Journal of Metaverse
Review Article
Received: 2023-08-17 | **Reviewing:** 2023-08-31 & 2024-02-05 | **Accepted:** 2024-02-06 | **Online:** 2024-02-07 | **Issue Date:** 2024-06-30
Year:2024, **Volume:**4, **Issue:**1, **Pages:**21-32, **Doi:** 10.57019/jmv.1344489

Meta: XR-AR-MR and Mirror World Technologies Business Impact of Metaverse

Ayşe Meriç YAZICI
İstanbul Gelisim University
İstanbul, Türkiye
ayazici@gelisim.edu.tr
0000-0001-6769-2599

Ayşegül ÖZKAN
Promat Basım Yayın San. ve Tic. A.Ş.
İstanbul, Türkiye
dr.aysegul.ozkan@outlook.com
0000-0002-9625-0332

Hasan ÖZKAN
İstanbul Aydın University
İstanbul, Türkiye
hasanozkan84@gmail.com
0000-0001-7644-4351

Abstract— Metaverse offers opportunities for companies to create innovative business models by providing a virtual platform where they can sell products and services and interact with customers in new and unique ways. Extended Reality (XR), Augmented Reality (AR), Mixed Reality (MR) and Mirror World technologies are important technological pathways for the metaverse. The metaverse concept is changing organizational structures with new opportunities and shaping the workforce for the future environment. The purpose of this review article is to discuss the concept of metanomics, the business implications of the metaverse in the context of the economy, business and employee-based value, future workforce, B2B opportunities and new business models. The concept of metaptation was associated with the metaverse in later studies to be conceptualized within the framework of adaptation theory. This review concludes by asserting that as the metaverse continues to evolve, driven by advancements in XR, AR, MR, and Mirror World technologies, it will not only revolutionize traditional business models but also necessitate a new paradigm of metaptation, where businesses must continuously adapt to harness the full potential of the metaverse in the realms of economic growth, innovative B2B opportunities, workforce development, and customer engagement. In order to be successful in this dynamic change process, businesses should adopt a strategic approach to adopting these innovative technologies. These strategic steps of businesses will contribute to gaining competitive advantage by enabling them to make the most of the commercial potential of the Metaverse.

Keywords— Metaverse, metanomics, business, metaptation, metaverse technologies

I. INTRODUCTION

Among the eight underlying technology pillars of Metaverse, Network, Edge/Cloud [1], Artificial Intelligence [2], Computer Vision [3], Blockchain [4], Robotics/IoT [5, 6], User Interaction and Extended Reality come together to form a whole that enables interactive virtual experinces [1]. The Metaverse consists of four main components; Virtual Worlds, Mirror Worlds, Augmented Reality and Lifelogging [7, 8].

The term Extended Reality (XR) is used to describe the full spectrum covered by these technologies, recognizing the various levels of immersion and interactivity offered by mixed reality and virtual reality experiences [9]. It includes a set of technologies that aim to attract individuals to digital platforms and provide them with a sense of virtual presence or physical presence in a simulated environment. There are examples of use of XR technologies in education, healthcare and industrial design. In education, XR can provide students with interactive and in-depth learning experiences. Virtual laboratories have potential for use in education, such as reenacting historical events and visually explaining complex concepts. In healthcare, XR can be used in healthcare services such as surgical planning, patient education, rehabilitation and psychotherapy. For example, surgeons can use virtual reality technologies for preoperative planning. In industrial design, XR can improve the product design process. It can reduce errors and speed up the design process by providing designers with an interactive and in-depth experience in 3D modeling and prototyping processes [10]. Virtual Reality (VR) creates a simulated environment that can mimic real-world or fictional spaces, allowing users to feel as if they are physically present in that environment [11]. The user is immersed in the simulated environment and is able to interact with it using head-tracking and hand-held controllers, which respond to their movements. The goal of VR is to create a convincing and realistic experience that is as close to the real world as possible [12]. Examples of usage areas of VR technology include entertainment and games, simulations and social experiences. In entertainment and gaming, virtual reality is used in many areas of entertainment, from video games to theme park experiences. It offers fun and interactive experiences by transporting users to completely different worlds. Simulations such as flight training, medical training and training in hazardous jobs can be made more realistic with virtual reality. This can be used to improve skills in dealing with dangerous situations. In social experiences, virtual reality can enhance social experiences by bringing users together in virtual worlds. It can support social interactions such as virtual concerts, events and meetings [13].

In contrast, Augmented Reality (AR) enhances the user's view of the real world by overlaying digital information on top of their view of the physical environment [14]. It uses various devices like smartphones, tablets, smart glasses, and head-mounted displays to project digital images, videos, sounds, and other information onto the user's view of the real world. AR can be used in a variety of applications, such as gaming, medicine, education, training,robotics, manufacturing, marketing, and entertainment [15]. The underlying technology in AR involves the ability to seamlessly and naturally integrate digital information using computer vision, image processing, and sensor fusion, enabling a device to sense and track the user's surroundings [16].

Cite (APA): Yazıcı, A. M., Özkan, A., Özkan, H. (2024). Meta: XR-AR-MR and Mirror World Technologies Business Impact of Metaverse. *Journal of Metaverse*. 4 (1), 21-32. **Doi:** 10.57019/jmv.1344489

Mixed Reality (MR) is a hybrid of VR and AR, and it combines the virtual and real worlds in a way that allows the user to interact with both in a seamless way [17]. In mixed reality, users can interact with virtual objects while also interacting with the physical world. This is achieved by combining objects found in the real world with virtual objects. Sensors, cameras, and other sensors are used to detect and understand the user's environment. This information allows the user to interact with virtual objects and combine them with real-world objects [18].

Mixed reality uses similar technologies, such as augmented reality and virtual reality. For example, mixed reality in education can provide students with interactive and in-depth learning experiences. In healthcare, mixed reality can be used in surgical planning, patient education, rehabilitation and therapy processes. In industrial design, it can improve the product design process. Designers can use this technology to create prototypes and view products in real-world environments. It is used in many areas of entertainment, from video games to theme parks. This technology allows players to physically interact in the real world. In fields such as industrial training and simulation, training in hazardous jobs, flight training and medical education, mixed reality provides more realistic simulations integrated with the real world [19].

Scientifically, XR is a multi-disciplinary field that draws on research from computer science, psychology, neuroscience, engineering, and human-computer interaction. Research on XR has focused on various aspects of the technology, such as the design and development of VR and AR systems, the effects of XR on user cognition and perception [20], and the ethical and social implications of XR technology [21].

A mirror world is a digital replica of the physical world that can be interacted with in real-time [22]. It is a type of mixed reality (MR) technology that allows users to manipulate and interact with digital representations of real-world objects and environments. The mirror world concept is essentially a virtual copy of the real world, where users can access and interact with digital versions of real-world places, buildings, and objects [23]. This technology can be accessed through various devices such as smartphones, tablets, or VR/AR headsets. The potential uses of mirror worlds are wide-ranging and include things like virtual tourism, remote collaboration, digital twinning of cities, and more. It has the potential to change the way we interact with the world and each other, allowing for new forms of communication, entertainment, and education. However, as with any innovation, there are concerns about privacy, security and impacts on society.

There are several different technologies that are used to create and power metaverse, including:

- 3D modeling and scanning: This technology is used to digitise real-world objects and environments in detail and accurately through various methods such as photogrammetry, laser scanning and structured light scanning. It can be used particularly effectively in the fields of 3D modelling, virtual reality experiences and space design, providing guidance and sales support to customers in product selection, such as IKEA's VR-based home decor application [22].
- Real-time rendering: Mirror worlds need to be able to display digital objects and environments in real-time, with minimal latency. This is achieved through the use of advanced rendering techniques and powerful graphics processors. Real-time rendering in mirror worlds is important to optimize user experience, make interactions natural and fluid, and provide users with a more realistic environment. This requirement aims to provide an excellent experience with instantaneous response and low latency, using advanced processing techniques and powerful graphics processors [24].
- Augmented reality (AR) and virtual reality (VR) technology: AR and VR headsets and other devices are used to display the mirror world to users, allowing them to interact with digital objects and environments in a natural and intuitive way [2].
- Cloud computing: Mirror worlds require a significant amount of computing power, and many are built using cloud computing infrastructure, allowing for scalability and easy access [25].
- Global Positioning System (GPS), Inertial Navigation System (INS) and other location-based technology: Mirror worlds need to be able to accurately locate and map the real-world objects and environments they are based on, and technologies such as GPS, INS, Wi-Fi, and Bluetooth are used for this [26].
- Artificial intelligence and machine learning: AI and ML are used to create more realistic and lifelike digital objects and environments, and to enable advanced features such as real-time object recognition and natural language processing. The creation of digital replications of specific human data and life histories is being driven by a number of separate technology advances, particularly in the health industry [27].
- 5G: 5G networks will be important for mirror worlds as it allows for low-latency, high-bandwidth communication between devices, which is crucial for real-time interaction and collaboration in mirror worlds [28].

The terms metaverse and mirror world are often used interchangeably, but they do have slightly different meanings. The metaverse refers to a collective virtual shared space, created by the convergence of virtually enhanced physical reality and physically persistent virtual reality, where users can interact in an immersive environment. The metaverse is a term that encompasses the entire spectrum of virtual worlds, augmented reality, and mirror worlds, and is often used to describe a vision of the future where virtual and physical worlds are seamlessly integrated. In short, the metaverse is a broader concept that encompasses a wide range of reality technologies, including mirror worlds, and envisions a future where these technologies are fully integrated into our daily lives.

After examining the existing literature and the unique technologies related to metaverse, our perspective is to evaluate metaptation as a new concept within the framework of adaptation theory. It is believed that this review, which can provide self-evaluation of the metaptation, will shed light on researchers in order to use it in different studies according to that perspective. In the structure of this paper: First, the emergent concept of metaverse is explained, going from firstly named to current state. Second, the concept of metanomics was mentioned, with special emphasis on the main dimensions. Third, the following topics as the value of metaverse on businesses and employees, future workforce, B2B opportunity and business models are discussed.

Business to Business (B2B) is when one business sells or supplies its products or services to other businesses [29]. In B2B trade, businesses can often purchase large quantities of products or offer each other professional services specialised in a particular industry or sector. This type of trade is often built on exclusive contracts and long-term business relationships [30].

II. What Is The Metaverse?

The term "metaverse" is a combination of the words "meta-" and "universe". "Meta-" is of Greek origin and means "beyond", "above" or "essence", while "universe" means "universe" in English [31]. The combination of these two words creates the term "Metaverse", which refers to a digital universe, often created using virtual and augmented reality technologies [32]. The term metaverse was popularised by Neal Stephenson's science fiction novel "Snow Crash" published in 1992 [33]. In the novel, the metaverse is depicted as a virtual reality space where users can interact with each other and digital environments using their avatars [34]. The concept of metadata is often linked to the idea of a shared, immersive digital space where people can interact with each other, virtual objects, and environments in real time. Although the metaverse is often discussed in the context of virtual reality, augmented reality, and mixed reality, it can also refer to more traditional online communities and spaces, such as massively multiplayer online games or social media platforms. Later, this concept was tried to be defined in different ways by many people and a common scientific definition was not put forward. With the increasing use of the concept and its promising future, Facebook changed its name and rebranded as Meta at 2021 [35].

Although the concept of metaverse has been around for decades, in recent years it has gained importance and increased in popularity with the emergence and development of new technologies in the fields of virtual reality, augmented reality, mixed reality, and blockchain [36].

One aspect of the metaverse is that it is a virtual world where users can be represented by avatars, which are digital representations of themselves. These avatars can interact with each other and the virtual environment in a variety of ways, such as walking, talking, manipulating objects and joining education programs [37]. The metadata repository can also contain various other features such as virtual economies and marketplaces where users can buy and sell virtual real estate as well as virtual goods [38].

Another aspect of the metaverse is that it is a decentralized and distributed system, meaning it is not controlled by any single entity or organization [39]. Rather, it is created and maintained by a community of users and developers who contribute to its development and growth. This decentralized structure provides more opportunities for user interaction and participation, as well as greater innovation and creativity.

Metaverse also encompasses a wide variety of virtual worlds, from a wide variety of multiplayer online games to social media platforms and virtual reality experiences to augmented reality applications such as having meetings, collaborating on projects [40]. These different types of virtual worlds can be interconnected and form a larger, more cohesive metaverse.

Despite all the beauty of the Metaverse universe, how to ensure its security is also an issue that needs to be discussed. Ensuring security within the metaverse requires a multi-layered approach. Firstly, in terms of data security, the use of strong encryption protocols and end-to-end encryption of user data are fundamental measures. Furthermore, it is important to adopt strict privacy policies when storing and processing user data. This ensures that users' personal information is protected from unauthorised access [41].

In terms of ethics, the principles of honesty, transparency and respect should be emphasised in interactions within the Metaverse. In environments where users interact in the virtual world, ethical codes of conduct should be established and violations should have serious consequences. In addition, artificial intelligence algorithms should be programmed and supervised in accordance with ethical norms [42].

In terms of security, Metaverse platforms should be updated frequently and vulnerabilities should be continuously monitored. Regular security audits should be conducted by cyber security experts to protect users and take precautions against potential threats. This will make the security of Metaverse sustainable and enable users to interact safely in this digital universe [43].

Overall, the metaverse is a complex and multifaceted concept that is still evolving and not yet fully defined. As technology continues to advance and more people become involved, the metaverse will likely become an increasingly important and influential aspect of our lives and society.

III. Metanomics

Metanomics is a concept that is related to the metaverse, and it refers to the economic and financial systems that operate within the metaverse [44]. Metanomics, involves the concept of a virtual economy where users engage in buying and selling virtual goods and services using virtual currencies or tokens. This concept is closely related to virtual economies that exist within online platforms, video games, virtual worlds, and even certain blockchain-based ecosystems. These virtual economies can be linked to the real-world economy, allowing users to convert virtual currency into real money and vice versa. Additionally, the concept of metanomics also covers the creation, management and exchange of virtual assets, like virtual land, virtual property, virtual goods and services, and other forms of virtual ownership [45]. Another

way to conceptualize metanomics is as a decentralized and distributed financial system that operates independently of traditional financial institutions [46]. This decentralized structure allows for greater innovation and creativity, as well as more opportunities for user engagement and participation.

Metanomics can also be considered as a set of protocols and standards that provide the underlying infrastructure for economic activities in the metaverse, such as making payments, creating virtual assets, and managing digital identities. Overall, metanomics is a complex and multifaceted concept that encompasses various aspects of the economy and finance in the metaverse. It is closely related to the concept of blockchain, decentralized finance (DeFi), non-fungible tokens (NFT) and it is still evolving and being defined as the metaverse ecosystem continues to grow and develop [47].

The dimensions of metanomics are diverse and can include several different areas, but some of the main dimensions include:

- Virtual Currency and Blockchain: Metanomics is closely tied to the concept of virtual currencies, such as Bitcoin, and blockchain technology, which is the underlying technology used to create and manage virtual currencies. This dimension includes the use of cryptocurrencies and smart contracts for transactions and payments in the metaverse [44, 48].
- Virtual Assets and Ownership: This dimension of metanomics involves the creation, management, and exchange of virtual assets such as virtual land, virtual property, virtual goods and services, and other forms of virtual ownership. This can include virtual marketplaces, virtual real estate, and virtual item trading [45, 49] .
- Virtual Identity and Digital Identity: In the context of technology and virtual reality, the metaverse refers to a collective virtual shared space created by the convergence of virtually enhanced physical reality and physically persistent virtual reality. Users often interact with this metaverse through avatars, which are digital representations of themselves. Avatars effectively represent digital personas by providing individuals with the ability to navigate, communicate, and interact in a virtual environment.This dimension of metanomics includes the management and protection of digital identities, including the use of digital signatures, cryptographic keys, and other security measures to ensure the authenticity and integrity of digital identities [38] .
- Decentralized Governance: The metaverse is a decentralized and distributed system, meaning that it is not controlled by any single entity or organization. This dimension of metanomics covers the governance and decision-making processes that occur within the metaverse, including decentralized autonomous organizations (DAOs) and other forms of community-driven governance [50].
- Interoperability and Interconnectivity: There are multiple virtual worlds, platforms, and applications in the Metaverse ecosystem. This dimension of interoperability and interconnectivity between different virtual worlds, platforms, and applications is essential to create a seamless and immersive experience across various virtual worlds, platforms, and applications. Without interoperability and interconnectivity, the metaverse would be fragmented and users would be limited to only being able to interact with other users within a single virtual world or platform. This would greatly limit the potential of the metaverse and limit the ability of users to interact and engage with one another. Interoperability and interconnectivity are also essential for creating a seamless and immersive user experience, which is critical for the success of the metaverse [51, 52]. These dimensions are not mutually exclusive and can overlap and interact in various ways, reflecting the complex and multifaceted nature of the metaverse and its economy.

IV. The Value of Metaverse on Business and Employees

Thanks to the rapidly growing metaverse market, the user base has expanded. Organizations are developing strategies for themselves using supply chain, human resources and digital technology [53]. The metaverse's immersive and interactive nature might enhance workplace satisfaction by providing employees with novel ways to engage with their tasks, team members, and the organization as a whole. This could contribute to a more engaging and enjoyable work experience, potentially leading to increased job satisfaction and productivity [54]. Online meetings, corporate events and seminars are held with virtual reality technology. While the sense of presence of virtual reality users increases, it is provided in conditions to increase user satisfaction [55]. The metaverse concept usually involves a high level of user engagement, personalization, and community interaction. Customized service strategies for each metaverse user can be an important aspect of creating a vibrant and engaging metaverse experience [56].

The potential of metaverse technology to enhance collaboration and information exchange in enterprises is increasingly being realised. For example, many companies in South Korea, through metaverse-based platforms, are turning to various applications with the aim of increasing interaction between employees and establishing smoother communication in a virtual environment. These applications aim to make business processes more efficient by offering a sense of presence and immersion similar to the physical world. This can ultimately lead to increased productivity and overall business performance [57]. Korea-based companies such as Jikban and Com2us are actively investing in metaverse technology to promote digital transformation in their businesses. By integrating metaverse elements into their operations, these companies aim to create more efficient and effective systems, possibly for their employees. This could include virtual workspaces, interactive platforms for communication and collaboration, and innovative ways of organizing and managing tasks [58]. The use of digital technologies in this context can actively influence the employees' metadatabase. In this context, metadata will not only contribute to positive motivation focused on a specific goal, but will also be effective in terms of the influence of the external environment on the formation of individual

motivation [59]. It has been shown that virtual teams providing users with visuals associated with positive emotions in online environments positively influences knowledge sharing behavior, and a shared vision has a moderating effect. In other words, the common goal of digital transformation has the potential to moderate the positive impact relationship between employees' motivation towards the metadata environment and the sense of reality provided [60]. As the adoption of metaverse technology in business environments continues to evolve, it will be possible to see how different companies approach this integration and how they balance virtual and physical workspaces to optimize productivity and business performance.

The metaverse presents both opportunities and challenges for marketers. It requires a proactive and adaptive approach to capitalize on new technologies for advertising, branding, customer engagement, and customer service. Those who embrace these changes and are willing to experiment and innovate are likely to thrive in this dynamic environment.

While the potential benefits of the metaverse are immense, there are significant challenges and consequences for businesses and individuals who fail to adapt. According to adaptation theory, such entities may face declining relevance, competitiveness, or even obsolescence. This situation may necessitate a 'mutation' or a strategic pivot to survive in the new digital environment. Mutation could refer to significant changes or pivots in business models, strategies, or operations. For example, a traditional retail business might transform into a fully virtual storefront within the metaverse, or a company that primarily relied on in-person services may shift to offering immersive virtual experiences. These mutations would represent fundamental changes in how these businesses operate, interact with customers, and deliver their products or services, driven by the need to adapt and thrive in the evolving digital landscape of the metaverse.

In the dynamic landscape of the metaverse, businesses that fail to adapt face significant challenges. These include the risk of becoming market irrelevant as consumer preferences and technological landscapes evolve. The loss of a competitive edge is another major concern, potentially leading to decreased profitability and diminished market share. In extreme cases, this inability to adapt could result in business failure, as operations become unsustainable in the new digital environment. Alternatively, businesses that struggle to adapt may find themselves targets for acquisitions or mergers by more technologically adept companies, effectively losing their independence. These scenarios underscore the critical importance of adaptability and innovation in the era of the metaverse.

Furthermore, the widespread adoption of metaverse technologies among different demographics faces obstacles such as technical issues and high costs. Overcoming these challenges requires concerted efforts, including educational initiatives and policy support, to facilitate a broader acceptance and integration of these technologies.

Finally, the development of a set of rules or guidelines for metaptation in the metaverse is essential. This framework should include ethical, social, and technical standards to ensure a balanced and inclusive virtual environment, enabling entities to adapt effectively and thrive in the metaverse.

V. The B2B Metaverse Opportunity and Business Models

The Metaverse is a collective virtual sharing space created by combining virtually enhanced physical reality with physically persistent virtual reality. Essentially, it is a combination of virtual reality (VR) and augmented reality (AR) technologies that allow users to interact with a digital environment while using avatars to represent themselves [61]. Metadata represents a space where people can interact with each other and digital objects in a shared environment that includes various platforms and devices. Metaverse has the potential to revolutionize education, providing students with immersive and interactive learning environments that allow them to explore historical events, conduct virtual science experiments, or collaborate on projects. Businesses can use the metaverse for virtual meetings, conferences, and collaborative workspaces, enabling remote teams to interact more naturally and efficiently. Customer service and support can become more personalized and engaging through avatars and virtual agents that help users more humanly. The Metaverse can facilitate virtual doctor-patient consultations, medical training simulations, and even therapy sessions in immersive environments [62]. The concept of the metaverse has the potential to reshape the way we interact with technology, each other, and our environment.

The metaverse, a concept that refers to a virtual reality space where users can interact with computer-generated environments and other users in real-time, aims to bridge the gap between the virtual and physical worlds and offer users a sense of presence and immersion in this digital environment [63]. Leading technology companies such as Nvidia, Roblox, Decentraland, The Sandbox, China's Baidu, and South Korea's Netmarble are striving to create metadata platforms that serve as virtual worlds where people can interact, play games, work, and do business [64]. With the metaverse, the technological mediation of communication has accelerated [65]. Many physical social media applications such as trainings, seminars, conferences and ways of working in the workplace have moved to the online space of the metaverse or personal phones [46]. As technology continues to advance, more companies will likely join this movement and contribute to the development of the metaverse in a variety of ways.

The Metaverse allows users to create their own avatars and connect with other people nearby to explore their various local neighbourhoods. People who can create an avatar will be able to feel more immersed in their experiences rather than watching a film or television show on their computer screens [66]. This will make them feel like they are participating in the event. It also creates new opportunities for businesses. Because businesses will now be able to communicate directly with their customers through their avatars instead of relying on traditional marketing tactics such as print ads or television commercials [67].

The Metaverse is the latest chapter in the technology revolution that has the power to transform many industries, bringing improvements in customer experience, service

quality and productivity [68]. The Metaverse will make many services scalable and offer unprecedented increases in productivity and cost reductions. The Metaverse, in its various incarnations such as mirror worlds, augmented reality and fully virtual worlds, offers exciting possibilities for the service industry in terms of enhancing existing services and entirely new services [69].

In the metaverse, adapting to advantageous protocols for metaptation is a multi-faceted process. Entities must first thoroughly understand these protocols, which encompass not just technological aspects but also ethical and operational standards. For instance, a business might realign its customer engagement strategies to adhere to these protocols, ensuring a seamless integration of virtual and physical customer experiences. This realignment demands innovation and a willingness to experiment, akin to a retail company venturing into virtual storefronts within the metaverse, a significant shift from its traditional business model.

Moreover, this adaptation is not a one-time effort but a continuous process of learning and evolution. As digital environments are rapidly changing, entities must remain agile and responsive. For example, an educational institution might continuously update its teaching methodologies to leverage emerging technologies in the metaverse, ensuring that its pedagogical approaches remain relevant and effective.

Feedback and iterative improvement are also crucial. A healthcare provider, for instance, may initially introduce virtual consultations in the metaverse, but through regular feedback from patients and staff, it can refine and expand its virtual healthcare services. Such an approach exemplifies the iterative process of adapting to Advantageous Protocols, where entities not only comply with the set rules but actively use them as a springboard for innovation and success in the digital landscape. This proactive and dynamic approach to adaptation in the metaverse is essential for entities to thrive amidst the constantly evolving digital trends.

VI. Future Workforce With Metaverse

The potential for businesses to adapt their business models and operational capacities to operate on the metaverse is significant, with transformational impacts on marketing, tourism, entertainment, healthcare, education and social networking. For users who choose to interact with the metaverse in the coming years, the seamless nature of the transition between the physical world and the virtual world, and the multimodal enhancement of experiences, opens up an infinite realm of possibilities that are beyond our current comprehension. This can open up unique opportunities and interactions within the business community and between individuals. This can open up unique opportunities and interactions within the business community and between individuals [70]. However, there are numerous challenges from a socio-technical and governance perspective as platform providers seek to enhance the ability of users and organizations to create their own virtual worlds.

A business model is a supporting policy that outlines how a business will generate revenue [71]. The business model defines how a business will buy its product, advertise it and generate sales [72]. A business model decides what a business should offer, how it should market its products, who it should strive to appeal to, and what revenue streams it can expect [73]. Especially recently, with the introduction of the virtual universe called the metaverse into our lives, major transformations in business models have started to be experienced.

Facebook refers to rebranding. The rebranding as "meta" reflects the company's shift towards focusing on the development of the metaverse, a virtual shared space created by the convergence of physical and virtual reality. This shift aims to move the company away from its over-reliance on advertising revenues and towards revenue generation through transactions within the metaverse. It notes that blockchain companies may need a sustainable collaborative business model that serves multiple stakeholders, which is necessary to generate significant revenue through alliances in the blockchain-based sharing economy, to drive innovations in value chains, and to build sustainable business models in the sharing economy as well as in the metaverse. It evaluates the change created by virtual worlds on the business model, that is, on the internationalisation process [74].

Metaverse is a virtual and interconnected space that has the potential to impact various sectors and aspects by combining virtual reality, augmented reality, blockchain, artificial intelligence and similar elements. It can serve a broad spectrum of interactions in areas such as entertainment, business, communications and commerce [75]. The fact that different countries may have different policies and regulations regarding the Metaverse is an important consideration. Each country's approach can affect how the Metaverse evolves and what kinds of applications are developed within its borders. As a pioneer in this field, the United States has created a comprehensive Metaverse framework that covers various aspects such as business, entertainment, art, and social interactions.China has a large market and strong Internet businesses and Internet applications. Domestic Internet companies have successively promoted business, video games and art in the Metaverse. Japan, with its cumulative advantages in the ACG industry and rich IP resources, focuses on application fields in animation and video games, while South Korea is led by the government and driven by the idol industry. German and Italian luxury brands are trying to get more people to become their customers through virtual products etc. [76].

The convergence of e-commerce and the metaverse opens up exciting new possibilities for business, providing opportunities to make virtual shopping experiences more interactive and personalised, create unique commerce environments within the virtual world, and build deeper connections with customers. As businesses continue to explore and utilize the capabilities of virtual environments, we will see significant changes in the way they operate, collaborate and create value in the global economy. E-commerce and the metaverse can enable businesses to establish a virtual presence, reducing the need for physical infrastructure and associated costs. Within the metaverse, businesses can develop and manage their virtual economies. These economies can include virtual currencies, digital assets,

and trading systems that facilitate transactions and interactions between businesses and customers. The Metaverse allows businesses to establish new forms of trade and partnership. Companies can collaborate and partner in innovative ways, crossing traditional boundaries and exploring new avenues for growth.

The rise of metaverse technology has opened up new ways for B2B businesses to engage with their customers and partners in innovative and immersive ways. Co-branded experiences in metaverses offer several advantages for B2B businesses looking to build stronger customer relationships and expand their reach. Some of these advantages are as follows [77]:

- Enhanced Interaction
- Shared Audiences
- Innovatiove Product Announcements
- Effective Conferences and Training
- Virtual Product Showrooms
- Real-Time Company Updates
- Networking Opportunities
- Cost Efficiency
- Data and Analytics
- Brand Co-operation

Just as in the physical world, businesses can sponsor events within the metaverse. The metaverse can provide rich data on user behavior and preferences due to the digital nature of the medium. This data can enable businesses to create highly targeted adverts that are more likely to resonate with potential customers. Engaging customers in immersive and interactive experiences within the metaverse can help develop a deeper sense of connection and loyalty. By actively participating in the metaverse and contributing valuable content, insights, and expertise, B2B businesses can position themselves as thought leaders in their industry [65]. The metaverse offers an exciting frontier for B2B businesses to explore new marketing and advertising opportunities. However, careful consideration of the challenges and strategic planning is necessary to make the most of this evolving environment.

Metaverse is a platform that allows businesses to connect with potential customers and partners across the globe by eliminating geographical boundaries [78]. Applications such as Zoom and Google Meet can also be used to overcome geographical barriers and connect; however, Metaverse differentiates itself from these applications by offering deeper and interactive experiences using virtual and augmented reality technologies. Metaverse enables its users to interact in 3D virtual environments and have an experience beyond the real world. This allows businesses to showcase their digital assets in a way that was not previously possible and develop deeper customer/partner relationships [79]. B2B businesses can develop innovative products and services that specifically address the digital environment of the metaverse. Businesses can use the metaverse as a platform to conduct market research and gather feedback on new products and ideas before fully launching them. The concept of metaverse has a lot of potential to increase productivity and collaboration across various industries and departments. Metaverse can host meetings and interactions in a virtual environment. For example, salespeople can meet potential customers from around the world without the need for extensive travel. This not only saves time and resources but also allows salespeople to use their time more efficiently. Human resources can conduct virtual interviews, training sessions, and onboarding processes. Customer service representatives can provide real-time support via avatars, improving the customer experience. Research and development teams can collaborate more effectively on projects regardless of their physical location [80]. B2B businesses with a global customer base can use metadata storage to reduce travel costs [81]. In summary, the metaverse presents B2B businesses with a myriad of opportunities to expand their reach, innovate their product and service offerings, and engage with customers in novel and captivating ways. The immersive nature of the metaverse allows businesses to create unique, interactive experiences that can significantly enhance customer engagement and satisfaction. For example, a B2B company specializing in manufacturing could use the metaverse to showcase virtual prototypes to clients worldwide, providing an interactive and detailed view of products that would be impossible in a traditional setting. When it comes to customer engagement, the metaverse provides businesses with a unique platform to interact with and serve their clients in ways that were previously unimaginable. Retail businesses, for instance, can offer customers a virtual shopping experience where they can explore products in a 3D environment, leading to deeper engagement and a more personalized shopping experience. This level of interaction can significantly enhance customer satisfaction and loyalty.

Moreover, the metaverse blurs the lines between physical and digital customer service, offering new opportunities for businesses to interact with their customers. For instance, a financial services company could use the metaverse to hold virtual financial advisory sessions, providing a more engaging and personalized service compared to traditional online or telephone consultations.

In essence, the metaverse is redefining the way businesses operate, interact with their workforce, and engage with their customers. It represents a new frontier where the integration of virtual and physical realities can lead to more efficient business operations and enhanced customer experiences.

VII. METAPTATION

"Metaptation" was introduced as a name to describe evolved patterns of biological organization that promote evolutionary versatility by influencing mutation and accommodating its consequences [68]. This term seems to have originated from the field of biology, specifically in relation to genetic and developmental functions. It encompasses the idea of evolutionary adaptations that are not just reactive but also proactive in shaping genetic variations for future evolutionary success.

The concept of 'metaptation' in social sciences has been redefined by amalgamating the principles of the metaverse with traditional adaptation theory, similar to the development of 'metanomics'. This new interpretation of metaptation focuses on how individuals and organizations adapt and evolve within the digitally immersive environments of the metaverse, highlighting a proactive approach to change and innovation in virtual spaces. The concept of the metaverse can be explained in terms of adaptation theory by considering the ways in which individuals, communities and businesses change and adjust to new situations and environments. Adaptation theory suggests that companies, individuals and groups must continuously adapt to changes in their environment in order to survive and thrive. The metaverse represents a new environment that companies, individuals and communities must adapt to, just as they have to adapt to changes in the physical world. This new environment is characterized by unique social, economic, and technological dynamics that require new forms of behavior, communication, and social organization. Unlike traditional adaptation linked to physical migration, behavioral adaptation in the metaverse involves evolving interaction methods in virtual settings. For instance, companies might utilize virtual reality for immersive team meetings in 3D spaces, altering collaboration dynamics. Communication patterns also transform in the metaverse. The use of avatars and interactive technologies fosters more engaging communication, impacting both social and business interactions. A practical example is a virtual marketplace where sellers and buyers interact through enhanced virtual interfaces, significantly differing from traditional online marketplaces. In order to effectively engage with the metaverse, individuals, communities and companies must continuously adapt and evolve their behavior, communication patterns, and cultural norms. This adaptation can occur through a process of experimentation and trial-and-error, as companies seek out new strategies for effectively engaging with the virtual environment. These changes in behavior and communication within the metaverse are core to metaptation. It encompasses adapting to new social norms, technological interfaces, and experiences unique to virtual environments. Metaptation involves not just reacting to these changes but also innovating within them. For instance, a company may experiment with different virtual engagement strategies to optimize its presence in the metaverse, reflecting a trial-and-error approach in adapting to this new virtual environment.

In summary, the metaptation represents the unique form of adaptation of individuals, groups or businesses to a new environment named metaverse by considering their behavior, communication patterns and cultural norms.

VIII. CONLUSION

The metaverse presents new opportunities for companies to create and implement innovative business models by prodiving a virtual platform for them to sell products and services, as well as engage with customers in new and unique ways. Additionally, the metaverse may lead to the creation of entirely new business models that do not exist in the physical world. The metaverse offers limitless possibilities for companies to monetize their offerings, and it will be exciting to see how businesses adapt and evolve to take advantage of these opportunities.

Based on our review, the metaverse, or a virtual shared space, can have a significant impact on businesses in a number of ways such as new market opportunities, increased engagement, cost savings, data collection and analysis and global reach. In the evolving landscape of the metaverse, businesses are encountering new market opportunities that necessitate a form of metaptation – an adaptive response akin to biological evolution but in the digital realm. The metaverse, with its expansive virtual environments, opens up avenues for businesses to explore innovative market strategies, tapping into global customer bases that were previously beyond reach. This transition aligns with metaptation, as it requires companies to evolve beyond traditional market strategies and embrace the virtual world's possibilities.

By providing a more immersive and interactive experience, the metaverse can help businesses increase brand loyalty. Furthermore, the shift to the metaverse offers significant cost savings, embodying the essence of metaptation. Companies can reduce their overhead costs by creating virtual offices and stores, rather than physical ones. By minimizing the need for physical infrastructure and enabling efficient remote operations, businesses can reduce operational costs while maintaining productivity. This adaptation to a more cost-effective business model is crucial in the metaverse's dynamic ecosystem. Furthermore, the metaverse generates vast amounts of data that businesses can use to better understand their customers and improve their offerings. The role of data collection and analysis in the metaverse further exemplifies metaptation. In this digital expanse, the ability to gather and utilize extensive user data becomes a cornerstone for business evolution, allowing for the refinement of customer experiences and the innovation of products and services. This strategic use of data is a critical aspect of adapting and thriving within the metaverse. Lastly, it also removes geographical barriers and allows companies to reach a global audience. The global reach afforded by the metaverse is a testament to the necessity of metaptation. Businesses must adapt their operations, marketing, and customer service to suit an international audience, a challenge that requires an evolutionary approach in business thinking and strategy.

On the other hand, we saw that the metaverse has the potential to significantly change the workforce in several ways such as enabling remote work and collaboration regardless of physical location, new job opportunities, skill upgradation and improving work-life balance by flexibility. These ways can lead to increased productivity, efficiency and reduced costs for companies. The concept of metaptation will be used more in future studies and with the advancement of metaverse technologies. Within the framework of adaptation theory, metaptation levels of enterprises will also need to be measured in order to adapt to new metaverse technologies. We recommend to develop a scale for future studies in the literature.

It's important to note that the metaverse is still in its early stages of development, and the exact impact it will have on the businesses is not yet clear. Nevertheless, the potential for

the metaverse to change the businesses is significant, and it will be interesting to observe how it evolves and transforms over time.

A. Adaptation Theory

The impact of the metaverse on the workplace can be effectively understood through the lens of adaptation theory, which can be distilled into four key attunement methods: structural, behavioral, physiological, and common. Structurally, the metaverse alters the very fabric of the work environment, transitioning from traditional physical spaces to virtual settings. This change requires organizations to rethink their infrastructure, such as using virtual office spaces and digital collaboration tools, to accommodate remote and flexible work models. Behaviorally, the metaverse demands a shift in how employees and management interact and operate. Workforce training, team collaborations, and customer interactions evolve to suit the immersive and interactive nature of the virtual world, necessitating new communication skills and work habits. Physiologically, while the metaverse primarily affects digital interaction, it also impacts the physical well-being of users, such as ergonomic considerations in prolonged virtual reality usage. Businesses need to address these physiological aspects to ensure a healthy work-life balance in the virtual realm. Lastly, common attunement refers to the universal adaptation of business culture and practices to the metaverse. This involves embracing a shared understanding and approach towards virtual work environments, ensuring that all levels of an organization are aligned and adept in leveraging the metaverse for optimal productivity and engagement. Each of these attunement methods plays a critical role in how businesses and their workforce adapt to the transformative impacts of the metaverse.

B. Business Impact

XR technologies are transforming the gaming industry by delivering immersive experiences and new forms of gaming. Metaverse can create new revenue streams through virtual products, services, and experiences. AR can enhance their shopping experience by allowing customers to virtually try products before they buy. Metaverse can enable virtual showrooms and interactive shopping environments.

XR technologies offer realistic simulations in the field of education, providing students with interactive and learning-promoting experiences. These technologies empower the learning process by giving students the opportunity to gain concrete and practical skills. Metaverse, on the other hand, can radically transform distance learning and collaboration by creating virtual classrooms and workspaces. XR technologies help students better understand abstract concepts by providing them with concrete experiences through virtual and augmented reality. For example, medical students can perform surgical operations in virtual hospitals, or engineering students can design and prototype in mixed reality. This allows students to translate theoretical knowledge into practice.

C. Future Research

Research is needed to establish standards for XR and Metaverse interoperability by allowing seamless transitions between platforms and experiences. As the metaverse blurs the lines between reality and sandbox, research is needed to address issues with data privacy, security, and ethical implications. Researchers can examine how the Metaverse affects social interactions, mental health, and the way people perceive reality.

D. Practical Applications

Companies should integrate XR and Metaverse into their customer engagement, branding and revenue generation strategies with the aim of enhancing customer experience and exploring potential revenue streams through innovative marketing methods. Prioritizing user-friendly interfaces and intuitive interactions will be crucial to XR and Metaverse adoption. The demand for 3D content and experiences will increase, creating opportunities for content creators and designers. It is critical for companies to consider integrating XR and Metaverse into their customer engagement, branding and revenue generation strategies. Adopting these technologies will be possible by prioritising user-friendly interfaces and intuitive interactions. For XR and the Metaverse to gain widespread acceptance, these elements must be taken into account. In the future, with the increasing demand for 3D content and experiences, new opportunities will arise for content creators and designers. By utilising these technologies, companies can offer customers more in-depth and interactive experiences, thus increasing brand loyalty. It is important to turn these technologies into practical applications to turn them into business opportunities. For example, by creating virtual store experiences, they can increase interaction with customers and make the online shopping experience more personalised. They can also increase collaboration and strengthen customer communication through virtual events and meetings. These strategic integrations can give companies a competitive advantage, offering the potential to expand their customer base and increase revenue. XR and Metaverse are powerful tools that drive innovation and accelerate companies' digital transformation journey.

E. Work Limitations

In the process of developing XR and Metaverse technologies, cooperation and standardisation among relevant stakeholders in the sector should be encouraged to overcome technical challenges such as device compatibility, network infrastructure and processing power. User-friendly tools and diversity-oriented designs need to be adopted to increase access to this technology for people with disabilities and people from different backgrounds. Furthermore, the integration of virtual and physical realities and careful consideration of cultural, ethical and social issues are important to ensure that these technologies have a positive impact on society.

The concept of XR, AR, MR, and Metaverse has significant potential to transform various industries, reshape human interactions, and create new economic opportunities.

However, their successful integration and adoption will depend on overcoming technical challenges, addressing ethical considerations, and carefully planning for a future where virtual and physical realities coexist.

FUNDING

The author(s) received no financial support for the research, authorship, and/or publication of this article.

AUTHORS` CONTRIBUTIONS

All authors have participated in drafting the manuscript. All authors read and approved the final version of the manuscript. All authors contributed equally to the manuscript and read and approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflicting interests.

REFERENCES

[1] Lee, L-H., Braud, T., Zhou, P., Wang, L., Xu, D., Lin, Z., Kumar, A., Bermejo, C., & Hui, P. (2021). All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda. *Journal of Latex Class Files, 14*(8).

[2] Tutgun-Ünal, A., & Tarhan, N. (2022). Metaverse Awareness and Generation to Transform Education. *International Journal of Academic Education, 8*(1), 64-74.

[3] Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors. *Information & Management, 51*(5), 497-510.

[4] Pan, X., Pan, X., Song, M., Ai, B., & Ming, Y. (2020). Blockchain technology and enterprise operational capabilities: An empirical test. *International Journal of Information Management, 52*, 101946.

[5] Sarkar, M., & De Bruyn, A. (2021). LSTM Response Models for Direct Marketing Analytics: Replacing Feature Engineering with Deep Learning. *Journal of Interactive Marketing, 53*, 80-95.

[6] Sestino, A., Prete, M. I., Piper, L.,& Guido, G. (2020). Internet of Things and Big Data as enablers for business digitalization strategies. *Technovation, 98*, 102173.

[7] Jeon, J. E. (2021). The Effects of User Experience-Based Design Innovativeness on User-Metaverse Platform Channel Relationships in South Korea. *Journal of Distribution Science, 19*(11), 81-90.

[8] Smart, J. M., Cascio, J., & Paffendorf, J. (2007). Metaverse road map pathways to the 3D web. *Acceleration Studies Foundation*.

[9] Le Noury, P., Polman, R., Maloney, M., & Gorman, A. (2022). A Narrative Review of the Current State of Extended Reality Technology and How it can be Utilised in Sport. *Sports Medicine, 52*, 1473-1489.

[10] Guo, X., Guo, Y. & Liu, Y. (2021). The development of extended reality in education: Inspiration from the research literature. *Sustainability, 13*(24), 13776.

[11] Gandhi, R. D., & Patel, D. S. (2018). Virtual reality–opportunities and challenges. *Virtual Reality, 5*(01).

[12] Theodoropoulos, A., Stavropoulou, D., Papadopoulos, P., Platis, N., & Lepouras, G. (2023). Developing an Iteractive VR CAVE for Immensive Shared Gaming Experiences. *Virtual Worlds, 2*(2), 162-181.

[13] Kari, T., & Kosa, M. (2023). Acceptance and use of virtual reality games: an extension of HMSAM. *Virtual Reality, 1*(2), 1585-1605.

[14] Herpich, F., Nunes, F. B., Petri, G., & Tarouco, L. M. R. (2019). How mobile augmented Reality is applied in education? A systematic literature review. *Creative Education, 10*(07), 1589.

[15] Dargan, S., Bansal, S., Kumar, M., Mittal, A., & Kumar, K. (2022). Augmented Reality: A Comprehensive Review. *Archives of Computational Methods in Engineering, 30*(2), 1057-1080.

[16] Kaur, D. P., & Mantri, A. (2015). Computer vision and sensor fusion for efficient hybrid tracking in augmented reality systems. *In 2015 IEEE 3rd International Conference on MOOCs, Innovation and Technology in Education (MITE)*, 176-181.

[17] Syal, S., & Mathew, R. (2020). Threats Faced by Mixed Reality and Countermeasures. *Procedia Computer Science, 171*, 2720-2728.

[18] Papadopoulos, T., Evangelidis, K., Kaskalis, T. H., Evangelidis, G., & Sylaiou, S. (2021). Interactions in augmented and mixed reality: An overview. *Applied Sciences, 11*(18), 8752.

[19] Tang, M. Y., Chau, K. Y., Kwok, A. P. K., Zhu, T., & Ma, X. (2022). A systematic review of immersive technology applications for medical practice and education-trends, applications areas, recipients, teaching contents, evaluation methods, and performance. *Educational Research Review, 35*, 100429.

[20] Doolani, S., Wessels, C., Kanal, V., Sevastopoulos, C., Jaiswal, A., Nambiappan, H., & Makedon, F. (2020). A review of extended reality (xr) technologies for manufacturing training. *Technologies, 8*(4), 77.

[21] Ligthart, S., Meynen, G., Biller-Andorno, N., Kooijmans, T., & Kellmeyer, P. (2022). Is virtually everything possible? The relevance of ethics and human rights for introducing extended reality in forensic psychiatry. *AJOB neuroscience, 13*(3), 144-157.

[22] Hong, S., Ahn, J. G., Ko, H., & Kim, J. (2008). Acquiring a physical world and serving its mirror world simultaneously. *In International Conference on Virtual and Mixed Reality*, pp.445-453.

[23] Croatti, A., & Ricci, A. (2020). From virtual worlds to mirror worlds: A model and platform for building agent-based extended realities. *17th European Conference, EUMAS*, Thessaloniki, Greece, pp. 459-474.

[24] Park, M., Yoo, B., Moon, J. Y., & Seo, J. H. (2022). InstantXR: Instant XR Environment on the Web Using Hybrid Rendering of Cloud-based NeRF with 3D Assets. *In Proceedings of the 27th International Conference on 3D Web Technology*, 1-9.

[25] Liu, Y. & Gao, G. (2022). Prediction of Social Communication Behavior Changes in the Meta Universe. *In 2022 6th International Seminar on Education, Management and Social Sciences, Atlantis Press*, 3528-3534.

[26] Kang, J. (2012). Design and Implementation of Digital Map Products Contributing GIS Perspective based on Cloud Computing. *International Journal of Computer and Communication Engineering, 1*(2), 159.

[27] De Kerckhove, D. (2021). The personal digital twin, ethical considerations. *Philosophical Transactions of the Royal Society A, 379*(2207), 20200367.

[28] Komatsu, K., Alavesa, P., Pauanne, A., Hänninen, T., Liinamaa, O., & Pouttu, A. (2022). Leveraging 5G in cyber-physical system for low-cost robotic telepresence. *In 2022 Joint European Conference on Networks and Communications & 6G Summit, EuCNC/6G Summit*, 399-404.

[29] Fauska, P., Kryvinska, N., & Strauss, C. (2013). The role of e-commerce in B2B markets of goods and services. *International Journal of Services, Economics and Management, 5*(1-2), 41-71.

[30] Cartwright, S., Liu, H., & Davies, I. A. (2022). Influencer marketing within business-to-business organisations. *Industrial Marketing Management, 106*, 338-350.

[31] Ioannidis, S., & Kontis, A. P. (2023). Metaverse for tourists and tourism destinations. *Information Technology & Tourism, 25*(4), 483-506.

[32] Simge, U., Yaşar, L., & Bilici, E. (2023). Metaverse as a Platform for Event Management: The Sample of the Metaverse Türkiye E-Magazine. *TRT Akademi, 8*(17), 122-143.

[33] Stephenson, N. (1993). *Snow Crash; Bantam Paperback*. Bantam Books; New York, NY, USA.

[34] Barrera, K. G., & Shah, D. (2023). Marketing in the Metaverse: Conceptual understanding, framework, and research agenda. *Journal of Business Research, 155*, 113420. https://doi.org/10.1016/j.jbusres.2022.13420

[35] Weinberger, M. (2022). What Is Metaverse?- A Definition Based on Qualitative Meta-Synthesis. *Future Internet, 14*(11), 310.

[36] Di Natale, A. F., Repetto, C., Riva, G., & Villani, D. (2021). Immersive virtual reality in K-12 and higher‐education: A 10-year systematic review of empirical research. *British Journal of Educational Technology, 51*(6), 2006-2033. https://doi.org/10.1111/bjet.13030

[37] Jin, S. A. A. (2011). Leveraging avatars in 3D virtual environments (Second Life) for interactive learning: The moderating role of the behavioral activation system vs. behavioral inhibition system and the mediating role of enjoyment. *Interactive Learning Environments, 19*(5), 467-486. https://doi.org/10.1080/10494820903484692

[38] Valaskova, K., Machova, V., & Lewis, E. (2022). Virtual Marketplace Dynamics Data, Spatial Analytics, and Customer Engagement Tools in a Real-Time Interoperable Decentralized Metaverse. *Linguistic and Philosophical Investigations, 21*, 105-120.

[39] Hwang, Y. (2023). When makers meet the metaverse: Effects of creating NFT metaverse exhibition in maker education. *Computers & Education, 194*, 104693. https://doi.org/10.1016/j.compedu.2022.104693

[40] Hwang, G. J., & Chien, S. Y. (2022). Definition, roles, and potential research issues of the metaversein education: An artificial intelligence perspective. *Computers and Education: Artificial Intelligence Article, 100082*. https://doi.org/10.1016/j.caeai.2022.100082

[41] Chen, C., Huixiang, Z., Jinkui, H., Yonghui, Z., Huihui, Z., Jiangyan, D., Shupeng, P., & Chengdwan, W. (2023). Deep Learning in the Ubiquitous Human-Computer Interacitve 6G Era: Applications, Principles and Prospects. *Biomimetics, 8*(4), 343.

[42] Bibri, S. E., & Allam, Z. (2022). The Metaverse as a virtual from of data-driven smart cities: The ethics of the hyper-connectivity, datafication, algorithmization, and platformazition of urban society. *Computational Urban Sciences, 2*(1), 22.

[43] Anshari, M., Syafrudin, M., Fitriyani, N. L., & Razzaq, A. (2022). Ethical Responsibility and Sustainability (ERS) Development in a Metaverse Business Model. *Sustainability, 14*(23), 15805.

[44] Moy, C., & Gadgil, A. (2022). *Opportunities in the metaverse: How businesses can explore the metaverse and navigate the hype vs. reality*. [Ebook], JPMorgan Chase. https://www.jpmorgan.com/content/dam/jpm/treasury-services/documents/opportunities-inthe-metaverse.pdf

[45] Shah, A., & Bahri, A. (2022). *Metanomics: Adaptive market and volatility behaviour in Metaverse*. SSRN. https://ssrn.com/abstract=4206410 http://dx.doi.org/10.2139/ssrn.4206410

[46] Thomason, J. (2022). Metaverse, token economies, and non-communicable diseases. *Global Health Journal, 6*(3), 164-167.

[47] Xu, M., Guo, Y., Hu, Q., Xiong, Z., Yu, D., & Cheng, X. (2022). A Trustless Architecture of Blockchain-enabled Metaverse. *High-Confidence Computing, 100088*.

[48] Moro Visconti, R. (2022). *From physical reality to the internet and the metaverse: A multilayer network valuation*. https://ssrn.com/abstract=4054674 http://dx.doi.org/10.2139/ssrn.4054674

[49] Hwang, Y., & Lee, H. (2022). The Future Direction of Maker Education with Metaverse and NFT: Focusing on the TMIOSS Model Based on the Non-fungible Owner and Seller Experience. *The Journal of Humanities and Social Science, 13*(1), 2941-2956.

[50] Goldberg, M., & Schär, F. (2022). Metaverse Governance: An Empirical Analysis of Voting Within Decentralized Autonomous Organizations *JDSUPRA*. https://www.jdsupra.com/legalnews/the-metaverse-decentralized-autonomous-8693438/

[51] Xiang, N. (2022). Metaverse: The latest chapter of the splinternet?. *In East Asia Forum Quarterly, 14*(2).

[52] Rawal, B. S., Mentges, A., & Ahmad, S. (2022). The Rise of Metaverse and Interoperability with Split-Protocol. *In 2022 IEEE 23rd International Conference on Information Reuse and Integration for Data Science (IRI)*, 192-199.

[53] Matt, C., Hess, T., & Benlian, A. (2015). Digital transformation strategies. *Bus. Inf. Syst. Eng., 57*, 339-343.

[54] Lee, H., & Hwang, Y. (2022). Technology-enhanced education through VR-making and metaverse-linking to foster teacher readiness and sustainable learning. *Sustainability, 14*, 4786.

[55] Wu, H., Cai, T., Luo, D., Liu, Y., & Zhang, Z. (2021). Immersive virtual reality news: A study of user experience and media effects. *Int. J. Hum.-Comput. Stud., 147*, 102576.

[56] Han, S. L., An, M., Han, J. J., & Lee, J. (2020). Telepresence, time distortion, and consumer traits of virtual reality shopping. *J. Bus. Res., 118*, 311-320.

[57] Palfreyman, J, & Morton, J. (2022). The benefits of agile digital transformation to innovation processes. *J. Strateg. Contract. Negot., 6*, 26- 36.

[58] Arpaci, I., Al-Emran, M., & Al-Sharafi, M. A. (2020). The impact of knowledge management practices on the acceptance of Massive open online courses (MOOCs) by engineering students: A cross-cultural comparison. *Telemat. Inform, 54*, 101468.

[59] Nadeem, M. A., Liu, Z., Ghani, U., Younis, A., & Xu, Y. (2020). Impact of shared goals on knowledge hiding behavior: The moderating role of trust. *Manag. Decis., 59*, 1312-1332.

[60] Tsai, Y. H., Ma, H. C., Lin, C. P., Chiu, C. K., & Chen, S. C. (2014). Group social capital in virtual teaming contexts: A moderating role of positive affective tone in knowledge sharing. *Technol. Forecast. Soc. Chang., 86*, 13-20.

[61] Choi, H. S., & Kim, S. H. (2017). A content service deployment plan for metaverse museum exhibitions-Centering on the combination of beacons and HMDs. *Int. J. Inf. Manag, 37*, 1519-1527.

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

[63] Henz, P. (2022). The psychological impact of the Metaverse. *Discover Psychology, 2*, 47. https://doi.org/10.1007/s44202-022-00061-3

[64] Gürsoy, D., Malodia, S., & Dhir, A. (2022). The metaverse in the hospitality and tourism industry: An overview of current trends and future research directions. *J. Hosp. Mark. Manag, 31*, 527- 534.

[65] Marr, B. (2022). Noika The metaverse and the future of work. https://www.nokia.com/networks/real-conversations/podcast-episode-9-the-metaverse-and-the-future-of-work/

[66] Alaghband, M. (2022). What Is the Metaverse—and What Does It Mean for Business?. https://www.mckinsey. com/capabilities/mckinsey-digital/our-insights/what-is-the-metaverse-and-what-does-it-mean-for-business.

[67] Hagiu, A., & Wright, J. (2015). Marketplace or Reseller?. *Manag. Sci., 61*, 184 203.

[68] Wirtz, J., & Zeithaml, V. (2018). Cost-effective service excellenge. *J. of the Acad. Mark. Sci, 46*, 59-80. Doi:10.1007/s11747-017-0560-7

[69] Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., & Wamba, S. F. (2022). Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management, 66*, 102542. https://doi.org/10.1016/j.ijinfomgt.2022.102542

[70] Dick, E. (2021). Public Policy for the Metaverse: Key Takeaways from the 2021 AR/VR Policy Conference. *Information Technology and Innovation Foundation*.

[71] Richardson, J. (2008). The business model: an integrative framework for strategy execution. *Strat. Change, 17*, 133e144. https://doi.org/10.1002/jsc.821

[72] Ibarra, D., Ganzarain, J., & Igartua, J. I. (2018). Business model innovation through Industry 4.0: A review. *Procedia manufacturing, 22*, 4-10.

[73] Wirtz, B. W., Pistoia, A., Ullrich, S., & Göttel, V. (2016). Business models: origin, development and future research perspectives. *Long. Range Plan. 49*, 36e54.

[74] Diogo, J. & Veiga, P. M. (2022). Implementing Automation Initiatives in Companies to Create Better- Connected Experiences. In J. Remondes

& S. Teixeira (Eds.), *in Metaverse Applications in Business: A Systematic Literature Review and Integrative Framework* (pp.110-136). IGI-Global.

[75] Belk, R., Humayun, M., & Brouard, M. (2022). Money, possessions, and ownership in the Metaverse: NFTSs, cryptocurrencies, Web3 and Wild Market. *Journal of Business Research, 153*, 198-205. https://doi.org/10.1016/j.jbusres.2022.08.031

[76] Ning, H., Wang, H., Lin, Y., Wang, W., Dhelim, S., Farha, F., Ding, J., & Daneshmand, M. A. (2021). A Survey on Metaverse: the State-of-the-art, Technologies, Applications, and Challenges. *ArXiv 2111.09673*.

[77] Bohns, V. (2017). A Face-to-Face Request Is 34 Times More Successful Than an Email *Harvard Business Review*. https://hbr.org/2017/04/a-face-to-face-request-is-34-times-more-successful-than-an-email

[78] Yemenci, A. D. (2022). Entrepreneurship in the world of metaverse: virtual or real?. *Journal of Metaverse*, *2*(2), 71-82.

[79] De Felice, F., Petrillo, A., Iovine, G., Salzano, C., & Baffo, I. (2023). How Does the Metaverse Shape Education? A Systematic Literature Review. *Applied Sciences*, *13*(9), 5682.

[80] Johnson, S. (2022). How the Metaverse Could Transform the B2B Enterprise *BusinessNews*. https://biz.crast.net/how-the-metaverse-could-transform-the-b2b-enterprise/.

[81] Winter, P. (2022). How The Metaverse Will Transform The Future of B2B Marketing *NewsRoom*. https://blog.tomorrow-people.com/metaverse-b2b-marketing.