The Metaverse as a Virtual Form of Smart Cities: Opportunities and Challenges

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ABSTRACT

The concept of the Metaverse has been around for decades and refers to a virtual world where users can interact with each other and digital objects in a three-dimensional space. This idea has been popularized in science fiction novels, movies, and video games, but in recent years, it has become increasingly relevant as technology has advanced. Meta (formerly known as Facebook) announced its rebranding in October 2021, and one of the main reasons for this was to signal its focus on the development of the Metaverse. Meta has stated that it believes the Metaverse could be the next big thing in computing, and it plans to invest heavily in the development of this technology. The Metaverse has the potential to change the way people live, work, and interact with each other. It could enable us to attend virtual events, work remotely in a virtual office, and shop in virtual stores. While the concept is still in its early stages, Meta's investment in the development of the Metaverse is a significant step forward in the realization of this vision. With companies like Meta investing heavily in the development of the Metaverse, one can expect that the technological future will shape the way people live, work, and entertain themselves in urban society. The fourth industrial revolution, which has been characterized by the integration of technologies such as Virtual Reality (VR), Artificial Intelligence (AI), Internet of Things (IoT), and big data, has been driving these changes. The COVID-19 pandemic has accelerated the adoption of digital technologies, with remote work and online shopping becoming the norm for many people. This trend was already happening in cities due to the pursuit of the smart city agenda, which aims to use technology to improve urban services and enhance the quality of life for residents. As people move towards a more technologically advanced future, it is crucial to consider the potential social, economic, and environmental impacts of these changes. While these technologies offer many benefits, such as increased efficiency and convenience, they also raise concerns about privacy, security, and job displacement. It is essential that policymakers, businesses, and communities work together to ensure that the benefits of technological advancements are shared equitably and a sustainable and inclusive future for all can be built.

Keywords
Meta, Metaverse, Covid 19, Urban environment, Virtual environment, Urban governance

1. INTRODUCTION
The global shift to digital work brought about by the COVID-19 pandemic has highlighted the significance of the smart city concept and virtual reality/augmented reality (VR/AR) technologies as potential solutions [1, 2]. However, this transition has also amplified concerns regarding the growing influence of big data companies in data policy and privacy, due to the rapid adoption of big data technologies [3]. Some critics have argued that the rapid deployment of these technologies in major cities has resulted in the increased monitoring of personal data and movements, which can have negative consequences for privacy and civil liberties. The COVID-19 pandemic has led to the rapid development and deployment of various digital technologies, including those related to dataveillance and geo-surveillance, to monitor the spread of the virus and enforce public health measures. However, the efficacy of these technologies has been questioned and challenged, with some experts arguing that they may not be effective in achieving their intended goals. For example, some facial recognition technologies have been criticized for being inaccurate, particularly when it comes to recognizing individuals wearing face masks, which have become a ubiquitous feature of pandemic life[4,5]. In addition, there have been concerns about the effectiveness of smartphone apps for contact tracing, as well as questions about the accuracy of predictive analytics in forecasting the spread of the virus. As people continue to develop and deploy new technologies, it is important to carefully consider their potential benefits and drawbacks, and to ensure that they are subject to rigorous testing and evaluation before being widely adopted. This can involve working closely with experts in various fields, including public health, data privacy, and civil liberties, to identify potential issues and address them proactively. important concerns about privacy and civil liberties. As governments and companies collect and analyze vast amounts of personal data to track the spread of the virus, there is a risk that this information could be used for other purposes, such as surveillance or targeted advertising. This could potentially infringe on individuals' rights to privacy, free expression, and due process. Furthermore, the use of these technologies may not be equitable, as marginalized communities may be disproportionately affected. For example, people without access to smartphones or reliable internet connections may be unable to participate in contact tracing programs, while others may face discrimination based on their race, ethnicity, or other factors. As such, it is important for governments and companies to prioritize privacy and civil liberties when designing and implementing pandemic control measures. This can involve using privacy-preserving technologies, ensuring transparency and accountability in data collection and use, and involving the public in decision-making processes. By taking these steps, one can help ensure that technology is used in a way that is both effective and respectful of individual rights and freedoms [6]. Authors of the study mentioned that human rights provide a crucial framework for protecting the public from regulatory overreach and ensuring

that digital health surveillance does not undermine fundamental features of democratic society. It is important to consider these concerns as one continue to develop and deploy new technologies, including those related to the Metaverse and other aspects of the digital revolution. This can involve implementing strong data privacy laws and regulations, as well as developing transparent and accountable systems for the use of digital technologies. The concept of a metaverse has been around for decades, but it has gained more attention from 2020. The word "metaverse," which Neal Stephenson first used in his 1992 novel Snow Crash to describe a three-dimensional virtual environment populated by avatars of actual people, rose to prominence in the technology industry in 2021**.** The term "metaverse" has gained significant attention and popularity in recent times, particularly since early 2021. The public offering of Roblox and the announcement by Nvidia's CEO about their plans to create a metaverse have further contributed to the buzz around this concept [7]. Facebook CEO Mark Zuckerberg announced on October 28, 2021, that the company would be rebranding as Meta.
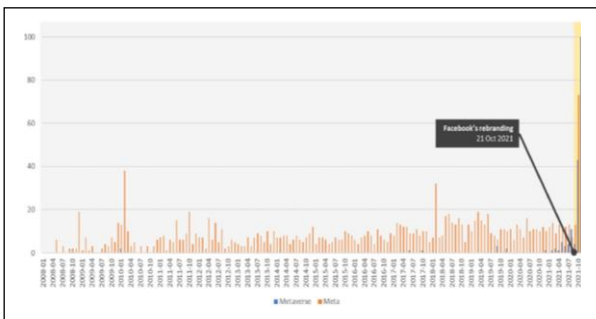

Fig 1: Rising popularity of the terms 'Meta' and 'Metaverse' terms since 'Facebook's rebranding and concept presentation. Sourced from Google Trends [8].

In addition, Zuckerberg announced that the change would be accompanied by a new logo, represented by an infinity sign, and a new stock ticker, MVRS [8]. Bibri and Allam argued that this rapid digital transformation, driven by the pandemic, has the potential to fundamentally reshape urban life and society [9]. They suggest that this transformation could pave the way for a new era of merging urban life and virtual life, where the boundaries between physical and digital spaces become increasingly blurred. The COVID-19 pandemic and other crises have forced major redefinitions in many aspects of human life, including how people interact with each other, work, travel, recreate, and communicate. In this new normal, digital technologies have played a critical role in enabling people to adapt to these changes and continue to function in their daily lives. However, this increased reliance on digital technologies has also given enforcement agencies an upper hand in their efforts to implement policies such as lockdowns and restricted movements. In cities where interconnectedness is more advanced, such as those with high levels of digital infrastructure and connectivity, digital technologies have played an even greater role in enabling these policies to be implemented effectively. This has raised concerns about privacy and surveillance, as well as the potential for these technologies to be used in ways that infringe on individual rights and freedoms. As one continues to navigate these crises and the changes they have brought about, it is important to carefully consider the role of digital technologies and how they can be used in a way that promotes both public health and individual rights and freedoms. The development and expansion of 5G and anticipated 6G connectivity speeds are expected to play a significant role in the actualization of the

Metaverse concept. 6G technology, which is still in the development stage, is expected to be even faster and more efficient than 5G, with the potential to support even more advanced applications and services, including the Metaverse [10]. In 2017, over 250 doctors and scientists from the European Union (EU) signed a petition expressing concerns about the potential health risks of 5G technology and calling for a moratorium on its rollout. Some of the concerns raised include the potential for 5G to increase exposure to electromagnetic radiation, which has been linked to various health issues such as cancer, neurological disorders, and reproductive problems. While there is ongoing debate and research in the scientific community about the potential health risks of 5G and other wireless technologies, it is important to note that the vast majority of research to date has not found any conclusive evidence of harm to human health from exposure to electromagnetic radiation from these technologies. However, it is still important to continue to monitor and study the potential health risks of these technologies as they become more widespread and to take appropriate measures to minimize any potential harm [11]. there are some critics who argue that the concept of the Metaverse is still too vague and lacking in concrete applications that would be useful to everyday users. Some have even characterized it as a "feel-good" idea promoted by tech giants without a clear vision for how it will be implemented or what benefits it will provide to users [12]. However, many proponents of the Metaverse argue that it has the potential to revolutionize the way people interact with digital content and with each other, providing new opportunities for entertainment, education, commerce, and socialization in a fully immersive virtual environment. Some critics have also argued that the Metaverse is a fantasy world created by powerful tech companies to control the life of people and drive us towards excessive consumption. This argument is based on the concern that the Metaverse could become a space where businesses have even greater control over human lives and behaviors, with users becoming trapped in a cycle of endless consumption[13]. Many others however believe that metaverse is not just a buzzword but a real evolution that is already underway. They argue that advances in technology, such as virtual reality, augmented reality, and artificial intelligence, are enabling us to create increasingly immersive and interactive digital environments that are blurring the boundaries between the physical and digital worlds[14].

This paper aims to provide an extensive literature review of the Metaverse, examining it from a broader perspective. Additionally, it explores the emerging products and services within the Metaverse and investigates its potential implications for smart cities, specifically in terms of their virtual manifestations. The focus is on the environmental, economic, and social dimensions of sustainability. The structure of the paper is as follows: Section 2 covers the literature survey and related work of the Metaverse. Section 3 maps the products of the Metaverse as introduced by Meta. In section 4 metaverse and its urban form has been discussed. This paper ends, in Section 5, with a conclusion.

2. LITERATURE REVIEW

Contrary to popular belief, the concept of the Metaverse is not a recent consideration that tech companies have just started to explore. In fact, the Metaverse was outlined in the Metaverse Roadmap, which was published back in 2007 [15]. This roadmap predicted that over the subsequent decade, the Internet would evolve into an immersive digital environment where individuals would be constantly surrounded by a wealth of digital information, whether they were navigating physical

spaces or delving into virtual worlds [16]. The prediction made in the Metaverse Roadmap back in 2007 was not merely speculative but was based on emerging technologies that were already under development. The roadmap team identified four main scenarios for the metaversal world: augmented reality, lifelogging, virtual worlds, and mirror worlds. Today, leading technology companies see the potential to blend these scenarios and create a world that goes beyond the physical reality: the metaverse. While it is still in its early stages of realization, the metaverse, often referred to as Web 3.0 [17], is believed to be very close or already present in its nascent form, with the potential to evolve in unforeseen ways. Many prominent tech firms are embracing the metaverse trend, with initiatives such as Nvidia Omniverse, Facebook Horizon, and Microsoft's enterprise metaverse leading the way. Even consumer brands like Gucci and Coca-Cola are getting involved by selling nonfungible tokens (NFTs) in metaverse platforms like Decentraland. This indicates the formation of a metaverse ecosystem, where various players, both small and large, collaborate to create a simulated second world that mirrors the world [18].

Just as the Internet cannot be owned by a single company, the metaverse cannot be exclusively owned by one corporation or a handful of tech giants [19]. While many consider the metaverse as the next iteration of the web, often referred to as Web 3.0 or the Spatial Web [17], which has the potential to revolutionize human interactions with the digital world [20], there is currently no unanimous agreement on how to precisely define or describe the metaverse due to its inherent complexity [15]. Some define it as follows:

(1) "A fully realized digital world that exists beyond the analog one in which we live", a reimagined version of the OASIS in Ready Player One [21].

(2) "A massive virtual world where millions of people or their avatars will interact in real time" [22].

(3) "An expansive network of persistent, real time rendered 3D worlds that support the continuity of identity and objects" [23, 24].

(4) "A shared virtual 3D world, or worlds, that are interactive, immersive, and collaborative" [18].

The evolution of the Internet from Web 1.0 to Web 2.0, followed by the rise of social media and virtual/augmented/mixed/extended reality, has now led to a convergence of these advancements, giving rise to the concept of the metaverse as Web 3.0. Currently, there are multiple definitions, concepts, and platforms claiming to represent the true essence of the metaverse. While the metaverse will not replace the entirety of the Internet, it is expected to become a significant aspect of people's digitally connected lives [15]. As mentioned by Zuckerberg in his earnings call, advertising is anticipated to play a meaningful role within the metaverse [25]. Venture capitalist and essayist Matthew Ball views the metaverse not just as a virtual space but as a successor state to the mobile Internet. He sees it as a framework for a highly connected life that will gradually emerge over time as different products and capabilities intertwine. As a result, there won't be a distinct pre-metaverse and post-metaverse era [24].

Zuckerberg's observation [26] regarding the substantial initial investment required for the implementation of the Metaverse highlights the need for significant financial and physical resources to bring this concept to fruition. Meta's rebranding and shift in focus toward actualizing the Metaverse concept further emphasize the necessity for paradigm shifts in governance and policy structures to embrace and facilitate this technological frontier. Smart urbanism and platform urbanism are closely interconnected as approaches to urban development, with the latter evolving from the multifaceted emergence of the former over the past two decades [20]. In terms of financing, it is worth noting that consumers of virtual digital products, particularly in the gaming industry, have already spent billions of dollars on various digital accessories for their online avatars. For instance, in 2020, the Extended Reality market was valued at approximately USD$26 to USD$33 billion [27]. Current commercial interests in this technology indicate that the consumer market could potentially grow to around USD$125.2 billion by 2026 [28].

To ensure the universal acceptance of the Metaverse beyond the realm of technologists and its integration into disciplines such as urban planning, significant financial and technological resources will be required. The research and development of the Metaverse have emerged as a prominent trend in smart urbanism, particularly in the design of realistically virtual cities utilizing large-scale data-driven AI systems. This aligns with the concepts of "virtual urbanism" or "augmented urbanism" [29], which apply urban planning, urban design, and urban geography principles to the design of virtual and augmented urban spaces. Therefore, a comprehensive understanding of the Metaverse, specifically in relation to its applicability in urban centers, is derived from technical circles [30]. Within these technical circles, urban planning practitioners engage in data harvesting and modeling activities to guide and inform the design of urban spaces. They employ techniques such as city and data mapping to facilitate micro recalibrations in policy determinations, allowing for a better understanding and resolution of existing and emerging urban issues. These activities intersect with new planning models, including the smart city concept [9] the "15-min city" concept, the "data-driven sustainable smart city" concept [31], among others.

The growing realization of the significance of digital and computing technologies is becoming more prominent, particularly as urban societies and city economies undergo a process of regrouping and re-strategizing their economic and social visions in response to the impact of COVID-19. In this context, the Metaverse can be seen as a fictional portrayal of urban worlds that convey both future possibilities and cautionary messages. Fictional representations offer alternative perspectives on how the future is perceived, influenced, and framed [32–33]. In a recent study conducted by Bibri [30], social scientific critiques and understandings of the socio-technical imaginaries of smart cities were expanded by analyzing and evaluating the Metaverse as a collection of fictional representations. This exploration delved into the urban worlds depicted in the Metaverse and the warnings they present, aiming to facilitate the construction of alternative and desirable urban futures.

3. MAPPING THE FIRST METAVERSE: PRODUCTS OF META

The concept of the Metaverse has gained significant attention in recent years, with numerous tech giants and other stakeholders exploring its potential. Meta (formerly known as Facebook) has been particularly active in proposing various interest areas that could become part of the Metaverse, such as virtual reality, social experiences, and commerce. At the same time, other companies like Apple, Microsoft, and Google are also independently pursuing their own versions of the Metaverse, which could potentially compete with or complement Meta's vision. The Metaverse is seen as a new

frontier for innovation, and companies are investing heavily in developing the technologies and infrastructure needed to make it a reality. It will be interesting to see how these various efforts come together and shape the future of the digital world. It is likely that the experiences and interactions users have in existing virtual and augmented reality platforms, as well as other digital environments, will inform and shape the development of the Metaverse. The goal that Meta as a firm is pursuing is to gradually change people' perceptions of the new idea of the Metaverse. This goal is described below and illustrated in Fig. 2. As a result, this section serves as a case study of a few chosen examples of possible metaverse products.
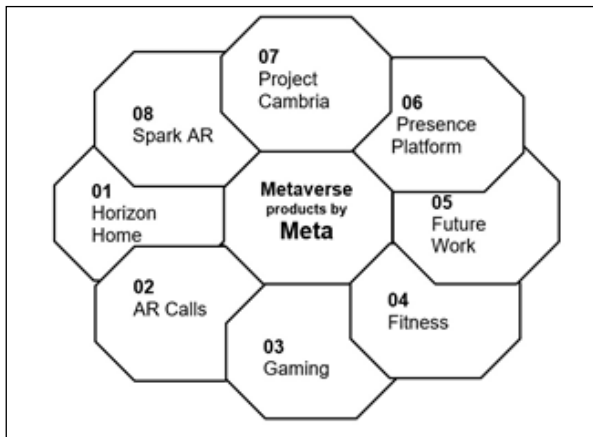

Fig 2.:Products announced by Meta during its product launch

4. THE METAVERSE AND THE URBAN FORM

The work environment has been transformed by technological advancements, leading to a widespread preference for remote work models. This shift has been driven by the increasing ability to communicate, collaborate, and perform various work-related activities without the need to physically be present in a workplace. This trend was further accelerated during the peak of the COVID-19 pandemic, which compelled a large portion of the population to work from home. The COVID-19 pandemic intensified the aforementioned trend, as the majority of people were compelled to work remotely. This trend has persisted into the Omicron period, highlighting how technology has revolutionized the work environment by offering limitless options and conveniences [34]. Nevertheless, there have been assertions that the emergence of the Metaverse will usher in fundamental changes to workplaces worldwide, presenting an array of new tools and possibilities [35]. The convergence of the physical and virtual realms implies that the distinction between individuals working in a virtual environment and those in a physical setting will become negligible. Furthermore, the virtual world is perceived to offer even more options for workers. One intriguing area to observe in the foreseeable future will be how these changes will affect the structure of urban areas since individuals will no longer need to be situated in a specific location to carry out their work. Consequently, it is probable that people may choose to reside in non-urban regions to escape challenges such as traffic, overcrowding, pollution, and exorbitant living expenses. This shift is fueled by the increasing ability of individuals to engage in virtual interactions, socialize, and participate in various activities within digital environments. As a result, the desire to migrate away from cities could gain momentum in the coming years.

In the foreseeable future, the emergence of the Metaverse is anticipated to offer a plethora of options for individuals, including Meta's Horizon Home platform. This platform enables people to personalize their virtual residences and position them in any desired location within the virtual realm [26]. The virtual homes within the Metaverse will offer users the chance to entertain and host friends while engaging in various activities, thereby reducing the need to physically reside close to friends and family. This shift in behavior will be supported by the growing trend of online shopping, which proponents of the Metaverse believe will be enhanced by presenting products in 3D format, enabling individuals to interact with them before making a purchase.
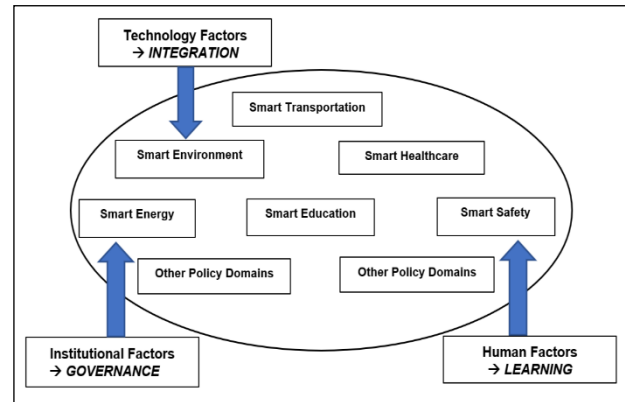

Fig 3: Visions of Smart City

The availability of more alternatives for urban residents may lead to a future where urban areas are not as densely populated as previously projected. Fig. 3. Consequently, the traditional concentration of high-rise office buildings and dense infrastructure may become obsolete. A decrease in urban population would necessitate a shift in urban planning and infrastructure, as factors like travel requirements and population density would no longer hold the same influence. New parameters and considerations would emerge to shape the future form and design of urban spaces. While it is acknowledged that the Metaverse is currently in its early stages of development [36], cities will likely continue to be attractive hubs for individuals pursuing diverse objectives. Even as the Metaverse evolves, urban areas, benefiting from existing substantial infrastructure, will still draw significant populations. However, the relationship between work and urban residential areas may undergo a transformation, potentially embracing planning models like the '15-minute city' concept [37]. The hyper-connectivity facilitated by the Metaverse will play a crucial role in maintaining the appeal of cities, particularly with the potential for increased revenue streams resulting from expanded digital transactions.

The concept of the data-driven smart eco-city, which aims to create smart and sustainable urban environments [38], recognizes the strong positive effects of natural components [39] and their association with positive psychological states. These effects include stress reduction [40], peak experiences [41], restoration of attention span [42], and the induction of positive emotions [43] when people are in the presence of natural environments. These benefits can also be experienced through virtual reality (VR) simulations of natural environments [44–47]. Designers can use VR to simulate the impact of natural conditions on emotional states [48]. In the context of the Metaverse, immersive simulations are expected to enhance the restorative effects of virtual natural environments.

Furthermore, transformative simulations, utilizing VR, can be effective tools for engaging citizens and exploring their future interactions with the environment through e-participation. This approach enables visualization of design projects or their alternatives and allows users to directly modify components of the 3D models [49]. This utilization of VR in participatory processes can facilitate the visualization, understanding, and modification of urban design projects within the Metaverse.

4.1 The Metaverse and Urban Resource Management

Resource management has long been a crucial consideration in the fields of natural resource management and urban planning. As the global urban population is expected to rise in the future, the importance of resource management becomes even more prominent. Research has shown that urban areas consume more than 75% of global resources and significantly contribute to environmental degradation through various forms of pollution [50]. These findings underscore the need for effective resource management strategies in urban areas to address resource consumption and mitigate environmental impacts. As more people migrate to urban areas, resources such as land, water, fisheries, minerals, and forests will become increasingly scarce. The trend of urbanization, including movements like tree-change, sea-change, and regionalization, will further exacerbate the consumption and depletion of these ecological assets. This intensification of resource consumption does not leave sufficient room for natural-based solutions to compensate for the loss of resources. Consequently, these challenges will persist unless effective urban resource management practices are implemented [51]. In this context, the concept of the Metaverse, as described by Zuckerberg [26], holds the potential to positively influence resource management practices. The Metaverse has the capability to disrupt future urban activities, including work, entertainment, recreation, and travel. By leveraging the virtual environment, the Metaverse may offer alternative avenues for engaging in these activities while reducing the strain on natural resources. It has the potential to shape a more sustainable approach to urban living, promoting resource efficiency and conservation.

There is a widespread belief that the development of the Metaverse will significantly reduce the need for physical travel, particularly to workplaces, entertainment venues, and other facilities. In the Metaverse, individuals will have the opportunity to engage in various activities such as work, exercise, learning, socializing, attending meetings, and more within digital environments that closely resemble the physical world. This shift is already noticeable in post-COVID era, where many individuals are hesitant to return to traditional office spaces in urban environments. Extended realities like augmented reality (AR) and augmented virtuality (AU) have demonstrated that people can interact, collaborate on projects, make phone/Teams/Zoom calls, and participate in other typical activities through digital platforms, mirroring their experiences in the physical world [26]. The adoption of the Metaverse has the potential to significantly reduce energy consumption from automobile use and decrease resource consumption related to the construction of workplace infrastructures and extensive transport networks. By enabling people to spend a substantial amount of their time in the virtual world and utilizing technologies like digital twins (DT) and Extended Reality (XR), individuals can engage in activities that mirror their physical world experiences. This increased accessibility to virtual technologies, combined with faster and more affordable internet services, can lead to a reduction in resource extraction

and consumption, as many tasks and interactions can be conducted digitally rather than in the physical realm.

The reduced demand for assets such as office spaces, transportation infrastructure, and entertainment centers will be influenced by the increasing adoption of the Metaverse. As more activities shift to the virtual environment, the attractiveness and utilization of physical assets like office blocks and energy-consuming gadgets such as entertainment units are likely to diminish. This shift occurs because the digital twins (DTs) of these assets will be readily available in the virtual realm, making the physical counterparts less necessary and infrequently used. Although research indicates that the Metaverse could lead to increased energy consumption by users, particularly due to resource-intensive features like high-resolution imagery and rendering, it is possible that the overall energy impact could be balanced by reduced consumption in physical spaces such as office buildings, entertainment centers, and transportation. Additionally, the growing focus on renewable energy options, as demonstrated by commitments from major tech companies like Microsoft and Apple, might help offset the energy demands associated with the Metaverse [52].

4.2 The Metaverse and Urban Governance

The prospect of the Metaverse is also being hailed by some, especially in relation to allowing for most social activities that necessitate the creation of resource-intensive products such as toys, games, and festival products, to be increasingly created and stored in the virtual world. This will help reduce resource consumption and pollution, as most of these products, in their physical form, end up in landfills, water bodies and other sensitive ecosystems [53]. Thereby, these have been negatively impacting on urban, aquatic, marine, and biodiverse environments and their non-human residents. With substantial products being stored in virtual environments, requiring only little physical resource development, cities will have capacities to enhance assets such as green spaces, water bodies within urban areas, cultural heritage sites, and many others. Further, this will help in enhancing the adoption of diverse nature-based solutions to help restore areas that have already experienced massive impacts of excessive resource consumption.

Urban governance encompasses the various ways in which individuals, institutions, and urban stakeholders collectively plan and manage the overall affairs of a city [54]. This process can often be intricate and contentious, particularly in terms of exercising authority, allocating and distributing resources, and implementing diverse agendas [55]. As a result, there is a growing recognition of the importance of unity of purpose to ensure the attainment of urban objectives and goals, as well as to comprehensively address emerging urban challenges in a cost-effective manner. This aligns with the United Nations' 17 Sustainable Development Goals (SDGs) [56], which emphasize the role of information and communication technology (ICT) in environmental protection, resource efficiency, infrastructure upgrading, socio-economic development, and knowledge advancement [57].

Urban governance involves the human decision-making process aimed at achieving coherent and sustainable functioning of all the components and dimensions within an urban environment. Given the diverse aspects and variables present in urban areas, the emergence of the Metaverse provides a timely platform for urban governance. By offering virtual urban services and assets, the Metaverse has the potential to enhance efficiency, foster trust and accountability,

and reduce costs, bureaucratic processes, and bottlenecks that often hinder or delay urban service delivery.

Seoul, South Korea provides an example of how the Metaverse can positively influence urban governance. The city is considering the adoption of the Metaverse concept to provide certain public services and cultural experiences in a digital environment [58]. Through the use of virtual reality (VR) headsets or augmented reality (AR) glasses, Seoul residents will be able to engage in immersive virtual tours of various city assets, such as social halls, museums, and parks, as well as access government services like filing civil complaints [59].

Table 1 : The contributions and challenges of urban sectors /technologies for smart cities.

Sr. No	Urban Sectors/ Technologies	Contributions	Challenges
1	Urban Form	(i) Encourages the building of human-centric urban areas (ii) Allows adoption of models like the 15-min city concept (iii) Promotes mixed use and multi-use of different urban assets (iv) Promotes the adoption of diverse green projects like the creation of green spaces (v) Promotes the creation of compact urban areas	(i) Might promote gentrification (ii) Potential risk of urban sprawl (iii) Could promote the adoption of new modernist planning models that have no capacities to promote human dimensions
2	Urban resource management	(i) Reduces the need for travel (ii) Decreases demand for physical infrastructure (iii) Minimizing waste (iv) Encourages the creation of new sustainable resources (v) Minimizes of extraction of and consumption of resources in some industry, e.g. entertainment industry (vi) Provides open spaces for more interaction; hence, promoting participation of a majority in decision making on how resources could be utilized	(i) Metaverse technologies could be energy-intensive (ii) Might require substantial resources to produce enough physical products (iii) Might encourage excessive resource consumption in the process of setting up infrastructures to support the concept (iv) Will require a change in policies that might take time
3	Urban governance	(i) Enhances efficiency of service provision (ii) Enhances accountability and transparency (iii) Encourage equity in resources allocation and monetization (iv) Might open new ways of interaction between different urban stake holders	(i) Large scale implementation could take time and be costly (ii) Potential risks related to privacy and social control (iii) Potential risk of misuse of personal data for privacy intrusion (iv) Potential challenges in formulation of laws on different aspects of Metaverse

This approach demonstrates how the Metaverse can enhance urban governance by leveraging technology to offer convenient and engaging experiences for citizens while optimizing the delivery of public services.

As stated in [60], the emergence of the Metaverse holds significant potential for governments to capitalize on various future opportunities. These opportunities primarily revolve around tackling key urban challenges, including healthcare delivery (e.g., Telehealth), urban planning (e.g., development proposal modeling), optimizing the use of urban spaces (e.g., participating in social and music events), generating new employment prospects, and enhancing education across different sectors.

It is anticipated that in the future, urban governments will have the capability to manage activities like registration of individuals and identity verification on virtual platforms, eliminating the need for physical presence. The Metaverse will play a crucial role in making this process feel realistic and authentic [26]. However, realizing the full potential of urban governance in the Metaverse will require significant investment and patience as the concept continues to evolve.

This vision is reminiscent of the futuristic world depicted in Hanna-Barbera's The Jetsons. Nonetheless, it is a cause worth supporting for local governments, as they stand to benefit from the diverse advantages it offers. Even before the full realization of the Metaverse, local governments can adopt technologies like augmented reality (AR), blockchain, and others to bridge inequality gaps in cities. Table 1 shows the contributions and challenges of urban sectors /technologies for smart cities. The challenges mentioned here have had a significant impact on individuals, particularly in urban areas, as they struggle to find time and opportunities to fulfill basic human needs such as socialization, self-actualization, and access to healthcare and education. This situation has also led to a rise in issues like unemployment, the erosion of culture and cultural heritage, and other problems that directly affect people's lives. However, the concept of the Metaverse holds promise in addressing some of these challenges by offering unprecedented opportunities for social interaction with loved ones regardless of geographical distances. Additionally, it enables individuals to work, innovate, and collaborate with colleagues and peers without the need to commute to physical workplaces.

The integration of the Metaverse is expected to bring about changes in urban morphology, as traditional planning models influenced by factors like vehicular flow become less relevant. Instead, the success of the Metaverse concept may accelerate the realization of planning models like the 15-minute city, which prioritize human and social dimensions. The technological advancements offered by the virtual environment present opportunities for supporting the growing population and its needs. However, financing plays a critical role as substantial resources are required for the necessary hardware and software. It becomes particularly important when considering the simultaneous pursuit of other technological concepts such as smart cities, which have faced challenges in implementation, partly due to financial constraints. Therefore, as corporations, big tech companies, governments, and other stakeholders invest in actualizing the Metaverse, it is crucial to consider the economic challenges faced by individuals and economies in the middle and lower tiers. Ensuring their inclusion requires providing sufficient infrastructure, hardware, and software to enhance accessibility and affordability.

5. CONCLUSION

The Metaverse presents local governments with various opportunities to enhance their interactions with residents, deliver fast and efficient real-time services, and effectively manage urban assets, including public spaces. It also opens up possibilities for generating new income streams, enabling local governments to undertake ambitious and capital-intensive projects. Additionally, the Metaverse provides a chance for local governments to restructure their urban planning models to prioritize human and social dimensions. Beyond governance entities, institutions such as businesses, educational organizations, and large corporations will have the opportunity to conduct their activities within the virtual world. This will facilitate improved interactions with existing and potential clients and allow them to enhance the quality of their products by leveraging technologies like distributed ledger technology (DT) that will be further advanced in the Metaverse. They will also have the potential to explore new frontiers, such as creating virtual products that are in-demand as people seek to enhance their avatars, thus becoming valuable commodities in the future as the Metaverse becomes more prevalent. There are doubts regarding the ability of the Metaverse to effectively address and overcome the common challenges associated with urban governance. These challenges include ongoing negotiations and conflicts, conflicting interests and incentives, disagreements and power struggles, unpredictable decision-making, inefficient collaboration, and ineffective networks. It is questionable whether the utilization of advanced technologies for human collaboration will be directed towards fostering more open governance processes, as they may be primarily driven by specific political and economic interests. The governance of smart cities, in general, has faced criticism for being heavily influenced by government policies and the agendas of high-tech companies and corporations. As a result, numerous studies have focused on highlighting the potential risks and negative implications of the technocratic and corporate-led approach to smart city governance.

The development of the Metaverse is currently at an early stage, and research in this field is limited and fragmented across different disciplines. As a result, there is a lack of comprehensive understanding regarding the actual opportunities and implications of this global platform. However, what is clear is that the concept of the Metaverse has already generated significant concerns regarding the risks and impacts associated with its underlying technologies in terms of human, ethical, and social values. The increasing attention and focus on the Metaverse, particularly following Facebook's rebranding to Meta, have coincided with a time when the world is facing numerous urgent challenges that require immediate solutions. One of the challenges that has significantly impacted the global environment is climate change, which continues to affect various aspects of our planet. The recent COP26 meeting acknowledged that this challenge may worsen even before the end of this century. Additionally, the world has been grappling with the dual challenges of rapid population growth and unchecked urbanization, which have become major issues over the past few decades. Another significant challenge that has affected every aspect of the global sphere is the COVID-19 pandemic, which disrupted economies and social development despite the progress made in these areas. It is noteworthy that these challenges have arisen alongside the emergence of novel and advanced technologies that, in theory, could have helped address or alleviate the widespread consequences of these issues.

To ensure that the adoption of the Metaverse aligns with its intended purpose, it is crucial to involve governance structures at both the city and national levels. Similar to the case of smart cities, enhancing governance in the context of the Metaverse will necessitate the active engagement of all stakeholders through public participation. The decision-making structure should prioritize bottom-up approaches instead of relying solely on top-down approaches. This inclusive and comprehensive approach will lead to more effective and inclusive solutions that address the diverse needs and perspectives of all the stakeholders involved.

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