



How Metaverse is Affecting Smart Cities Economy

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ABSTRACT

In recent years, the convergence of physical and digital realms within the metaverse has become a focal point of interest, particularly in the post-COVID-19 era. This exploration takes on heightened significance given the myriad opportunities the metaverse offers to the modern world, particularly in shaping a smarter, more efficient economy. The impact of metaverse ecosystems extends across various domains of the Smart City, with a pronounced emphasis on the smart economy. The metaverse's role in transforming economic interactions, transactions, and innovation is crucial. However, the metaverse city also presents new challenges concerning trust, privacy, and ensuring inclusivity, highlighting the importance of ethical and equitable economic practices. This paper puts forward a comprehensive research agenda that aims to seamlessly integrate the metaverse into Smart Cities, with a strong emphasis on fostering a smart economy. This agenda seeks to engage researchers, practitioners, and policymakers to harness the full potential of metaverse technology in a manner that drives economic growth and innovation while ensuring equitable and inclusive prosperity for all.

CCS CONCEPTS

• **Human computer interaction (HCI)** → Interaction paradigms; Mixed / augmented reality.

KEYWORDS

smart cities, metaverse, smart economy

ACM Reference Format:

Ioanna Chatzopoulou, Paraskevi Tsoutsas, and Panos Fitsilis. 2023. How Metaverse is Affecting Smart Cities Economy. In *27th Pan-Hellenic Conference on Progress in Computing and Informatics (PCI 2023)*, November 24–26, 2023, Lamia, Greece. ACM, New York, NY, USA, 6 pages. <https://doi.org/10.1145/3635059.3635099>

1 INTRODUCTION

In recent years, the concept of a Smart City (SC) has undergone a significant transformation, driven by the extensive use of ICT tools. More recently, the metaverse has emerged as a powerful technology, especially accelerated by situations like the COVID-19 pandemic.

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PCI 2023, November 24–26, 2023, Lamia, Greece

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ACM ISBN 979-8-4007-1626-3/23/11

<https://doi.org/10.1145/3635059.3635099>

This convergence has given rise to the idea of using the metaverse in a smart city, reshaping established structures, processes, practices, and cultures within SC, and redefining key aspects of smart urbanism specifically under the emphasis is placed for the development of participatory SCs, where citizens and key stakeholders of the city are highly involved, cooperating on smart solutions and working for a better quality of life [1]. While there is a wealth of literature on the metaverse in various domains like technology, education, medicine, cybersecurity, and consumer behavior, limited attention has been given to its applications in SCs, particularly its impact on the smart city economy.

To bridge this gap and enhance our understanding, this study conducts a systematic literature review covering the past five years (up to 2018) to explore the growing adoption of metaverse technologies by SC and how they transform various application domains. We discuss how the SC model, as proposed by Giffinger in 2007 [2] is adapting and evolving with the integration of the metaverse, giving emphasis on Smart Economy addressing both the opportunities presented by this new era and concerns related to privacy, safety, trust, and the well-being of vulnerable members of society.

The remainder of this paper is structured as follows: Section 2 provides an overview of smart urbanism and smart economy, primarily based on Giffinger's model of the Smart City. Section 3 outlines the methodology and data gathering process used in this review. In Section 4, we examine the new perspectives and unique opportunities that arise from the adoption of metaverse technology within key Smart City areas, highlighting state-of-the-art applications and concluding with the identification of challenges and open issues associated with metaverse cities. Finally, in Section 5, we summarize our key findings and suggest a potential future research agenda.

2 BACKGROUND

2.1 An overview of the Smart Cities' key areas and of SC Economy Tables

Academic literature introduces various models to define the key dimensions of a Smart City. For instance, [3] presents a three-dimensional model covering technological, human, and institutional aspects, while [4] emphasizes viability, workability, and sustainability achieved through pervasive networked technology. Another popular model is the Triple Helix model which elucidates the roles of stakeholders in Smart Cities, involving municipalities, universities, and businesses [5]. Triple Helix evolved into the Quadruple Helix with the incorporation of local communities and citizens in Smart City governance [6, 7].

Researchers in [8] propose a six-dimensional model emphasizing urban infrastructure, business-driven urban development, high-tech industries, inclusive strategies, social and relational capital,

and social and environmental sustainability. Another approach by [9] defines six common areas of Smart Cities, encompassing ICT, entrepreneurship, inclusiveness, social capital, economic and environmental issues. These models share common characteristics, including technology integration, standardization of processes, transparency, efficiency, e-service delivery, electronic payment systems, innovation initiatives, environmental sustainability, and public-private partnerships.

Furthermore, Giffinger's (2007) six-dimensional Smart City model, introduced in 2007, centers on the synergy between independent, self-aware citizens and their activities. In this review, we explore the applications of the metaverse within the Smart City framework regarding the economy dimension, by mainly using Giffinger's model as a basis.

Giffinger's Smart City model has been instrumental in the quest to systematize the approach to Smart City complexity within the literature, as it provides a comprehensive framework to understand and analyze the multifaceted nature of Smart Cities. It revolves around six core dimensions: economy, mobility, environment, people, living, and governance. Each dimension plays a pivotal role in shaping the city's development and functionality. In "Smart Mobility" dimension, the emphasis is on logistics and infrastructure, ensuring an efficient, sustainable, and secure transportation system. Simultaneously, accessible ICT infrastructure connects the city's residents, facilitating efficient mobility solutions [10]. "Smart Environment" underscores the importance of sustainable resource management, environmental protection, and a clean, unpolluted natural environment. "Smart People" revolves around factors like education, lifelong learning, diversity, openness, creativity, and civic participation, all of which contribute to the city's social and intellectual vitality. "Smart Governance" emphasizes participatory decision-making, efficient public utilities, and transparent administration, while considering political strategies and perspectives. Finally, "Smart Living" encompasses safety, housing quality, cultural and educational facilities, healthcare services, tourist attractions, and social cohesion, collectively defining the overall quality of life within a Smart City. Giffinger's model serves as a foundational reference point for researchers and policymakers, enabling a holistic understanding of the complex dynamics of Smart Cities.

Consequently, a key dimension of a smart city that is included in all aforementioned models is the "Smart Economy". This is also clear from the growing interest in the publications on the topic regarding SC over time [11]. A smart economy is one that is driven by innovation, entrepreneurship, and a productive and flexible labor market. It is also an economy that is integrated with the global marketplace and has a strong reputation for attracting and retaining businesses and residents. There is a number of ways to improve the smart economy in a city. One important step is to invest in scientific research and ICT development. This will help to foster innovation, create new e-businesses and e-commerce models as well as increase online consumption percentages. Another important step is to promote entrepreneurship based on urban and environmental sustainability, ensuring resource efficiency (e.g. sharing resources without ownership and resources allocation to avoid waste management). This can be done by creating an environment that is supportive of new business ventures. Furthermore, it is also important to create a skilled and adaptable workforce, specifically in relation to ICT.

This can be implemented by investing in education and training programs. It is also important to create an environment that is attractive to skilled workers, by offering competitive salaries and benefits. Finally, it is important to attract international businesses and investment. This can be achieved by marketing the city to international businesses and by offering them incentives to locate in the city. It is also important to create an environment that is welcoming to international businesses, such as by providing them with access to support services and by removing barriers to entry.

2.2 Metaverse technology

The contemporary Smart City concept integrates e-government initiatives and urban management strategies that heavily leverage ICT tools, Internet of Things (IoT) technology, and, more recently, the metaverse [12, 13]. This shift towards a metaverse-driven urban landscape has been accelerated by the pandemic, making digital technologies a staple of urban life, ultimately steering us towards the metaverse vision.

The metaverse, a concept rooted in science fiction, presents a virtual realm that transcends and complements our physical world. This shared 3D cyberspace enables myriad experiences, from socializing and working to learning and exploring. As a convergence of technology, it fosters interactive and immersive user experiences, while also encouraging the production, sale, and exchange of digital assets. The metaverse operates as a digital extension of our social, playful, and productive lives, fostering the continuity of identity, objects, history, and human rights. It acts as a bridge between the physical and digital realms, facilitating engagement and connection in multisensory experiences, where people can coexist in both real and digital worlds. Some of the key characteristics - that differentiate the metaverse from other technologies [14–21] are:

- **Persistence:** The metaverse is persistent, meaning that it exists even when users are not logged in. This allows for virtual worlds and experiences to be continuously active and evolve over time.
- **Synchronicity:** The metaverse is synchronous, meaning that everyone experiences it in real time. This allows for users to interact with each other and with digital objects in a natural and seamless way.
- **Immersion:** The metaverse is immersive, meaning that users feel like they are actually present in the virtual world. This is achieved through a combination of factors, including high-quality graphics, realistic physics, and sensory feedback.
- **Decentralized:** The metaverse will be powered by decentralized technologies, such as blockchain and peer-to-peer networks. This will give users more control over their data and experiences.
- **Open:** The metaverse will be open and accessible to everyone. There will be no central authority controlling who can participate or what can be done in the metaverse.
- **Interoperable:** The metaverse will be interoperable, meaning that users will be able to move seamlessly between different virtual worlds and experiences. This will allow for a more unified and immersive metaverse experience.

The way we interact with digital environments and the worlds of work, entertainment, commerce, and social relationships could all

be revolutionized by the metaverse. As society progressively adopts virtual lifestyles, municipalities globally are acknowledging the potential of the virtual domain. Municipalities are actively exploring and investing in technologies that align with their forward-thinking vision, recognizing the potential of the virtual realm. This distinctive technology, referred to as "Citiverse," is introduced as an innovative concept redefining the metaverse within the context of smart cities. Citiverse integrates metaverse and city-specific technologies and systems, customized to address urban needs. This integration presents opportunities to reshape urban planning, redefine our urban lifestyles, and rethinking economic opportunities. In essence, citiverse offers a fresh perspective on how cities can leverage the synergy between virtual environments and urban technologies to advance their agendas. To address challenges in implementing the citiverse, the International Telecommunication Union (ITU) has established a focus group dedicated to working on these issues [22].

According to [23, 24] the metaverse could be used to:

- **Create virtual twins of cities:** Virtual twins are digital replicas of real-world objects and systems. They can be used to simulate and test different scenarios before they are implemented in the real world. For example, a virtual twin of a city could be used to simulate the impact of a new transportation system or a new building on the city's traffic flow and air quality.
- **Provide new ways to access city services:** The metaverse could be used to provide new ways for citizens to access city services, such as online education, healthcare, and government services. For example, citizens could use the metaverse to attend virtual classes, consult with a doctor, or apply for a passport.
- **Improve collaboration and communication:** The metaverse could be used to improve collaboration and communication between different stakeholders in a smart city, such as government agencies, businesses, and citizens. For example, city planners could use the metaverse to collaborate with citizens on new urban development projects.
- **Create new economic opportunities:** The metaverse could create new economic opportunities for businesses and individuals. For example, businesses could use the metaverse to create and deliver new products and services, such as virtual concerts and shopping experiences. Individuals could use the metaverse to create and sell digital assets, such as virtual clothing and accessories.

A critical factor and catalyst for the establishment and rapid growth of the metaverse ecosystem in recent years have been the advancements in convergence-based computing and immersive technology. Metaverse technology is related to communication, networking, computing, and storage infrastructures and is grounded in the following eight pillars: AI, Blockchain, Computer Vision (CV), 5G & 6G, Edge Computing, User interactivity, XR, Robotics/Network of Things. In metaverse supporting technology is included Big Data, Digital Twins, 3D virtual worlds, as well as a plethora of platforms for interaction (e.g. Horizon Home, AR Calls, Gaming platform, Presence Platform, Project Cambria, Spark AR, Future of Work, Fitness), gadgets and multimodal equipment (e.g. HMDs and AR

googles). Simultaneously, interactivity in the metaverse realm is implemented through avatars, users' digital representatives.

3 RESEARCH METHODOLOGY

This systematic literature review post-2018 research the transformative dynamics of the Smart City concept and the emergent metaverse technology, investigating how the latter affects various facets of Smart Cities. More specifically, this paper is addressing how SC economy is affected by the introduction of metaverse. To accomplish this, the review follows the PRISMA systematic research methodology [25], designed to enhance reporting clarity and scientific rigor in systematic reviews and meta-analyses. It offers a structured approach to conducting systematic reviews, ensuring clarity in reporting, presentation of evidence, and transparency throughout the research process. This method plays a crucial role in enhancing the quality and replicability of research studies, contributing to the robustness of scientific literature.

The research process comprises three stages. The planning stage involves formulating a comprehensive search query for literature within the last quinquennium, focusing on the intersection of the metaverse and Smart Cities. The review stage considers peer-reviewed journals, books, and conference proceedings, with 94 eligible articles subjected to full-text scrutiny based on predefined inclusion/exclusion criteria, regarding availability, reliability, documents published in English language and duplication. The final stage involves the analysis and categorization of 65 articles into three key themes: metaverse definition and core elements, metaverse and Smart City implementation fields, and metaverse challenges in Smart Cities.

This systematic review unfolds a well-structured research work, aiming to advance our understanding of how the metaverse reshapes the Smart City economy.

4 DISCUSSION AND FINDINGS

Within the domain of smart economy, innovation and entrepreneurship synergize to drive sustainable growth, driven by seamless technological integration that fosters a dynamic and resilient ecosystem. The metaverse plays a pivotal role in enriching the smart economy, creating immersive digital environments for commerce, innovation, and connectivity, thereby offering limitless opportunities for collaboration and growth. The transformative influence of the metaverse on the smart economy can be encapsulated, as outlined in Table ??, through five key arguments:

- **Economic Transformation:** The metaverse has ushered in new economic opportunities, attracting substantial investments and delivering impressive returns on a global scale. Leading technology giants have poured billions of USD into the metaverse, encompassing financial resources, hardware infrastructure, and software applications. This substantial investment reflects the metaverse's growing momentum and appeal.
- **E-commerce:** Both traditional and e-commerce ventures flourish within the metaverse. It offers a platform for selling physical and digital goods, providing users with realistic and enjoyable shopping experiences enriched by multi-sensory features. Retail companies leverage the metaverse to allow

Table 1: Smart Economy's transformation by applying the metaverse

Smart Economy Factors	Metaverse Impact on Economic Transformation in SC	Case examples
Economic transformation / e-commerce	Foster a culture of innovation and creativity	New digital products e.g. HMDs, AR googles and VR headsets, hand-held touch screen devices, immersion helmets and sensor networks, smartphones, tablets, contact lenses [28]. New type of financial transactions based on cryptocurrencies (Bitcoin and Ethereum, Robux in Roblox, Linden Dollars in Second Life and Simoleans in The Sims) and NFTs assets e.g., 'Skins', clothes for avatars, art pieces, video games, sport shoes, collectibles, virtual shops, real estate, land in metaverse etc. [27, 31, 36–38].
	Attract tech companies and startups	Significant investments by major IT players (e.g. Microsoft, Apple, Magic Leap, Roblox, Epic Games, Nvidia, etc.) over \$10billion [15, 26]. Opportunities for startups, such as Genies company that creates avatars for celebrities, Now.gg, a global platform-as-a-service for game developers and Teslasuit company to offer haptic feedback to metaverse users) [40]. Expected global turnover in XR market in 2030: \$1.92.4trillion [24].
	Drive economic growth through R&D and innovation Investment in hardware infrastructure and software applications in metaverse	Consumers' increased spending of metaverse on virtual goods \$54billion/annually, according to JP Morgan [27]. and on haptic suit, gloves, shoes and advanced VR equipment up to \$1000 (intention by 65% consumers) [14, 15, 24, 28].
Entrepreneurship	Encourage the establishment of new businesses	Metaverse platforms enable for selling physical and digital goods and establishment of a new business model: from Direct to Consumer (D2C) to Direct to Avatar (D2A) and Virtual to Virtual [29]. It allows reduction of physical store size, costs saving, displaying inventory, skip traditional supply chain and intermediaries, direct connection with consumer [28, 30].
	Support and incentivize entrepreneurship	Competitive advantage by lowering cost, increasing effectiveness and cohesion with business stakeholders, interactivity with customers. Also, by providing high-performance consumption and hedonic experiences. E.g., virtual product design, healthcare platforms, sports competitions, immersive training, tourism experiences, and realistic and enjoyable shopping experiences (simulation of touch a fabric, smell a perfume, check furniture' suitability) [31].
Productive and Flexible Labor Market	Enhance the skills of the local workforce and improved training	Updated workforce competences e.g., technological, social, and emotional rather than physical and manual skills, adaptation to human-machine interaction and staff training on metaverse (Hilton hotel group, Walmart etc.) [21, 30, 32, 33].
	Creation of new job profiles and job creation	New employments e.g., designers, content creators, social media marketers, human and virtual influencers, digital advertisers, agents on AR-related tourism commerce, freelancers with VR, AR and metaverse expertise [30, 34] Job creation opportunities in the game's world e.g. Crypto Gaming United (CGU) intends to employ 1,000,000 people in developing countries using P2platform by 2024 [42].
	New remote working options through metaverse workspaces and applications	Metaverse workspaces: Microsoft Mesh (by Microsoft Teams) and Meta's Horizon Workrooms [34]. Oculus Quest headset enabling the management and share all work files and documents without logging on to personal computers [13]. Multiculturalism and cross-regional socialization (by teleworking) [26].
	Promote flexibility in employment and work styles	New work patterns, ICT-based mobile work, digitally enabled forms of self-employment, outside a full-time, permanent and bilateral employment relationship [26, 34].

	Use of modern technology such as avatars for interaction with customers	In customer services (Facebook messenger, Lemonade Insurance, Los Angeles Superior Court, HSBC Hong Kong's Amy etc), in banking industry (ING Bank, Natwest Bank, UBS etc by 87%), in travel and hospitality industry (by 241%), for consumer goods (e.g. IKEA's website, SK-II by 187%) [34, 35].
International Integration	Attract foreign investment and global companies	BMW, Ericsson, Adobe investments in Omniverse Nvidia: the metaverse for engineers, enabling simulating scenarios of a complete factory model attracting companies [26].
	Facilitate trade and economic partnership/ Bolster the city's global economic presence	Meta partnerships with key global entities from industry, governments, non-profit organizations, academic institutions and civil rights groups including: Colorintech (UK), Alte Nationalgalerie (Germany), Peres Center for Peace and Innovation (Israel), Seoul National University, University of Hong Kong, Centre for Technology, Robotics, Artificial Intelligence and Law (TRAIL) from the National University of Singapore, Howard University [43].
Economic Image and Brands	Develop a positive image to attract investment	Brands' investments in marketing strategy based on metaverse by engaging advertising, promoting avatars accessories and organizing immersive events to engage audience, especially Gen Z by Gucci, Calvin Klein, Prada, Vans, Nike, Coca-Cola, Mahou, Heineken, Samsung, Volkswagen etc. (e.g., Ralph Lauren's virtual stores on Roblox are online 24 hours a day, to anyone, anywhere in the world, with virtual puffer jackets and plaid caps priced around \$5) [19, 23, 39].
	Cultivate city's brand as a business destination	Virtual replicas of Orlando, Las Vegas, and Boston for different scenarios of urban development (land use, new streets), urban governance and virtual tour in city's assets using metaverse in Seoul, South Korea [13].
	Improve the city's overall reputation	Increased share price of firms with metaverse announcement, e.g, Metaverse Concept Index in Chinese stock market [19].

customers to visualize products and experiences before making purchases.

- **Workplace Revolution:** The metaverse has restructured the modern workplace, offering flexibility and new remote working options. This transformation has led to the creation of a variety of job opportunities, particularly for young individuals well-versed in eXtended Reality (XR) technology.
- **Enhanced Brand Engagement:** Major technology companies and brands are investing in the metaverse to connect with audiences, launch avatar accessories, and organize immersive events. This engagement not only strengthens brand-customer relationships but also reflects positively on a company's stock performance.
- **Digital Interactivity and Financial Transactions:** The metaverse enhances advertising by enabling digital interactivity between users and firms. Financial transactions within the metaverse are increasingly based on cryptocurrencies and Non-Fungible Tokens (NFTs). This includes the sale of tangible goods, digital assets, art pieces, and various collectibles through NFTs, driving a significant market.

In summary, the metaverse is fundamentally reshaping the landscape of the smart economy, introducing new economic dimensions, innovative shopping experiences, flexible workplaces, and engaging brand interactions, while experiencing novel forms of digital interactivity and financial transactions. This transformative impact underscores the metaverse's growing importance in the global economic landscape.

5 RESEARCH DIRECTIONS AND CONCLUSIONS

In the domain of smart cities, the metaverse is emerging as a transformative force, set to reshape the very foundations of the smart city and economy. To navigate this digital frontier, the key research directions unveiled by this study point towards:

- a) **Metaverse Integration in Smart Cities:** We embark on an exploration of how the metaverse can seamlessly integrate into the intricate fabric of smart cities. The focus here lies in developing the essential infrastructure and technologies required for the harmonious coexistence of these two futuristic domains.
- b) **Economic and Social Impacts:** As the metaverse extends its reach into the heart of smart cities, our research explores the profound economic and social effects it ushers in. This includes an in-depth examination of how the metaverse influences financial transactions, workforce dynamics, and the very nature of urban living.
- c) **Privacy and Security:** In a world where reality intertwines with virtuality, a paramount concern is the safeguarding of privacy and data security. Our research directions encompass the creation of stringent regulations and innovative technologies to protect personal information and ensure secure transactions within the digital urban landscape.

The metaverse's integration into smart cities promises a thrilling journey for the smart economy. It fundamentally alters economic activities, customer engagement, collaboration [44] and the world of work. However, there are certain difficulties and complexities

coming with this transition. Moreover, this demands meticulous planning, robust infrastructure, and a commitment to preserving individual privacy. The arrival of the metaverse in the context of smart cities isn't just a passing trend; it's a monumental shift that will redefine the way we live, work, and interact in our urban environments. The smart economy is about to embark on a new chapter, and this one is filled with boundless possibilities.

REFERENCES

- [1] Panos Fitsilis, Paraskevi Tsoutsas, Vyron Damasiotis, and Rodanthi Tsvola. 2023. How Do Citizens Want to Participate in Smart City Programs? Some Answers from Greece. In *Sustainable, Innovative and Intelligent Societies and Cities* (pp. 135-154). Cham: Springer International Publishing.
- [2] Rudolf Giffinger, Christian Fertner, Hans Kramar, Robert Kalasek, Natasa Pichler-Milanovic, and Evert J Meijers. 2007. Smart cities. Ranking of European medium-sized cities. Final Report.
- [3] Taewoo Nam and Theresa A Pardo. 2011. Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times* (pp. 282-291).
- [4] Dale Leorke. 2020. Reappropriating, reconfiguring and augmenting the smart city through play. *Making Smart Cities More Playable: Exploring Playable Cities*, 51-70.
- [5] Loet Leydesdorff and Mark Deakin. 2010. The triple helix model and the meta-stabilization of urban technologies in smart cities. arXiv preprint arXiv:1003.3344.
- [6] Patrizia Lombardi, Silvia Giordano, Hend Farouh & Wael Yousef. 2012. Modelling the smart city performance. *Innovation: The European Journal of Social Science Research*, 25(2), 137-149. Patrizia Lombardi, Silvia Giordano, Hend Farouh & Wael Yousef
- [7] Yannis Charalabidis, Charalampos Alexopoulos, Nikolaos Vogiatzis, and Dimitrios E Kolokotronis. 2019. A 360-degree model for prioritizing smart cities initiatives, with the participation of municipality officials, citizens and experts. *E-participation in smart cities: Technologies and models of governance for citizen engagement*, 123-153.
- [8] Andrea Caragliu, Chiara Del Bo, and Peter Nijkamp. 2011. Smart cities in Europe. *Journal of urban technology*, 18(2), 65-82.
- [9] Robert A. Cropp and Mark Benton. 2019. Towards a working model of e-participation in smart cities: What the research suggests. *E-participation in smart cities: Technologies and models of governance for citizen engagement*, 99-121.
- [10] Paraskevi Tsoutsas, Omiros Iatrellis, Omiros Ragos, and Fitsilis Panos. 2021. A framework for developing teamwork enabled services in smart city domains. In *2021 the 4th International Conference on Computers in Management and Business* (pp. 26-32).
- [11] Paraskevi Tsoutsas, and Ioannis Ch Lampropoulos. 2022. Preparing for smart cities' future competences: Trends arising through keyword and review analysis. *Building on Smart Cities Skills and Competences: Human factors affecting smart cities development*. Cham: Springer International Publishing 37-51.
- [12] Diana Soeiro. 2021. Smart cities and innovative governance systems: A reflection on urban living labs and action research. *Fennia-International Journal of Geography*, 199(1), 104-112.
- [13] Zaheer Allam, Ayyoob Sharifi, Simon Elias Bibri, David Sydney Jones, and John Krogstie. 2022. The metaverse as a virtual form of smart cities: Opportunities and challenges for environmental, economic, and social sustainability in urban futures. *Smart Cities*, 5(3), 771-801.
- [14] Simon Elias Bibri and Zaheer Allam. 2022. The Metaverse as a virtual form of data-driven smart cities: The ethics of the hyper-connectivity, datafication, algorithmization, and platformization of urban society. *Computational Urban Science*, 2(1), 22.
- [15] Simon Elias Bibri. 2022. The social shaping of the metaverse as an alternative to the imaginaries of data-driven smart Cities: A study in science, technology, and society. *Smart Cities*, 5(3), 832-874.
- [16] Simon Elias Bibri, Zaheer Allam Bibri, and John Krogstie. 2022. The Metaverse as a virtual form of data-driven smart urbanism: platformization and its underlying processes, institutional dimensions, and disruptive impacts. *Computational Urban Science*, 2(1), 24.
- [17] Octavian-Dragomir Jora, Alexandru Georgescu, Vlad I. Rosca, Paul Cristian Vasile, Carmen Maria Constantinescu, and Andreea Dinu. 2022. The New Age of Metaverse and the Old School Universe: Business on the Edge of Final Frontiers. *Fostering Recovery through Metaverse Business Modelling*, 599.
- [18] Roman Schuijers. 2023. Governance in virtual space: institutional foundations for virtual environments in the metaverse (Doctoral dissertation).
- [19] Yingbo Xu, Wei Liu, Tong He and, Sang-Bing Tsai. 2023. Buzzword or fuzzword: an event study of the metaverse in the Chinese stock market. *Internet Research*.
- [20] Andrew Hudson-Smith. 2022. Incoming metaverses: Digital mirrors for urban planning. *Urban Planning*, 7(2), 343-354.
- [21] Senthil Kumar Jagatheesaperumala, Kashif Ahmadb, Ala Al-Fuqahac and Junaid Qadird. 2022. Advancing Education Through Extended Reality and Internet of Everything Enabled Metaverses: Applications, Challenges, and Open Issues. arXiv preprint arXiv:2207.01512.
- [22] International Telecommunication Union. 2023. 3rd ITU Forum on "Cities and the metaverse: shaping a citiverse for all", Arusha, Tanzania.
- [23] Pavel Sidorenko Bautista. 2022. City Branding and Place Branding in the Metaverse: how real cities build their virtual image and how virtual cities do it3.
- [24] Bani Pamungkas. 2022. The Future of Cities in the Metaverse Era: Are Indonesian Cities Ready?. *Megafury Apriandhini*, SH, MH Chair of 4th OSC, 401.
- [25] Matthew J Page, David Moher, Patrick M Bossuyt *et al.*, 2021. PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. *bmj*, 372.
- [26] Zhisheng Chen. 2023. Metaverse office: exploring future teleworking model. *Kybernetes*.
- [27] Peter Buell Hirsch. 2022. Adventures in the metaverse. *Journal of Business Strategy*, 43(5), 332-336.
- [28] Stefany Dayana Rojas Rodriguez. 2023. Digital marketing in the metaverse and its effect on E-commerce.
- [29] Dedy Juniadi, Siti Aisyah, and Zainur Hidayah. 2022. Capaian Smart Economy dan Tantangannya di Era Metaverse. *Megafury Apriandhini*, SH, MH Chair of 4th OSC, 291.
- [30] Kritcha Yawised, Darlin Apasrawirote, and Chalal Boonpan. 2022. From traditional business shifted towards transformation: The emerging business opportunities and challenges in 'Metaverse' era. *Incbaa* 2022, 162-175.
- [31] Jung-Hwan Kim, Minjeong Kim, Minjung Park, and Jungmin Yoo. 2023. Immersive interactive technologies and virtual shopping experiences: Differences in consumer perceptions between augmented reality (AR) and virtual reality (VR). *Telematics and Informatics*, 77, 101936.
- [32] Davy Tsz Kit Ng, Jac Ka Lok Leung, Jiahong Su, Ross Chi Wui Ng, and Samuel Kai Wah Chu. 2023. Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educational technology research and development*, 1-25.
- [33] Sanaa Kaddoura and Fatima Al Hussein. 2023. The rising trend of Metaverse in education: challenges, opportunities, and ethical considerations. *PeerJ Computer Science*, 9, e1252.
- [34] Roberta Caragnano. 2023. Labour Law: New Workplaces in the Metaverse and Opportunities for Cultural and Heritage Professions. *Athens JL*, 9, 211.
- [35] Fred Miao, Irina V. Kozlenkova, Haizhong Wang, Tao Xie, and Robert W. Palmatier. 2022. An emerging theory of avatar marketing. *Journal of Marketing*, 86(1), 67-90.
- [36] Russell Belk, Mariam Humayun, and Myriam Brouard. 2022. Money, possessions, and ownership in the Metaverse: NFTs, cryptocurrencies, Web3 and Wild Markets. *Journal of Business Research*, 153, 198-205.
- [37] Tomas Andres Guarna, T. A. 2022. Trust Machines: Cryptocurrencies, Blockchains, and Humans in Cultures of Mistrust (Doctoral dissertation, Massachusetts Institute of Technology).
- [38] Leon Anidjar, Nizan Geslevich Packin, and Arguri Panezi. 2023. The Matrix Of Privacy: Data Infrastructure In The Ai-Powered Metaverse. Available at SSRN.
- [39] Amira Kadry. 2022. The metaverse revolution and its impact on the future of advertising industry. *Journal of Design Sciences and Applied Arts*, 3(2), 131-139.
- [40] Tom Taulli. 2022. The Metaverse: Startups in the Virtual World. In *How to Create a Web3 Startup: A Guide for Tomorrow's Breakout Companies* (pp. 135-149). Berkeley, CA: Apress.
- [41] Ilaria Mancuso, Antonio Messeni Petruzzelli, Umberto Panniello Mancuso. 2023. Digital business model innovation in metaverse: How to approach virtual economy opportunities. *Information Processing & Management*, 60(5), 103457.
- [42] Nir Kshetri. 2022. Metaverse and developing economies. *IT Professional*, 24(4), 66-69.
- [43] Aram Mohammed-Amin Qadir, Ava Omar Fatah. 2023. Platformization and the Metaverse: Opportunities and Challenges for Urban Sustainability and Economic Development. *EAI Endorsed Transactions on Energy Web*, 10(1).
- [44] Panos Fitsilis, Paraskevi Tsoutsas, Leonidas Anthopoulos, and Omiros Ragos, 2018. Teamwork behavior in smart and sustainable cities ecosystems. In *The Eighth International Conference on Advanced Collaborative Networks, Systems and Applications*, Venice, Italy.