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## Metaverse as a field of communication and networking in the digital domain

*Alexandros Kalemis*

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# Metaverse as a field of communication and networking in the digital domain: challenges and prospects

Alexandros Kalemis*

**Abstract**

The purpose of this research is to present the Metaverse technology as a digital metamorphosis of reality and to investigate, based on literature review, the possibilities of shaping and experiencing urban social space within a fully or partially controlled virtual environment. In this context, the city transforms into its digital twin, with multiple identities and geographies, where cultural, social, technological, and economic components coexist. Users immerse themselves in this environment and interact with other users and objects in a manner similar to real life. Within a context of an as realistic and integrated as possible experience of a network of multiple exchanges, transactions, and communications at interpersonal, professional, commercial, and political levels, significance lies not only in shaping a user-friendly interface but also in the systematic digitization and integration of material world information with the use of innovative technical means based on Artificial Intelligence, Cloud Computing, Robotics, Augmented Reality, and Internet of Things principles. Conceptually, the properties of Virtual Worlds are examined, focusing on those characteristics related to the Metaverse, the contribution of the aforementioned tools to this effort, followed by examples of application areas across a wide range of activities. The Metaverse offers a renewed perspective on human communication and social relations through immersive interaction methods in the cyberspace, enhancing the digitization of urban environment, commerce, and politics, adaptability to new technologies in view of the Fourth Industrial Revolution, and a sense of participation and collectivity in decision-making.

**Keywords:** Metaverse, communication, networks, immersive interactions.

## Introduction

The concept of the Metaverse, an expansive digital realm where users interact and engage in various activities inside virtual environments, has garnered increasing attention in recent years. As the world becomes increasingly digitalized in multiple aspects of our everyday life, the Metaverse emerges as a captivating field of study, offering profound insights into the evolving landscape of communication and networking in the digital domain. With the onset of the COVID-19 pandemic, the necessity of virtual spaces for communication and collaboration has been underscored like never before. The pandemic forced a rapid shift towards remote work, virtual socializing, and online education, highlighting the importance of robust digital platforms that can facilitate meaningful interactions and connections. In this context, the Metaverse emerges as a critical path for exploration, offering pioneering solutions to the challenges posed

* PhD(c) Urban & Regional Planning, NTUA School of Architecture, akalemis@mail.ntua.gr.

by physical distancing measures and the limitations of conventional digital communication channels. By delving into its complexities as a field of communication and networking, researchers may uncover valuable insights into its potential to transcend geographical barriers, foster immersive experiences, and reshape the ways of connection and engagement in the digital, Anthropocene era. Moreover, studying the Metaverse allows us to anticipate and address the challenges inherent in its development, including issues of privacy, security, and accessibility. By considering its dynamics and implications for communication and networking, we can harness its transformative prospective to create inclusive, engaging, and interconnected digital environments that enhance human connection and collaboration in the post-pandemic epoch.

The research aims to contribute to an understanding of the new, emerging spatialities developing in the Metaverse, a field that is experiencing intensive research in scientific institutes around the world with an exponential increase in international publications. Therefore, the contribution of a comprehensive study, focusing on the analysis of the Metaverse as a social space, while simultaneously encapsulating the trends, choices, and preferences of users, is expected to propose an improved framework of practical interventions at the level of design, planning and regulatory framework, creating more equitable, sustainable, and human-centered digital spaces.

The structure of the research consists of five (5) chapters, the first one being the Introduction. Chapter 2 elaborates a comprehensive literature review of the notions “digital twin” and “virtual worlds”, establishing an essential theoretic background for the main concept of the “Metaverse”. In Chapter 3, benefits and prospects of the Metaverse are analyzed in a multidisciplinary level, meaning socializing, business and the politics sectors. The risks and challenges of the newly-emerged technology are evaluated in Chapter 4. A balanced view both of positive and negative aspects of the Metaverse usage is summarized in the Conclusions chapter, following an extensive enlistment of all bibliographical references used as the main source of information and study material.

## Analysis of theoretical framework

*The concept of Digital Twin*

The first attempts of an ontological approach to the “digital twin” concept by academic scholars and scientific institutions date back to the early years of the new millennium (Grieves, 2014). However, the first significant definition was published by NASA in 2012, defining the Digital Twin as an “integrated multi-physics, multi-level, probabilistic simulation of a hypothetical vehicle or system that utilizes the best available physical models, enhanced sensors, [...] to reflect the life of its [...] twin” (Glaessgen, and Stargel, 2012). According to Chen’s definition (2017), the digital twin is “a digitized prototype of a real device or system that represents all functional characteristics and connections” (Chen, 2017), including, according to Zheng et al.

(2018), “virtual information that fully describes a hypothetical or existing material object from micro-atomic to macro-geometric levels” (Zheng, Yang, and Cheng, 2018). Liu et al. (2018) provide a more dynamic view, referring to the continuous adaptation of this prototype to functional changes, based on electronic data collection, predicting the future trajectory of its real counterpart (Liu, Meyendorf, and Mrad, 2018), which is crosschecked through continuous tests, maintenance tasks, and data collection throughout its lifespan (Madni, Madni, and Lucero, 2019).


**Figure 1:** The digital twin of a cityscape, generated via the SketchUp design application. (https://www.sketchup.com [accessed 10 December 2023]).

The concept of the Digital Twin is frequently confused with those of the Digital Model and the Digital Shadow, as all three of them bear close similarities. A Digital Model is the digitized version of an existing object when there is no automatic data upgrade between them in case of changes occurred in one or the other. Therefore, any alteration in one cannot automatically affect the other's elements. A Digital Shadow refers to the digitized representation of an existing object, which is unilaterally affected by it, while any change in it cannot affect the physical object itself. In Digital Twins, unlike the pair of aforementioned concepts, the key element is the bidirectional communication and interaction between the existing object or system and its numerical counterpart. This does not imply that the Digital Twin is necessarily an accurate replica of its physical counterpart, nor is it a simple three-dimensional graphical depiction (Fuller et *al.,* 2020).

*Properties of Virtual Worlds*

According to Sadler (Sadler, 2012), Virtual Worlds share some fundamental characteristics, among which are:

**Three-dimensional online environment,** capable of simulating the real world in various historical or fictional settings and spatiotemporal contexts (Dass, Dabbagh, and Clark, 2011).

**Avatar.** Inspired from the Hindu religion (Lochtefeld, 2002), it takes on the meaning of the user's representation or "incarnation" in the virtual environment through a digital humanoid, a "digital twin" that is a numerical representation of a real person (Ducheneaut et *al.,* 2009).

**Real-time interaction**, where avatars interact with each other and their environment's objects under innovative communicational conditions (González et *al.,* 2013).

**24/7 access**, as the central system allows users to enter and interact seamlessly on a daily, round-the-clock basis (Sadler et *al.,* 2013; Kafai, Fields, and Searle, 2010).

**Persistence**, as both the avatar and its actions are recorded, saved and retained by the time the user logs off, exiting the platform (Warburton, 2009; Choi, and Baek, 2011).

**Social space**, since a virtual world is able to provide interaction between real human beings through their avatars (Jensen, Phillips, and Strand, 2012).

**Quantifiability**, as a virtual realm, analogous to the physical one, grows or weakens proportionally to the presence and activity of populations that occurs within its frontiers (Spence, 2008; Messinger, Stroulia, and Lyons, 2008).

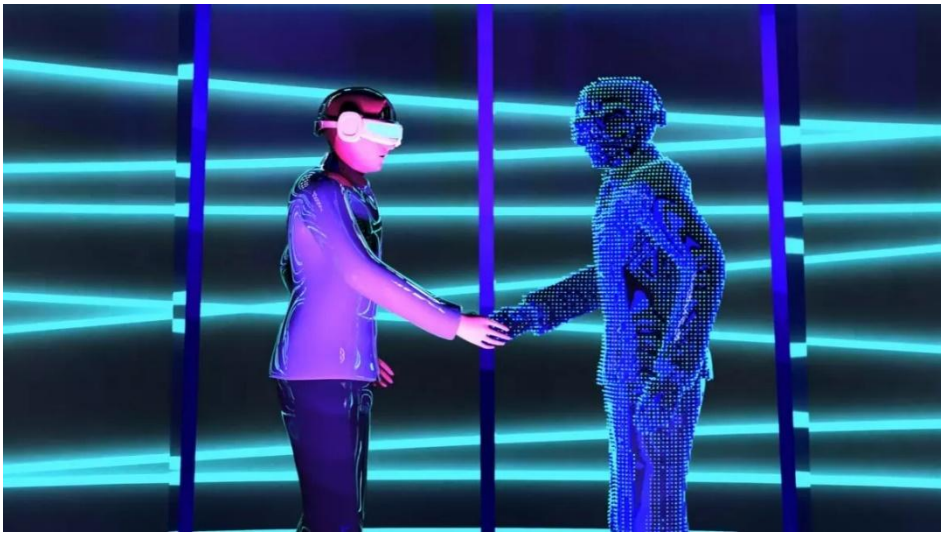

**Figure 2:** In Virtual Worlds, users interact with each other and the digital environment through their avatars. (https://www.ispo.com/en/news-trends/metaverse-revolution-sports-world [accessed 9 January 2024]).

*The concept of Metaverse*

Metaverse is defined as the three-dimensional digital world where the entrance and participation of users are possible and is constructed through methods and techniques of Augmented Reality (AR), Virtual Reality (VR), and blockchain (Laeeq, 2022). Renowned Metaverse platforms include Second Life, Decentraland, Metahero, Horizon Worlds, The Sandbox, and CelebrityAtlas (Papailiou, 2022).

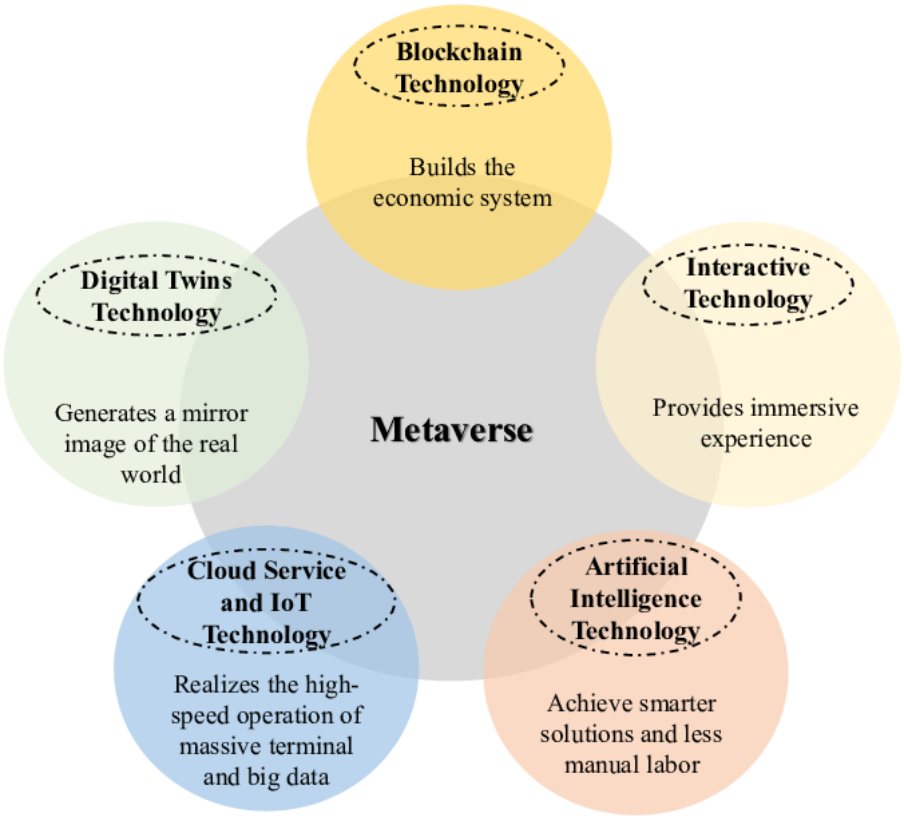


**Figure 3:** Diagram of Metaverse-related technological advances and their impact on the Metaverse development. (Chen, Zefeng & Wu, Jiayang & Gan, Wensheng & Qi, Zhenlian. (2022). Metaverse Security and Privacy: An Overview. 2950-2959. https://www.doi.org/10.1109/BigData55660.2022.10021112 [accessed 10 April 2024]).

Contrary to the definition of the external architectural environment as a form of relationships between humans, residence, and city (Tsigas, 2009), the Metaverse environment allows the "residents" of online communities a multitude of activities related to commerce, economy, entertainment, recreation, arts, sports, and education. All these shape a network of virtual "communities", teemed with participatory actions and movements (Hamurcu, 2022; Ng, 2022).

## Benefits and Prospects of the Metaverse

The main benefits of using the Metaverse as a module of digital interaction include **communication and collaboration**, as users are able to network online, chat, and exchange in virtual spaces, expanding the scope of experiences in areas of work and social interactions. Also, the Metaverse allows for the creation of virtual educational environments with plenty of engaging, immersive, interactive, and –what is most important– realistic experiences (Saleeb et *al.,* 2013; Alemán-Saravia, Deroncele-Acosta, 2021). Therefore, the possibility to organize entertainment events, concerts, and social activities is provided, while users navigate through art exhibitions and museums through their avatars (Del Mar Aragó, 2022). Interaction with items of art is not passive, since users are able to express themselves creating artistic content

using AI tools or in connection to the physical world, by sharing their finalized project with the community.

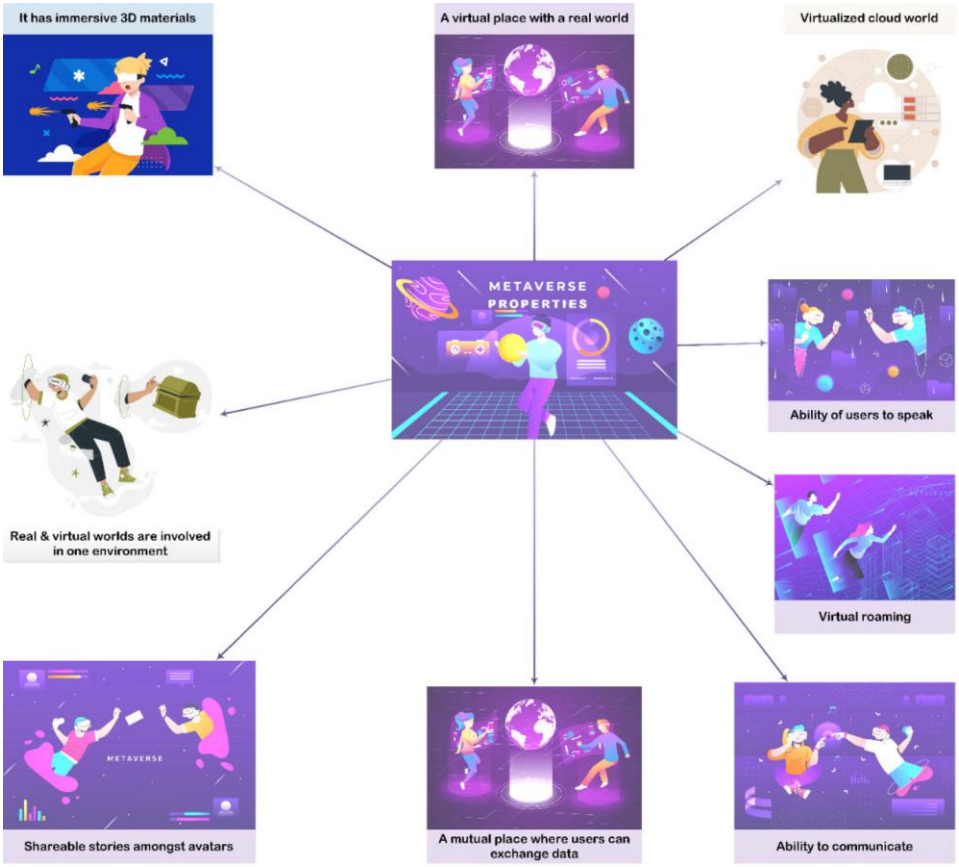


**Figure 4:** Graphical illustration of principal Metaverse properties. (Al-Ghaili, A. M. et al. (2022). Review of Metaverse's Definitions, Architecture, Applications, Challenges, Issues, Solutions, and Future Trends. https://www.doi.org/10.1109/ACCESS.2022.3225638 [accessed 12 April 2024]).

*Metaverse and Interpersonal Communication*

The Metaverse, as a digital, virtual space where users are able to interact both with virtual environments and each other, contributes to interpersonal communication by providing new possibilities and experiences. Users share the opportunity, through the creation of their avatars, to reflect either their real appearance or various fictional versions, allowing for an alternative virtual ego, designed specifically for interpersonal communications (Castillo, and Prieto, 2023; Fialho, and Catapan, 1999). Participating in events and activities that occur within the Metaverse, such as games, events, concerts, lessons, etc., offers the opportunity for virtual meetings replacing or complementing physical meetings among participants that share common interests, regardless of their physical location. Communication may occur on multiple levels, including voice, text and audiovisual media, offering the users enriched experiences (Saker, and Frith, 2022; Shayo et *al.,* 2007). In terms of professional communications, interconnectivity between coworkers provides alternative experiences than traditional office locations (Saleem et

*al.,* 2019). Finally, educational experiences are enhanced, as students are immersed in interactive and engaging educational environments, organized and provided by their teachers or instructors (Lepez, 2022).

Overall, the ability to interactively communicate and participate in virtual environments in the Metaverse, provides a totally new dimension to interpersonal communications, enhancing connection and collaboration between people who might reside in distant locations, in every part of the globe where an Internet connection is provided (Suh, 2023).

*Metaverse, Entrepreneurship, and Commercial Transactions*

The contribution of the Metaverse to the labour sector is vital, offering new opportunities and applications both for business firms and professionals. Through the Metaverse platforms, businesses conduct virtual meetings and sessions, as alternatives to physical meetings, thus facilitating coordination. The coworkers' teams are currently able to collaborate in virtual spaces, creating environments that encourage creativity and effective communication, participating as well in virtual events and professional communities (Warburton, 2009). Professionals are able to use the Metaverse to furtherly create and present creative content both to their colleagues and clients (Jeong, 2021; Lee et *al.,* 2021).

**Figure 5:** A digital twin of a business meeting room in Second Life platform. (Addison A. & O'Hare, L. (2008). How Can Massive Multi-user Virtual Environments and Virtual Role Play Enhance Traditional Teaching Practice?, *Proceedings of the Researching Learning in Virtual Environments ReLIVE08 conference*, p. 13).

In terms of professional education, both educational institutions and enterprises may use the Metaverse as a means to allocate educational programs, training scenarios, and educational experiences to their attendees. In medical and sustainability sectors in particular, the Metaverse is proved to be effectively used for simulation as well as training, being among the most popular and highly-preferred areas of investment so far (Figure 7) (Wang et *al.,* 2022; Zhang et *al.,* 2022; Houda, 2023).

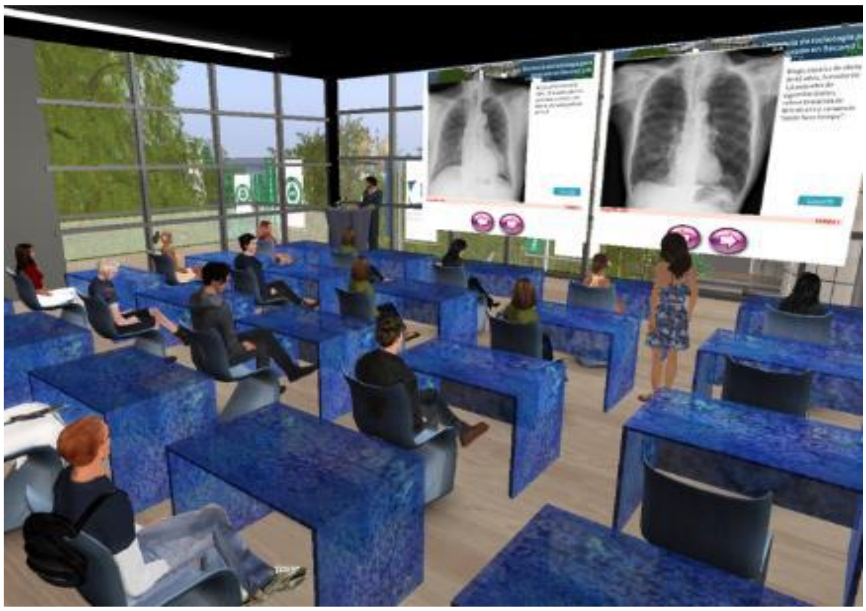

**Figure 6:** A virtual reality Medicine class. Students, represented by their avatars, are seated in digital twins of desks, while the instructor's avatar presents them with slides projected on virtual slideboards. (Göçen, A. (2022). Metaverse in the context of education. *USOBED International Journal of Western Black Sea Social and Human Sciences*, 6(1):98-122. https://doi.org/10.46452/baksoder.1124844 [accessed 19 April 2024]).

The Metaverse will significantly influence e-commerce, as the global metaverse market is expected to grow dramatically by the year 2030 (Jeong, Yi, and Kim, 2022). Virtual storefronts, virtual markets, and virtual exhibition spaces can be created within the Metaverse, allowing users to browse, purchase, and interact with virtual representations of products (Swilley, 2015). Moreover, the Metaverse enables shopping experiences like virtual try-ons or personalized virtual shopping assistants (Rathore, 2017; Jenkins, 2022). However, it is important to note that the Metaverse is still in its premature stages, and the full extent of its impact on e-commerce has not yet been fully viewed or examined (Bhushan et *al.,* 2021). Various technological and regulatory challenges need to be addressed to fully integrate the Metaverse with current e-commerce and platform economy practices (Baskaran, 2023; Bratu, and Sabău, 2022).

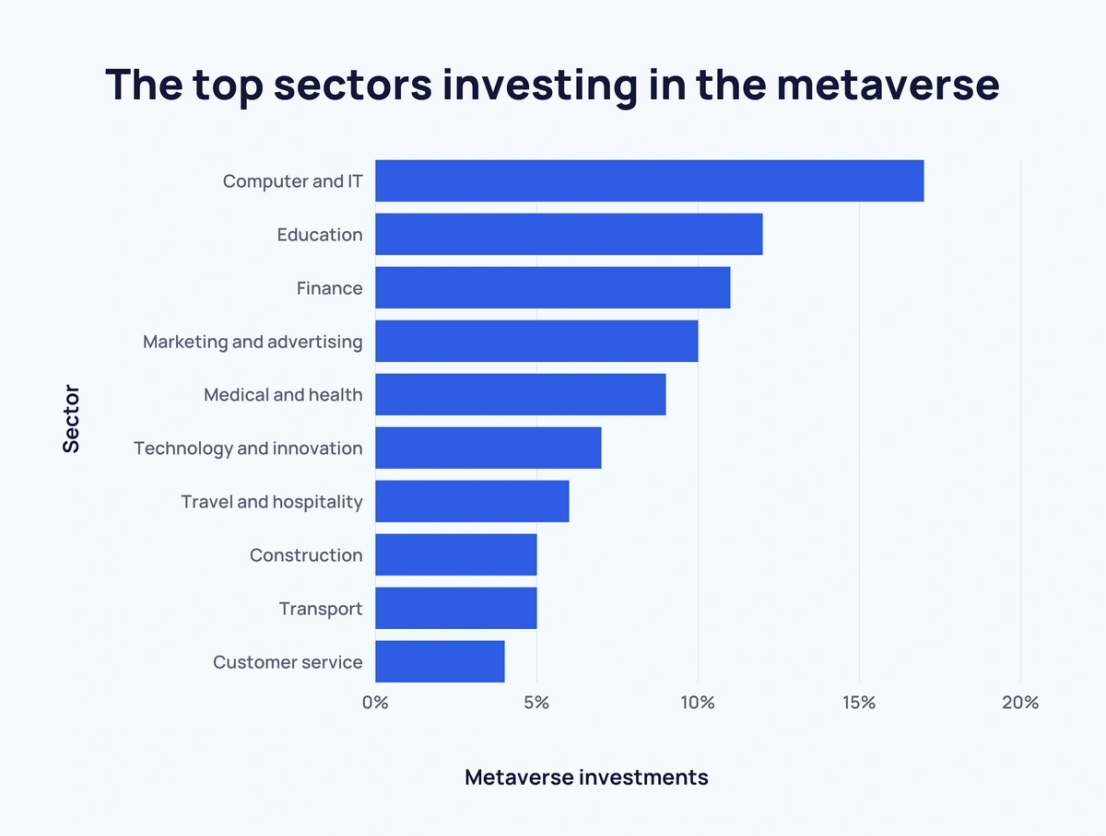


**Figure 7:** A list of up-to-date Metaverse statistical data for 2024. (https://explodingtopics.com/blog/metaverse-stats [accessed 12 February 2024]).

*Metaverse and Politics*

The Metaverse offers a virtual space where citizens are able to meet through their avatars, discuss, organize events, and interact on political issues and activities. On their side, politicians can organize events, meetings, and discussions in the virtual space of the Metaverse, attracting participants beyond the physical borders of their territory, from various parts of the world, by organizing campaigns to promote their ideas, views, proposals, as well as answer voters' questions through virtual events. While those meetings can take place in all-access digital spaces, specialized areas can also be created specified for political discussions and activities. Thus, politicians are able to use the Metaverse as a vehicle to shape public opinion and promote their agenda as effectively as with conventional methods (Delfino, Beramendi, and Zubieta, 2019).

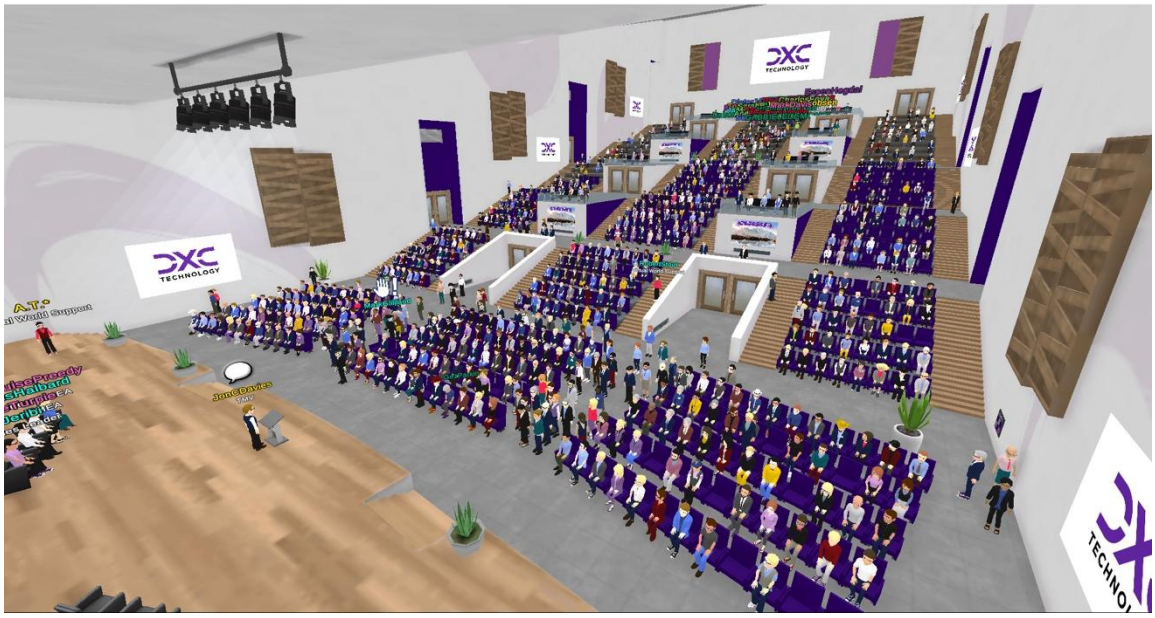


**Figure 8:** Snapshot of a virtual parliamentary consultation in association with DXC Technology. (https://www.newstatesman.com/spotlight/tech-regulation/public-sector-tech/2022/12/five-ways-metaverse-transform-british-politics-next-five-years [accessed 12 February 2024]).

## Challenges of the Metaverse

While the Metaverse is not yet fully formed, allowing for further evolutionary reformations, communication and networking risks and challenges are already apparent (De Felice et *al.,* 2023). Privacy Protection is a major one, jeopardizing its proper use and sustainability, since data collection and processing from the platforms' entrepreneurial providers must be handled carefully to ensure the protection of users' personal data (Wang et *al.,* 2022; Far, and Rad, 2022). Ensuring cybersecurity in the Metaverse is essential and might be achieved through the development of secure and protected virtual environments (Di Pietro, and Cresci, 2021; Huang, Li, and Cai, 2023). Regulatory adaptation is also needed to address new issues that arise in the Metaverse, including property rights, security, and consumer protection (Kymaki, 2022; Pavlopoulou, 2021). Finally, in terms of psychological impact, the digital representation of a person in the Metaverse might imply challenges related to their integration into the community, as long as the interaction with other members.

## Conclusions

The prospective of the Metaverse as an innovative human interaction domain is broad and diverse, offering new opportunities for communication, work, education, and entertainment in the digital territory. Its concept has the potential to enhance social cohesion by providing a shared virtual space that transcends physical borders, where people can interact and collaborate,

participating in collective activities, such as virtual events, games, or creative projects and facilitating connections and fostering a sense of community among individuals who may be physically distant, contributing to a sense of belonging and universality. However, its successful implementation requires addressing a multitude of challenges, including privacy issues, security, regulatory matters, and social acceptance. Finally, it is important to consider that the Metaverse is still a complex and evolving concept, and its future impact on social cohesion will depend on various factors, including its continuously evolving design, regulation, and fair usage.

**References**

Alemán-Saravia, A. C., Deroncele-Acosta, A. (2021). *Technology, Pedagogy and Content (TPACK framework): Systematic Literature Review*. Proceedings - 2021 16th Latin American Conference on Learning Technologies, LACLO 2021, 104-111. https://ieeexplore.ieee.org/document/9725226.

Baskaran, K. (2023). *Customer Experience in the E-Commerce Market Through the Virtual World of Metaverse*. In Handbook of Research on Consumer Behavioral Analytics in Metaverse and the Adoption of a Virtual World, 153-170. IGI Global.

Bhushan, B., Sinha, P., Sagayam, K. M., & Andrew, J. (2021). Untangling blockchain technology: A survey on state of the art, security threats, privacy services, applications and future research directions. *Computers & Electrical Engineering*, 90, 106897.

Bratu, S., & Sabău, R. I. (2022). Digital commerce in the immersive metaverse environment: cognitive analytics management, real-time purchasing data, and seamless connected shopping experiences. *Linguistic and Philosophical Investigations*, 21, 170-186.

Castillo, G. D. C., & Prieto, C. A. A. (2023). Metaverso: mundo paralelo digital en la primera infancia: Metaverse: digital parallel world in early childhood. *Maestro y Sociedad*, 20(3), 784-790. https://maestroysociedad.uo.edu.cu [accessed 14 November 2023].

Chen, Y. (2017). Integrated and intelligent manufacturing: Perspectives and enablers. *Engineering, 3*(5), 588-595.

Choi, B., & Baek, Y. (2011). Exploring factors of media characteristic influencing flow in learning through virtual worlds. *Computers & Education, 57*(4), 2382-2394. https://doi.org/10.1016/j.compedu. 2011.06.019.

Dass, S., Dabbagh, N. & Clark, K. (2011). Using Virtual Worlds: What the Research Says. *Quarterly Review of Distance Education, 12*(2).

De Felice, F., De Luca, C., Di Chiara, S., & Petrillo, A. (2023). Physical and digital worlds: implications and opportunities of the metaverse. *Procedia Computer Science*, 217, 1744-1754. https://doi.org/10.1016/j.procs.2022.12.374.

Del Mar Aragó, M. (2022). Nuevos espacio-tiempos. La inmersividad en la era digital. ASRI: Arte y sociedad. *Revista de investigación*, (21), 72-83. https://doi.org/10.5281/zenodo.7643031.

Delfino G., Beramendi M., Zubieta E. (2019). Participación social y política en Internet y brecha generacional. *Revista de Psicología. 37*(1), 195-216 (ISSN 0254-9247). https://doi.org/10.18800/psico.201901.007.

Di Pietro, R., & Cresci, S. (2021, December). *Metaverse: security and privacy issues*. 2021 Third IEEE International Conference on Trust, Privacy and Security in Intelligent Systems and Applications (TPS-ISA), 281-288. IEEE. https://doi.org/10.1109/TPSISA52974.2021.00032.

Ducheneaut, N., Wen, M. H., Yee, N., & Wadley, G. (2009, April). *Body and mind: a study of avatar personalization in three virtual worlds*. In Proceedings of the SIGCHI conference on human factors in computing systems, 1151-1160. https://doi.org/10.1145/1518701. 1518877.

Far, S. B., & Rad, A. I. (2022). Applying digital twins in metaverse: User interface, security and privacy challenges. *Journal of Metaverse, 2*(1), 8-15. https://dergipark.org.tr/en/download/article-file/2248394 [accessed 4 December 2023].

Fialho, F. A. P., & Catapan, A. H. (1999). Knowledge building by full integration with virtual reality environments and its effects on personal and social life. *Bulletin of Science, Technology & Society, 19*(3), 237-243. https://doi.org/10.1177/027046769901900309.

Fuller, A., Fan, Z., Day, C., & Barlow, C. (2020). Digital twin: Enabling technologies, challenges and open research. IEEE access, 8, 108952-108971. https://doi.org/10.1109/ACCESS.2020.2998358.

Glaessgen, E. and Stargel, D. (2012). *The digital twin paradigm for future NASA and U.S. Air force vehicles*. Proc. 53rd AIAA/ASME/ASCE/AHS/ASC Struct., Struct. Dyn. Mater. Conf. 20th AIAA/ASME/AHS Adapt. Struct. Conf. 14th AIAA, 1818.

González, M. A., Santos, B. S. N., Vargas, A. R., Martín-Gutiérrez, J., & Orihuela, A. R. (2013). Virtual worlds. Opportunities and challenges in the 21st century. *Procedia Computer Science*, 25, 330-337. https://doi.org/10.17705/1jais.00183.

Grieves, M. (2014). *Digital twin: Manufacturing excellence through virtual factory replication*. NASA, Washington, DC, USA, White Paper 1.

Hamurcu, A. U. (2022). The metaverse, online communities, and (real) urban space. *Urbani izziv, 33*(2), 73-81. https://www.jstor.org/stable/10.2307/27184920.

Houda, E. (2023). Augmented Reality and Virtual Reality in Distance-Based Continuing Education: Theoretical Exploration in the Moroccan Enterprise. *African Scientific Journal, 3*(18), 573-573. https://doi.org/10.5281/zenodo.8149722.

Huang, Y., Li, Y. J., & Cai, Z. (2023). Security and privacy in metaverse: A comprehensive survey. *Big Data Mining and Analytics, 6*(2), 234-247. https://doi.org/10.26599/BDMA. 2022.9020047.

Jenkins, T. (2022). Immersive virtual shopping experiences in the retail metaverse: Consumer-driven E-commerce, blockchain-based digital assets, and data visualization tools. *Linguistic and Philosophical Investigations*, (21), 154-169.

Jensen, S. S., Phillips, L., & Strand, D. L. (2012). Virtual worlds as sites for social and cultural innovation. *Convergence, 18*(1), 3-10.

Jeong, Y. K. (2021). Development of the cultural creative contents industry with the metaverse in corona pandemic era. *글로벌문화연구, 12*(2), 71-96.

Jeong, H., Yi, Y., & Kim, D. (2022). An innovative e-commerce platform incorporating metaverse to live commerce. *International Journal of Innovative Computing, Information and Control, 18*(1), 221-229. https://doi.org/10.24507/ijicic.18.01.221.

Kafai, Y. B., Fields, D., & Searle, K. A. (2010). Multi-modal investigations of relationship play in virtual worlds. *International Journal of Gaming and Computer-Mediated Simulations (IJGCMS), 2*(1), 40-48.

Kymaki, I. (2022). The Oversight Board and constitutional dimensions of social media self-regulation. *e-POLITIA Electronic Journal of Public Law*, issue 4, October-December 2022, p. 516. https://www.epoliteia.gr/e-journal/2022/10/20/e-politeia-teyxos-4-oktwvrios-dekemvrios-2022 [accessed 19 November 2023].

Laeeq, K. (2022). Metaverse: why, how and what. How and What. https://www.researchgate.net/publication/358505001_Metaverse_Why_How_and_What (retrieved at 5-9-2023).

Lee, L. H., Lin, Z., Hu, R., Gong, Z., Kumar, A., Li, T., ... & Hui, P. (2021). When creators meet the metaverse: A survey on computational arts. https://doi.org/10.48550/arXiv.2111.13486.

Lepez, C. O. (2022). Metaverso y educación: una revisión panorámica. *Metaverse Basic Appl. Res, 1*(2). https://doi.org/10.56294/mr20222.

Liu, Z., Meyendorf, N. & Mrad, N. (2018). The role of data fusion in predictive maintenance using digital twin. Proc. Annu. Rev. Prog. Quant. Nondestruct. Eval., Provo, UT, USA, Art. no. 020023.

Lochtefeld, J. (2002). *Avatar.* The Illustrated Encyclopedia of Hinduism. 1:A-M, Rosen Publishing, ISBN 0-8239-2287-1, 72–73.

Madni, A., Madni, C. & Lucero, S. (2019). Leveraging digital twin technology in model-based systems engineering. *Systems, 7*(1), 7.

Messinger, P., Stroulia, E., & Lyons, K. (2008). A typology of virtual worlds: Historical overview and future directions. *Journal of Virtual Worlds Research, 1*(1).

Ng, D. T. K. (2022). What is the metaverse? Definitions, technologies and the community of inquiry. *Australasian Journal of Educational Technology, 38*(4), 190-205. https://doi.org/10.14742/ajet.7945.

Papailiou, A. (2022). The use of Augmented Reality in the era of Industry 4.0 and its multidimensional contribution to enhancing the user experience. Diploma Thesis. Hellenic Open University. Patras. 111. https://apothesis.eap.gr/archive/item/171020 [accessed 19 September 2023].

Pavlopoulou, P. (2021), Newly-established rules for controlling social media. A phenomenon of regulatory intervention by civil society in the context of globalisation, EFDD, issue 1, pp. 9-18. https://www.constitutionalism.gr/wp-content/uploads/2021/06/2021-04-15_Pavlopoulos-kanones-eleghou-internet.pdf [accessed 19 November 2023].

Rathore, B. (2017). Virtual Consumerism: An Exploration of E-Commerce in the Metaverse. International Journal of New Media Studies: *International Peer Reviewed Scholarly Indexed Journal, 4*(2), 61-69. https://www.ijnms.com/index.php/ijnms/article/view/109/89 [accessed 4 December 2023].

Sadler, R. (2012). Virtual worlds: An overview and pedagogical examination. *Bellaterra Journal of Teaching & Learning Language & Literature, 5*(1), 1-22. https://doi.org/10.5565/rev/jtl3.456.

Sadler, R., Dooly, M., Thomas, M., Reinders, H., & Warschauer, M. (2013). Language learning in virtual worlds: Research and practice. Contemporary computer-assisted language learning, 159-182.

Saker, M., & Frith, J. (2022). Contiguous identities: the virtual self in the supposed metaverse. First Monday. https://doi.org/10.5210/fm.v27i3.12471.

Saleeb, N., Dafoulas, G. A., Saleeb, N., & Dafoulas, G. (2013, July). Artificial Intelligence in 3D Virtual Environments as Technological Support for Pedagogy. In Intelligent Environments (Workshops), 443-453.

Saleem, K. M., Iqbal, M., Saadi, H., Fatima, A., & Enam, R. N. (2019, March). Collaboration of virtual reality in our professional life. In 2019 International Conference on Information Science and Communication Technology (ICISCT) (pp. 1-4). https://doi.org/IEEE.10.1109/CISCT.2019.8777402.

Shayo, C., Olfman, L., Iriberri, A., & Igbaria, M. (2007). The virtual society: Its driving forces, arrangements, practices, and implications. In Psychology and the Internet (pp. 187-219). Academic Press. https://doi.org/10.1016/B978-012369425-6/50027-8.

Spence, J. (2008). Demographics of virtual worlds. Journal for virtual worlds research, 1(2). https://doi.org/10.4101/jvwr.v1i2.360.

Suh, A. (2023). How users cognitively appraise and emotionally experience the metaverse: focusing on social virtual reality. Information Technology & People. https://doi.org/10.1108/ITP-06-2022-0461.

Swilley, E. (2015, December). *Moving virtual retail into reality: Examining metaverse and augmented reality in the online shopping experience*. In Looking Forward, Looking Back: Drawing on the Past to Shape the Future of Marketing: Proceedings of the 2013 World Marketing Congress (pp. 675-677). Cham: Springer International Publishing.

Tsigas A. (2009), The importance of phenomenology in the architecture of the home and the city today and in the future. The Importance of Philosophy in Architectural Education, Conference, Patras: 9, 10, 11 October 2009.

Wang, Y., Lee, L. H., Braud, T., & Hui, P. (2022, July). Re-shaping Post-COVID-19 teaching and learning: A blueprint of virtual-physical blended classrooms in the metaverse era. 2022 IEEE 42nd International Conference on Distributed Computing Systems Workshops (ICDCSW), 241-247. IEEE. https://doi.org/10.1109/ICDCSW56584.2022.00053.

Wang, Y., Su, Z., Zhang, N., Xing, R., Liu, D., Luan, T. H., & Shen, X. (2022). A survey on metaverse: Fundamentals, security, and privacy. IEEE Communications Surveys & Tutorials. https://doi.org/10.1109/COMST.2022.3202047.

Warburton, S. (2009). Second Life in higher education: Assessing the potential for and the barriers to deploying virtual worlds in learning and teaching. *British journal of educational technology, 40*(3), 414-426. https://doi.org/10.1111/j.1467-8535.2009.00952.x.

Zhang, X., Chen, Y., Hu, L., & Wang, Y. (2022). The metaverse in education: Definition, framework, features, potential applications, challenges, and future research topics. *Frontiers in Psychology*, 13, 6063. https://doi.org/10.3389/fpsyg.2022.1016300.

Zheng, Y., Yang, S., & Cheng H. (2018). An application framework of digital twin and its case study. *Journal of Ambient Intelligent Humanized Computers, 10*(3), 1141-1153.