monitoring and avatar interactions shows a sophisticated understanding of how virtual environments can boost creativity and productivity. Using avatars, users can interact with equipment in virtual environments as well as monitor and operate production operations in real time. Because of the shared reality experiences and human-centered interactions, it promotes increased productivity, cooperation, and invention. Manufacturing processes can be accelerated and monitored in real-time by combining immersive experiences and full-body interactions with virtual assets. This allows for remote troubleshooting, repairs, and training through simulation.

While recognizing issues like technological acceptance and security, Salminen and Aromaa (2024) further highlight the Metaverse's role in promoting collaboration and supporting essential services like simulation and design, such as virtual product presentations and increased employee training. Furthermore, Mourtzis (2023b) and Khalaj et al. (2023) stress the significance of digital twin technology in the Metaverse's manufacturing process optimization, emphasizing continuous simulation and monitoring for long-term productivity increases.

Metaverse and Entertainment

As stated by Mohammed et al. (2024), the Metaverse is transforming gaming by blending the lines between the actual and virtual worlds to foster social engagement, immersion and business potential. With the use of virtual assets and NFTs, they put a strong emphasis on connecting game engines with the Metaverse to enable expanded ecosystems and enhanced gameplay. This increases player base size and engagement, which boosts revenue and loyalty.

Oh et al. (2023) address issues like scalability and performer-audience interaction while focusing on virtual concerts in the Metaverse. They further talk about platforms like WAVE. To improve communication and audience experiences, they suggest strategies like Software-Defined Networking and clustering algorithms. Immersion performances are provided by virtual concerts, which redefine entertainment and audience interaction.

Metaverse and Tourism

According to Kouroupi and Metaxas (2023), the tourist sector experiences a transformation due to the incorporation of the Metaverse, VR and AR. These technologies offer virtual substitutes for traditional travel. They tackle problems like overtourism and open new economic opportunities. Although the Metaverse makes it easier to advertise sustainability and highlight tourism products, issues with affordability and infrastructure still exist. Stakeholder involvement and efficient destination management are essential for the success of Metaverse tourism. It can attract tourists, share economic gains, and lessen its negative environmental effects through virtual tours, cultural promotion, and sustainability programs. Additionally, it improves tourist experiences through digital innovations and personalized recommendations, providing a revolutionary approach to tourism that addresses traditional issues.

Furthermore, the Metaverse could transform the travel industry by providing enhanced sales via immersive marketing and more efficient booking procedures. Personalized experiences that attract visitors and locals alike can help tourism destinations leverage Metaverse platforms to access new revenue streams. Moreover, it enables creative advertising strategies and data-driven governance, which could result in improved effectiveness and a higher standard of living for all parties involved (Florido-Benítez, 2024).

Metaverse and Transportation

Bag et al. (2023) demonstrate how the Metaverse is revolutionizing supply chain management. First, supply chain processes may be modeled and tested in virtual environments, which helps to maximize efficiency and foresee problems before they arise. Through scenario testing, businesses can utilize virtualization to find bottlenecks and increase productivity. Participants in the supply chain can work together more quickly in the Metaverse, which shortens lead times and enhances decision-making. Complete product monitoring is made possible by digital twins, which helps inform data-driven maintenance choices. Costs are reduced and inventory management is improved using simulations and predictive analysis to enable real-time visibility of stock and storage optimization. Blockchain integration increases confidence and transparency by improving supply chain traceability, transaction security, and authenticity. In conclusion, SCM is improved by the Metaverse through increased efficacy, transparency, collaboration, and decision-making, resulting in cost savings and competitive advantages.

4.2 Risks and Challenges

It is essential to recognize and responsibly handle the wide range of risks associated with the Metaverse's development. Although there is great potential regarding its benefits in several industries, an objective evaluation must consider the challenges it presents. Significant concerns about data privacy and network security, especially in vulnerable fields like healthcare, have been addressed by Wang et al. (2023). Furthermore, risks regarding the possible effects of excessive usage on one's physical and emotional well-being also exist. These should be taken into consideration as the Metaverse develops. According to Radanliev (2024), the incorporation of blockchain technology, which is essential to the Metaverse, presents challenges related to finances and cybersecurity. The creation of multi-user platforms such as the Metaverse also requires overcoming network performance limits, ensuring robust system security, and synchronizing users, as highlighted by Almeida et al. (2023).

Hu (2023) therefore calls for coordinated efforts to provide high-speed internet infrastructure and guarantee hardware compatibility both being essential for the Metaverse's general acceptance and usability. In addition, Rahman et al. (2023) point out that there are several key obstacles, including sustainability, interoperability, and the difficulty of merging the virtual and physical worlds. For efficient Metaverse navigation, Salminen and Aaromaa (2024) emphasize the significance of resolving technological challenges, focusing user-friendly design, addressing accessibility concerns, and fostering digital literacy.

Above all, dealing with these complex issues necessitates interdisciplinary collaboration. Governments and businesses should work together, according to Florido-Benítez (2024), to reduce risks and promote a sustainable and inclusive digital ecosystem.
Essentially, the responsible and equitable growth of the Metaverse depends on identifying and proactively resolving the dangers associated with it. Only then the transformational potential can be realized, while ensuring the security and well-being of its users.

5 Discussion

The Metaverse fosters innovation across various sectors by introducing new tools and immersive experiences. Authors agree on its transformative potential. In art, VR/AR enriches viewing, encouraging collaboration and sensory immersion. Furthermore, it streamlines decision-making, collaboration, and enhances user experiences. In the construction sector, it facilitates design modifications, remote inspections, and improves productivity as well as safety. In the field of education, the Metaverse enables real-time collaboration, tailored learning, and immersive experiences, enhancing engagement and comprehension. The financial sector can leverage it to improve security, engagement, and efficiency, fostering innovation in banking services. The food industry can profit from personalized experiences and sustainability initiatives, enhancing brand loyalty and profitability. In healthcare environments the Metaverse can enhance patient outcomes and accessibility through surgical precision and therapy in virtual environments. Moreover, Manufacturing can profit from optimized processes with virtual prototyping, remote monitoring, and digital twins, boosting productivity and sustainability. In entertainment it redefines gaming and concerts, fostering social engagement and business potential through immersive experiences. In the tourism industry, the Metaverse offers virtual travel alternatives, addressing overtourism and sustainability, enhancing tourist experiences and destination management. In Supply Chain Management virtual modeling and real-time monitoring driving cost savings and efficiency gains can be profitable use cases.

The authors widely agree on the enhancement of experience and collaboration, improved learning and training possibilities as well as a positive effect regarding efficiency and productivity enabled by leveraging the Metaverse.

Especially in healthcare and educational contexts, security and privacy concerns have been addressed. So, to fully approach these concerns as well as general implications, further research is needed. Long-term, multidisciplinary research projects should be initiated to completely comprehend the concept of a Metaverse. Also, the challenge of integrating the Metaverse into existing systems can be demanding across different industries. So, this technical perspective also requires more investigation. Moreover, the economic viewpoint must be considered. While some authors focus on the potential of the Metaverse and the thereby increased revenue, some point out affordability issues.

Additionally, it must be mentioned that this research paper contains only a limited amount of literature reviewed. It furthermore focusses on specific use cases discussed in research studies published in the years 2023 and 2024 exclusively. Important topics like sustainability aspects, including social, economic, and ecological factors, must also be considered when evaluating the development of virtual environments. Besides, staying updated on legislative and political developments regarding regulatory frameworks for the Metaverse or virtual environment in general is crucial.

As the Metaverse is in an early stage of development generally applicable implications cannot be drawn from recent studies. This research paper can be used as a starting point for further research regarding the different sectors. Managers should engage with the topic, collect information about potential use cases for the industry they are working in, and discuss the possibilities with employees and other stakeholders to identify business cases.

6 Conclusion

Summarized, it can be said that to fully understand the whole context of the Metaverse, significantly deeper research, studies and information is needed. While the Metaverse holds promising opportunities for different sectors, the already existing concerns should always be part of the discussion about its further development and application. Also, user-centric, value generating approaches will be essential as the success of the Metaverse also depends on peoples' willingness to use the technology.

Therefore, a holistic approach including interdisciplinary research should be preferred to cope with the complexity of this topic and its implementation on a larger scale. Additionally, it might need a robust framework to leverage advantages while minimizing negative impacts.

Moreover, the evolution of the Metaverse is still in an early stage and therefore its further development is still open. This, on one hand, can be seen as an opportunity to be an early adopter, what might lead to a competitive advantage in the future, for example regarding the chances and business opportunities of a virtual economy as a surrounding ecosystem of the Metaverse. On the other hand, its development depends on various determinates like national regulatory, technical advancements and sustainability aspects. So, it cannot easily be predicted. Accordingly, it depends on one's risk awareness if leveraging emerging technologies like the Metaverse are integrated into a strategic roadmap, build a specific business case or are completely left aside. As there already exist early proofs of concept, it will be interesting to see how companies leverage the Metaverse and the enabling technologies to generate significant and sustainable value while stemming the challenges and risks.

In conclusion, this literature review underscores the multifaceted nature of the Metaverse, highlighting its transformative potential across industries and the need for further research to navigate its complexities and maximize its benefits for society. Because only if we achieve an understanding of possibilities, risks and implications as holistically as possible, we can create a Metaverse, that benefits as many people as possible.

References

Accenture (2022). *Going beyond with extended reality.* March 16, 2022. https://www.accenture.com/us-en/about/going-beyond-extended-reality.

Almeida, L.G.G.; Vasconcelos, N.V.d.; Winkler, I. and M.F. Catapan (2023). Innovating Industrial Training with Immersive Metaverses: A Method for Developing Cross-Platform Virtual Reality Environments. *Appl. Sci*. 13, 8915. https://doi.org/10.3390/ app13158915.

Bag, S., Rahman, M.S., Srivastava, G. S.K. and S.K. Shrivastav (2023). Unveiling metaverse potential in supply chain management and overcoming implementation challenges: an empirical study. *Benchmarking: An International Journal.* https://doi.org/10.1108/BIJ-05-2023-0314.

Bendel, Oliver (2024). *Metaverse*. Gabler Wirtschaftslexikon. https://wirtschaftslexikon.gabler.de/definition/metaverse-123520 (visited on 05/20/2024).

Bizel, Gulhan (2023). A Bibliometric Analysis: Metaverse in Education Concept. *Journal of Metaverse.* 3 (2), 133-143. Doi: 10.57019/jmv.1310768.

Boschert, S. and C.H.R. Rosen (2018). NEXT GENERATION DIGITAL TWIN. *Proceedings of TMCE 2018, Gran Canaria, Spain.* https://www.researchgate.net/profile/Stefan-Boschert/publication/325119950_Next_Generation_Digital_Twin/links/5af952ca0f7e9b026bf6e553/Next-Generation-Digital-Twin.pdf.

Carmigniani, J. and B. Furht (2011). *Augmented Reality: An Overview*. In: Furht, B. (eds) Handbook of Augmented Reality. New York: Springer. https://doi.org/10.1007/978-1-4614-0064-6_1.

Cheng, Shenghui (2023). Metaverse: Concept, Content and Context. Cham: Springer Nature.

De Felice, F.; Petrillo, A.; Iovine, G.; Salzano, C. and I. Baffo (2023). How Does the Metaverse Shape Education? A Systematic Literature Review. *Appl. Sci.* 13, 5682. https://doi.org/10.3390/ app13095682.

El Jaouhari, Asmar; Arif, Jabir; Samadhly, Ashutosh and Anil Kumar Bandrana (2023). ARE WE THERE OR DO WE HAVE MORE TO DO? METAVERSE IN FACILITY MANAGEMENT AND FUTURE PROSPECTS. *International Journal of Strategic Property Management* 27 (3), 159-175. https://journals.vilniustech.lt/index.php/IJSPM/article/view/19516.

Erik, A., Kuvvetli, B.I., Kuvvetli, Y. and S.M. Hamidy (2023). The Type-2 Q-rung Orthopair CoCoSo method for Workplace Design Problems on the Metaverse. *Management & Marketing* 18, 340 - 354, DOI: 10.2478/mmcks-2023-0018.

Florido-Benítez, Lázaro (2024). Metaverse cannot be an extra marketing immersive tool to increase sales in tourism cities. *INTERNATIONAL JOURNAL OF TOURISM CITIES*. *Emerald Publishing Limited*. https://www.emerald.com/insight/content/doi/10.1108/IJTC-01-2024-0001/full/html.

Gupta, Ashutosh (2022). *What Is a Metaverse?*. https://www.gartner.co.uk/en/articles/what-is-a-metaverse (visited on 05/20/2024).

Hanandita, Saphira; Prahani, Binar K.; Hariyono, Eko and Marianus (2024). Metaverse: A Paradigm Shift in STEM Education for Science Learning Beyond the Review. *E3S Web of Conferences* 482. https://doi.org/10.1051/e3sconf/202448204004482.

Hartwich, E., Ollig, P., Fridgen, G. and A. Rieger (2022). Probably something: a multi-layer taxonomy of non-fungible tokens. *Emerald Publishing Limited*. https://www.emerald.com/insight/content/doi/10.1108/INTR-08-2022-0666/full/pdf?title=probably-something-a-multi-layer-taxonomy-of-non-fungible-tokens.

Harvey, Campbell R.; Ramachandran, Ashwin; Santoro, Joey and Fred Ehrsam (2021). DeFi and the Future of Finance. 1st Edition. Hoboken: John Wiley & Sons.

Hosseini, Shimasadat; Abbasi, Ali; Magalhaes, Luis G.; Fonseca, Jaime C.; da Costa, Numo M.C.; Moreira, António H.J. and João Borges (2024). Immersive Interaction in Digital Factory: Metaverse in Manufacturing. *Procedia Computer Science* 232, 2310–2320.

Hu, Z. (2023). Visual art evaluation methods in future digital works: From virtual reality to metaverse. *Journal of Intelligent & Fuzzy Systems* 45, 2347–2365, DOI:10.3233/JIFS-223376.

Hussain, S. (2023). Metaverse for education – Virtual or real? *Front. Educ*. 8, 1177429. https://doi.org/10.3389/feduc.2023.1177429.

Kaigom, Eric Guiffo (2024). Potentials of the Metaverse for Robotized Applications in Industry 4.0 and Industry 5.0. *Procedia Computer Science* 232, 1829–1838.

Kamińska, D.; Sapiński, T.; Wiak, S.; Tikk, T.; Haamer, R.E.; Avots, E.; Helmi, A.; Ozcinar, C. and Anbarjafari (2019). Virtual Reality and Its Applications in Education: Survey. *Information* 10, 318. https://doi.org/10.3390/info10100318.

Khalaj, O.; Jamshidi, M.; Hassas, P.; Mašek, B.; Štadler, C. and J. Svoboda (2023). Digital Twinning of a Magnetic Forging Holder to Enhance Productivity for Industry 4.0 and Metaverse. *Processes* 11, 1703. https://doi.org/10.3390/pr11061703.

Kim, Kisoo et al. (2023). Metaverse Wearables for Immersive Digital Healthcare: A Review. *Advanced Science* 10. DOI: 10.1002/advs.202303234.

Kouroupi, N. and T. Metaxas (2023). Can the Metaverse and Its Associated Digital Tools and Technologies Provide an Opportunity for Destinations to Address the Vulnerability of Overtourism? *Tour. Hosp*. 4, 355–373. https://www.mdpi.com/2673-5768/4/2/22.

Kulova, Ivelina; Nikolova-Alexieva, Valentina and Radi Paskalev (2024). The metaverse and sustainability as drivers revolutionizing customer experience in the food industry. *BIO Web of Conferences 102*, FoSET. https://doi.org/10.1051/bioconf/202410204009.

Lee, C. (2023a). MEMORIALIZATION THROUGH METAVERSE: NEW TECHNOLOGIES FOR HERITAGE EDUCATION. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-2-2023 29th CIPA Symposium "Documenting, Understanding, Preserving Cultural Heritage: Humanities and Digital Technologies for Shaping the Future*, Florence: Italy, p. 919-926. https://doi.org/10.5194/isprs-archives-XLVIII-M-2-2023-919-2023.

Lee, K. (2023b). Counseling Psychological Understanding and Considerations of the Metaverse: A Theoretical Review. *Healthcare* 11, 2490. https://doi.org/10.3390/ healthcare11182490.

Lee, J. and Y. Kim (2023). Sustainable Educational Metaverse Content and System Based on Deep Learning for Enhancing Learner Immersion. *Sustainability* 15, 12663. https://doi.org/10.3390/su151612663.

Li, Yingying and Ajune Wanis Ismail (2024). Multi-person interaction in collaborative virtual conference for Metaverse. *Indonesian Journal of Electrical Engineering and Computer Science* 33, 1998~2006. DOI: 10.11591/ijeecs.v33.i3.pp1998-2006.

Mitchell, Alanah (2024). Metaverse adoption for the teaching and learning of project management: an exploratory study of student use. *International Journal of Information Systems and Project Management* 12 (1). https://aisel.aisnet.org/ijispm/vol12/iss1/5.

Mitra, S. (2023). Metaverse: A Potential Virtual-Physical Ecosystem for Innovative Blended Education and Training. *Journal of Metaverse* 3 (1), 66-72. DOI: 10.57019/jmv.1168056.

Mohamed, Azza and Rouhi Faisal (2024). Exploring metaverse-enabled innovation in banking: Leveraging NFTS, blockchain, and smart contracts for transformative business opportunities. *International Journal of Data and Network Science* 8, 35-44.

Mohammed, Sahar Yousif; Aljanabi, Mohammed; Gadekallu and Reddy Thippa (2024). Navigating the Nexus: A systematic review of the symbiotic relationship between the metaverse and gaming. *International Journal of Cognitive Computing in Engineering* 5, 88-103. https://doi.org/10.1016/j.ijcce.2024.02.001.

Mourtzis, D. (2023a). The Metaverse in Industry 5.0: A Human-Centric Approach towards Personalized Value Creation. *Encyclopedia* 3, 1105–1120. https://doi.org/10.3390/ encyclopedia3030080.

Mourtzis D. (2023b). Digital twin inception in the Era of industrial metaverse. *Front. Manuf. Technol.* 3. doi: 10.3389/fmtec.2023.1155735.

Mozumder, M.A.I.; Armand, T.P.T.; Imtiyaj Uddin, S.M.; Athar, A.; Sumon, R.I.; Hussain, A. and H.-C Kim (2023). Metaverse for Digital Anti-Aging Healthcare: An Overview of Potential Use Cases Based on Artificial Intelligence, Blockchain, IoT Technologies, Its Challenges, and Future Directions. *Appl. Sci.* 13, 5127. https://doi.org/10.3390/ app13085127.

Mystakidis, S. (2022). Metaverse. *Encyclopedia* 2, 486–497. https://doi.org/10.3390/ encyclopedia2010031.

Nguyen, Tuong; Lee, Adrian and Anushree Verma (2022). *Die Entwicklung des Metaverse erfolgt schrittweise. Was das für die Strategie von Tech-Produkten bedeutet, erfahren Sie hier.* https://www.gartner.de/de/artikel/entwicklung-des-metaversums-erfolgt-schrittweise-bedeutung-fuer-die-strategie-von-tech-produkten (visited 05/25/2024).

Oh, S., Chung, K., Aliyu, I., Hahn, M., Jeong, I.-K., Yu, C.-R., Um, T.-W., and J. Kim (2023). XDN-Based Network Framework Design to Communicate Interaction in Virtual Concerts with Metaverse Platforms. *Appl. Sci*. 13, 9509.

Piccarozzi, Michela; Silvestri, Cecilia; Fici, Luigi and Luca Silvestri (2024). Metaverse: a possible sustainability enabler in the transition from Industry 4.0 to 5.0. *Procedia Computer Science* 232, 1839–1848.

Pradana, Mahir and Elisa Hanifah Putri (2023). Metaverse in education: A systematic literature review. *Cogent Social Sciences* 9 (2), 2252656. https://www.tandfonline.com/doi/full/10.1080/23311886.2023.2252656.

Qian, Pengxin; Yang, Dawei and Chunxue Bai (2023). Metaverse: Freezing the time. *Clinical eHealth* 6, 29–35. https://doi.org/10.1016/j.ceh.2023.06.002.

Rabe, L. (2024). *Haben Sie schon einmal von dem Begriff "Metaversum" bzw. "Metaverse" gelesen oder gehört?*. Statista.com. https://de.statista.com/statistik/daten/studie/1292297/umfrage/bekanntheit-von-metaverse-in-deutschland/ (visited on 05/20/2024).

Rahman et al. (2023). Use of Metaverse Technology in Education Domain. *Journal of Metaverse* 3 (1), 79-86. Doi: 10.57019/jmv.1223704.

Radanliev, Petar (2024). The rise and fall of cryptocurrencies: defining the economic and social values of blockchain technologies, assessing the opportunities, and defining the financial and cybersecurity risks of the Metaverse. *Financial Innovation* 10 (1), 1-34. https://doi.org/10.1186/s40854-023-00537-8.

Rejeb, A.; Rejeb, K. and H. Treiblmaier (2023). Mapping Metaverse Research: Identifying Future Research Areas Based on Bibliometric and Topic Modeling Techniques. *Information* 14,356. https:// doi.org/10.3390/info14070356.

Resnick, Marty and Jackie Wiles (2022). *What Is a Metaverse? And Should You Be Buying In?*. Gartner.com. https://www.gartner.com/en/articles/what-is-a-metaverse (visited on 05/25/2024).

Salminen, Karoliina and Susanna Aromaa (2024). Industrial metaverse – company perspectives. *Procedia Computer Science* 232, 2108–2116.

Tella, Adeyinka; Ajani, Yusuf Ayodeji and Vivian Ugonna Ailaku (2023). Libraries in the metaverse: the need for metaliteracy for digital librarians and digital age library users. *LIBRARY HI TECH NEWS* 8, 14-18. DOI 10.1108/LHTN-06-2023-0094.

Tingelhoff, F. and J.J. Marga (2023). Perspektiven auf das Metaverse: Der Zeitgeist des Internets der Zukunft. *Wirtsch. Inform. Manag* 15, 290–294. https://doi.org/10.1365/s35764-023-00485-z.

Tukur, Muhammad; Schneider, Jens; Househ, Mowafa; Dokoro, Ahmed Haruna; Ismail, Usman Idris; Dawaki, Muhammad and Marco Agus (2024). The Metaverse digital environments: A scoping review of the techniques, technologies, and applications. *Journal of King Saud University - Computer and Information Sciences* 36 (2). https://doi.org/10.1016/j.jksuci.2024.101967.

Urban, Nicklas T. (2020). *Blockchain for Business - Erfolgreiche Anwendungen und Mehrwerte Für Netzwerkteilnehmer Identifizieren*. 1st Edition. Berlin: Springer Gabler.

Wang, Y., Li, C., Qu, L., Cai, H. and Y. Ge (2023). Application and challenges of a metaverse in medicine. *Front. Robot* 10. doi: 10.3389/frobt.2023.1291199.

Waqar, Ahsan; Othman, Idris; Alman, Muhammad Shafiq and Muhammad Basit Khan (2023). Analyzing the Success of Adopting Metaverse in Construction Industry: Structural Equation Modelling. *Journal of Engineering* 2023, 1-21. https://www.hindawi.com/journals/je/2023/8824795/.

Webster, J. and R.T. Watson (2002). Analyzing the Past to Prepare for the Future: Writing a Literature Review. *MIS Quarterly*, 26.

Weinberger, M. (2022). What Is Metaverse? - A Definition Based on Qualitative Meta-Synthesis. *Future Internet* 14, 310. https:// doi.org/10.3390fi14110310.

Weinberger, M. and D. Gross (2023). A Metaverse Maturity Model. *Global Journal of Computer Science and Technology* 22 (2), DOI:10.34257/GJCSTHVOL22IS2PG39.

Xinyi, Z. (2022). Metaverse-oriented visual art quality enhancement strategies: a field architecture design and fuzzy assessment theory perspective. *Journal of Intelligent & Fuzzy Systems* 12 (3), 18-20.