

Potential Impact of the Metaverse on Residential Space ChangesĐorđe Alfirević¹, Marina Nenковиć-Riznić², Sanja Simonović Alfirević³¹ Associate Professor, Faculty of contemporary arts, Belgrade, Serbia² Principal Research Fellow, Institute of architecture and urban & spatial planning of Serbia, Belgrade, Serbia³ Senior Research Associate, Institute of architecture and urban & spatial planning of Serbia, Belgrade, Serbiadjordje.alfirevic@gmail.com, ORCID: <https://orcid.org/0000-0002-5384-0922>marina@iaus.ac.rs, ORCID: <https://orcid.org/0000-0003-4431-4151>sanjas@iaus.ac.rs, ORCID <https://orcid.org/0000-0003-1243-8459>

Abstract: This paper contributes to the understanding of how technological innovations, such as the metaverse, shape our living environment, providing insights into potential changes in residential spaces that we can expect in the future. By analysing current development trends, the study explores how the concept of the metaverse might transform the way we live and utilise residential space. The focus is on potential changes in residential environments over time, under the influence of the metaverse. The research centres on four key aspects of potential alterations: a) miniaturisation of the area and structure of living spaces, b) the disappearance of certain types of rooms, c) the reduction of the size and dimensions of specific spaces (social spaces for entertainment and gathering, kitchen spaces, etc.), and d) the transformation of physical spaces into virtual entities.

The research methodology included an analysis of current development trends in metaverse technology and its impact on the architectural design of residential spaces. Descriptive analysis, trend analysis, and case studies were employed to identify potential changes and their effects on residential space users. The aim of the paper is to re-examine the hypothesis that the implementation of metaverse technology will significantly transform residential spaces, causing miniaturisation, the disappearance of certain traditional room types, reduction in the size and dimensions of certain rooms, and the transformation of physical spaces into virtual entities.

Metaverse technology holds great potential to transform how we live and use residential spaces. Anticipated changes include more efficient use of space, adaptation of rooms to meet the new needs of users, and the integration of virtual elements into physical spaces to support interactions via the metaverse. This research provides a foundation for further exploration and implementation of metaverse technology in the architectural design of residential spaces.

Keywords: Metaverse, Residential space, Technological innovation, Miniaturisation of living spaces, Virtual-physical transformation, Architectural design

1. Introduction

The concept of the metaverse is not of recent origin. Its history is extensive, with the term first being mentioned in the works of French poet and playwright Antonin Artaud, who used the phrase “virtual reality” in his collection of essays *The Theatre and Its Double* (Artaud, 1938). The re-emergence of this term dates back to 1992, when it appeared in Neal Stephenson’s science fiction novel *Snow Crash* (Stephenson, 1992), describing a virtual reality (VR) space that integrates the internet and augmented reality (AR) (Joshua, 2017). In this novel, Stephenson depicted an advanced virtual world into which users log in and participate in interactive experiences through their digital avatars. The metaverse in *Snow Crash* represents an alternative reality, merging the virtual world with social networking, functioning as an expansive, three-dimensional digital community where users, through their avatars, inhabit various spaces, from virtual cities to conventional locations where social interactions occur. In Stephenson’s metaverse, the boundary between the real and virtual world becomes so blurred that many aspects of everyday life unfold within this digital space. Today, when the term “metaverse” is used to describe new technologies that bridge the digital and physical worlds, it is possible to trace a direct line of inspiration from Stephenson’s novel to contemporary efforts to create these virtual worlds. The metaverse concept was initially tested in video games and multimedia platforms (Gent, 2022; Ludlow and Wallace, 2007), and recently, there has been a significant shift in research towards the use of the metaverse in urban planning and design (Petkov, 2023). Supporting the development of these creative endeavours, the metaverse utilises tools such as augmented reality, geographic information systems, and machine learning algorithms.

In urban planning and design, the term “metaverse” is relatively new and still in development, but it can be understood as a digital or virtual representation of a city or urban environment, where users can interact with the computer-generated setting and with each other in real-time. The metaverse has enhanced urban planning and architectural design by enabling immersive digital environments that facilitate dynamic simulations, collaboration, stakeholder participation, and visualisation of city projects and infrastructure, as well as

architectural design down to the level of residential units (Dorostkar, Najarsadeghi, 2023; Allam et al., 2022; Yaqoob, Salah, Jayaraman, Omar, 2023). Additionally, the metaverse offers users a variety of interactive experiences and services. It is important to note that the concept of the metaverse in planning and design is still in its infancy, and its practical application may significantly contribute depending on the motivations for its use, users' desires, and the technical proficiency of the designers. Furthermore, ethical issues such as privacy concerns, equal access, and governance of the metaverse present limitations.

The popularisation of the metaverse experienced a surge during the COVID-19 pandemic (2020–21), when, due to disrupted social interactions, the metaverse provided psychological relief from the lack of contact. This psychological imbalance caused by COVID-19 across the global population (including students, professionals, and the general public) had a direct impact on communication, interaction, and participation in all activities, which was partially mitigated through the use of the metaverse as a parallel living space (Nenković-Riznić, 2024).

Within their own residential units, via the metaverse, users were able to enhance their experiences and extend the imposed movement restrictions. As such, this concept also served as a safe space where users could continue all the activities they participated in before the pandemic, such as learning, studying, conducting office and fieldwork, and similar tasks, all from their own homes. On the other hand, it also caused various issues, particularly with regard to users' return to reality and resumption of old habits after the end of isolation, among other challenges.

2. Research methods

The research is conducted through an analysis of current trends in metaverse technology and its impact on the architectural design of residential spaces. The methods employed include descriptive analysis, trend analysis, and case studies, all aimed at identifying potential changes and their effects on residential space users.

Trend analysis involves a systematic examination of the latest advancements in metaverse technology, with a focus on identifying key aspects that could potentially influence the organisation and design of residential spaces. This method provides insight into developmental directions and predictions of future changes in residential architecture, considering the increasing influence of virtual technologies.

Descriptive analysis is used to thoroughly describe existing concepts such as micro-apartments, coliving and cohousing spaces, and kitchenless apartments. This method enables an understanding of the characteristics and elements that define these residential spaces, as well as their functionality within the context of contemporary living.

Case studies are employed to illustrate specific examples of how metaverse technologies have already been integrated into residential spaces and how they have affected the design and functionality of these spaces. These examples offer practical insights into the theoretical findings and provide a foundation for assessing potential future changes.

By combining these methods, the research aims to provide a comprehensive overview and understanding of the impact of metaverse technologies on residential architecture, identifying key changes and their potential impact on residential space users.

3. Previous research

Previous studies on the metaverse cover a wide range of areas, from technological to social aspects. In terms of technological aspects, research has focused on: a) the development of hardware devices that enable the creation and use of immersive virtual environments, b) the use of cryptocurrencies for ownership and transactions within the metaverse, and c) the communication between different software platforms within the metaverse (Biswas, 2023; Lee, Braud, Zhou, Wang, Xu, Lin, Hui, 2021).

Research that encompasses social and cultural aspects addresses questions such as: a) how users form and express their identities in the metaverse, including avatar choice, digital wardrobes, and virtual interactions, b) how social connections and communities are formed and maintained in virtual worlds, c) how the metaverse affects real-world social interactions, d) how the economy functions within the metaverse, e) ownership issues, and f) aspects of territoriality, among others (Dwivedi, Hughes, Baabdullah, Ribeiro-Navarrete, Giannakis, Al Debei, et al., 2022; Mitrushchenkova, 2022; Morgan, 2023; Kye, Han, Kim, Park, Jo, 2021).

Legal regulation and policy have also been a focus of interest, examining the legal frameworks that could apply to the metaverse, including ownership rights, data protection, and platform liability for content and user activities. Additionally, governance issues are studied, exploring who owns and controls different parts of the virtual world and how governance models might evolve on a global scale.

A particularly significant area of research that has attracted many scholars involves the negative consequences of the internet (and the metaverse) on users, including its impact on mental health, as well as ethical issues and

privacy concerns (Dwivedi, Kshetri, Hughes, et al., 2023; Henz, 2022). Studies examine how prolonged use of the metaverse can affect users' mental health, including the development of addiction, social isolation, and altered perceptions of reality.

A specific psychological disorder, known as "hikikomori," has been observed over the past two decades in Japan, where young people become deeply entrenched in the online world and reject any social interaction outside the confines of their home, relying on the internet for nearly all their needs, and using the metaverse as a form of social interaction (Adamski, 2018).

A group of studies focused on architecture and design explores topics such as: a) housing within and outside the metaverse, b) the design of virtual rooms, and c) the interaction between physical and virtual spaces (Fischer, 2022). This research focuses on how real spaces are transformed into virtual ones, including the creation of digital replicas of real spaces or entirely new virtual worlds (Liu, Xie, Li, Hossain, El Saddik, 2022; Zallio, Clarkson, 2022). These studies also investigate how physical spaces can be transformed through AR technologies, as well as how residential space design may evolve under the influence of the metaverse.

4. Current trends in housing worldwide

Over the past few decades, residential architecture has undergone significant transformations, driven by innovative concepts that respond to the contemporary needs and lifestyles of people around the world. Three key trends emerging in this context are micro-apartments, coliving and cohousing spaces, and kitchenless apartments. These trends are not merely fleeting innovations but represent fundamental shifts that will shape the future of residential architecture. They reflect a broader transition towards a more sustainable, functional, and socially connected way of living. As social, economic, and technological conditions continue to evolve, these concepts are likely to become standards in residential architecture, offering new opportunities to adapt living spaces to the needs of future generations.

4.1 Micro-housing

Micro-apartments represent a radical response to the growing demand for affordable housing in urban areas. This type of housing consists of residential units of extremely small dimensions that offer substandard living conditions. Such apartments typically provide only the most basic amenities, such as a living room, kitchen, and bathroom, and do not meet all functional requirements. Residents of these units consciously forego certain living comforts to reside in a particular location or to reduce housing maintenance costs. According to many researchers, micro-apartments represent the future of global housing (Kholid & Zaharin, 2019; Geffner, 2018; Adorno, 2018; Aureli, Tattara, & Korbi, 2018; Thøgersen, 2017; Kilman, 2016; Ferré da Ponte, 2016; Iglesias, 2014; Teige, 2002, et al.). With current social developments and population growth, one of the biggest challenges will be providing adequate housing for a large number of people, making the miniaturisation of living spaces a potential and sustainable solution. The primary motives for living in micro-apartments often include the desire to live in urban environments, proximity to neighbourhoods and community amenities, the need for alternative housing models that partially address population needs, and the availability of shared spaces to meet social needs (Adorno, 2018). The debate surrounding the advantages and disadvantages of micro-housing has been ongoing since the early 1970s. The main advantages of this model include a reduced environmental impact, lower energy consumption and material usage for construction and ongoing maintenance, greater interaction with the surrounding environment, and decreased consumerism (Hein & Nießen, 2020; Brysch, 2019; Kholid & Zaharin, 2019; Adorno, 2018; Geffner, 2018; Kilman, 2016; Ferré da Ponte, 2016; Iglesias, 2014, et al.). However, the key disadvantages include a lack of privacy (inability to rest, concentrate, or find solitude), inadequate ventilation, and insufficient natural lighting (Soub & Memikoğlu, 2020; Thøgersen, 2017; Kilman, 2016; Iglesias, 2014; Richmond, 2012, et al.)

4.2 Coliving and Cohousing

Coliving and cohousing spaces offer alternative housing models that promote communal living and collaboration among residents. The coliving concept involves the shared use of residential units by individuals who are not related but share similar interests and values. This housing model allows residents to share common spaces, such as living rooms, kitchens, and workspaces, thereby reducing living costs and fostering social interaction. Unlike cohousing, which refers to an intentional community of private homes clustered around shared spaces (Carswell, 2012:664), coliving is a broader term that encompasses cohousing concepts and pertains to varying degrees of shared living spaces and facilities (Steding, 2017:3). Jo Williams, in her research, highlights that the spatial organisation of shared spaces must encourage a higher level of social interaction among residents. Common areas should be centrally positioned, while private spaces should be minimised to motivate residents to make greater use of communal spaces (Williams, 2005:199). According to

research conducted by Rachel Osborne, residents of coliving spaces are most willing to share facilities from primary areas such as lounges, communal kitchens, media rooms, and recreational areas. However, they are more reserved when it comes to sharing facilities from secondary spaces, such as workspaces, fitness rooms, laundries, and shared kitchens and bathrooms. Most residents are unwilling to share their bedrooms and private bathrooms (Osborne, 2018:76). Results from an online survey conducted by the Space 10 and Urgent Agency teams, entitled *Imagine: Exploring the Brave New World of Shared Living*, indicate varying levels of sharing between residents and preferences regarding communal spaces. The survey reveals that a significant number of respondents identified individual space sharing (34%) and the mess created by others (21%) as disadvantages, while socialisation opportunities (37%) and shared living costs (21%) were perceived as major benefits (Pagh, Williams, Braskov, Christensen, 2018).

4.3 Kitchenless apartments

Contemporary trends in architecture and residential design increasingly lean towards the minimisation of specific rooms, including the kitchen, which is often reduced from a functional room to a mere utility in the home. Kitchenless apartments represent an innovative approach in residential architecture. These apartments either eliminate the traditional kitchen or significantly reduce its size, thereby creating more space for other functionalities. The concept of kitchenless apartments relies on the idea that modern residents increasingly utilise external services for food provision, such as restaurants and food delivery, thereby diminishing the need for extensive kitchen space. This concept, known as the "kitchenless apartment", has been explored by Anna Puigjaner, who has written about the potential of apartments without traditional kitchens in the 21st century (Puigjaner, 2016). The elimination of the kitchen often provokes both curious and negative reactions, as kitchens are perceived as an essential part of the home. However, Puigjaner argues that rethinking the apartment through the lens of its uses rather than its square footage can lead to significant lifestyle changes. In practice, apartments without a conventional kitchen often feature compact kitchenettes, which are functionally integrated into the living area (Mirka, 2023). This approach to kitchen space minimisation offers several advantages. Firstly, it enables more efficient use of space, particularly in urban environments where apartments are often compact. Furthermore, by eliminating or minimising the kitchen, space is freed up for other purposes, such as social activities or workspaces. Additionally, this concept can contribute to reduced housing costs and increased flexibility in the design of residential units. Although the "kitchenless apartment" concept may appear radical, it reflects a broader trend towards transforming traditional residential spaces to align with contemporary needs and lifestyles (Davies, 2022; Lian, 2019). In this sense, the minimisation and transformation of kitchen spaces are part of a larger movement towards adaptive and multifunctional housing solutions that meet the needs of 21st-century residents.

5. Characteristic housing examples in the metaverse

The integration of the metaverse into the realm of residential architecture, and conversely, the incorporation of residential architecture into the metaverse, has revolutionised the way we conceive and design living spaces. Digital platforms enable architects and designers to create innovative and futuristic homes that not only align with contemporary technological trends but also redefine the very essence of habitation. These examples of digital architecture provide unique insights into the possibilities offered by the metaverse.

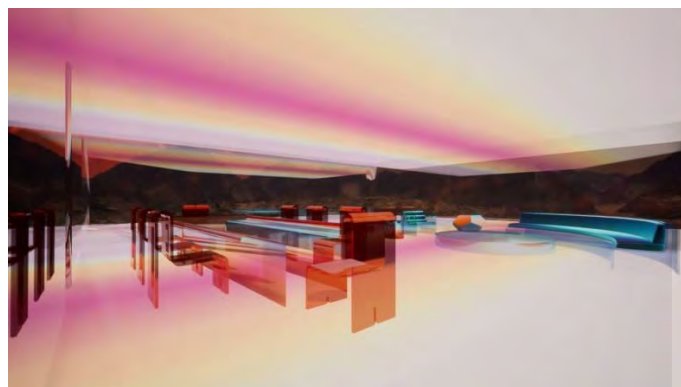


Figure 1 Mars House, metaverse (Krista Kim, 2020)

The Mars House, designed in 2020 by artist Krista Kim, represents the first digital house in the world to be sold. According to the creator, the structure, composed of light, creates a healing atmosphere. Mars House is a light

sculpture with a base that extends to a pool, spanning the entire perimeter of the house. All furniture is designed from tempered glass and fabrics, with renewable materials. The floor and ceiling are covered in colour gradients created by the artist. Kim aims for this space to reflect her passion for "meditative design", a new definition of avant-garde luxury for the digital age. Her intention is to create a meditative environment on screens, akin to a digital zen garden, where users can retreat from the real world (Harrouk, 2021).



Figure 2 Hampton Hall, metaverse (Stately Homes, 2022)

Hampton Hall is a luxurious villa featuring a bowling alley, a spa, and 70 rooms, and it also includes a replica in the metaverse. This villa is available for purchase, with the buyer receiving preferential rights that encompass a copyright-protected blueprint and the virtual version of the villa. In addition to the physical property, the owner will possess its digital counterpart, or "digital twin." The estate also includes a complex with an indoor pool, a steam room, a sauna, bowling lanes, a bar, a gym, and a treatment room. The garage accommodates up to six cars and features a car lift leading to a basement with a car gallery, a billiards room, and a home cinema. The house is designed to be both elegant and comfortable, ideal for dinners and family gatherings.



Figure 3 The Crystal Residence, metaverse (Andrés Reisinger, Alba de la Fuente, 2022)

Crystal Residence is an innovative building that blends the beauty of the wilderness with the precision of modern design. Its mirrored facade reflects the surrounding landscape and changes with it, creating a harmony

between man and nature. The interior is decorated in neutral tones that evoke a sense of tranquility and warmth, while the room layout is designed to manipulate light and create a jewel-like gleam. The project is inspired by the process of transforming carbon into diamond, symbolising the hidden beauty of the desert. According to the author, although the house is a digital creation, it could be fully constructed in reality (Asins, 2023).

It can be concluded from the above that metaverse architecture is still heavily influenced by the legacy of real-world architecture, being cautiously applied with the aim of intriguing potential users with something new, captivating, inspirational, and, above all, different from real-world architecture. The metaverse undoubtedly offers endless possibilities for creating spaces not constrained by physical laws, allowing architects and designers to unleash their creativity and craft the homes of the future. Future developments will likely trend towards even more intensive efforts to attract and enchant users, encouraging them to transition from reality to “meta-reality” (Raad, Rashid, 2023). However, what will become of residential architecture in the real world if people “move,” i.e., spend a significant portion of their time in the metaverse?

6. Potential impacts of the metaverse on the residential space organisation

Internet addiction has become a clinical disorder with significant negative consequences for an individual's social, work, family, financial, and economic functioning. It represents a contemporary form of dependency characterised by a state in which internet use has become the dominant life activity, isolating the individual from other social processes and creating adverse effects on both themselves and their surroundings (Chou, Condron, Belland, 2005; Widyanto, Griffiths, 2006; Cash, Cosette, Steel, Winkler, 2012). Considering that the metaverse is often regarded as the evolutionary next generation of the internet (Feng, Lyu, 2022), given that it represents an enhanced, more interactive, and immersive way of connecting and engaging with digital content, it can be anticipated that, like the internet, the metaverse will have the potential to become a form of addiction. Moreover, there is a real possibility that the metaverse could generate more addicts than the internet (Barreda-Ángeles, Hartmann, 2022). Supporting this assertion are several factors: a) the metaverse provides a much deeper and more realistic experience through VR and AR technologies, allowing users to become fully immersed in the digital world, which may increase the time spent in these environments; b) it enables more intense and dynamic social interactions within virtual worlds, which can be highly appealing to users seeking social connection and interaction; and c) it facilitates the creation and customisation of virtual identities and spaces, potentially heightening user attachment to these worlds (Bojic, 2022; Feng, Lyu, 2022). It is evident that the metaverse has the potential to significantly impact users' lives, with some likely to develop an addiction to it. However, the question arises: on what basis can we assert that the metaverse will influence the physical characteristics of residential spaces?

6.1 Miniaturisation of space

Several key factors related to the metaverse extend beyond individual dependency, influencing broader social and architectural changes. As users spend increasing amounts of time in the metaverse, spaces such as living rooms may become less relevant to their daily activities. Traditional living rooms, which have often been the centre of social activities and gatherings, may lose their primary function. With the growing prevalence of the metaverse, users will increasingly rely on virtual spaces for social interactions, rendering physical living rooms less significant (Feng, Lyu, 2022). This trend may result in a reduction in the size of living rooms or their transformation into multifunctional spaces (Alfirević, Simonović Alfirević, 2022). Instead, workspaces (equipped with computers) will gain greater importance, as they will be adapted for activities more aligned with virtual interactions. Home workspaces will become crucial, not only for professional tasks but also for accessing the metaverse. These spaces will be outfitted with advanced technology to facilitate easy access to virtual worlds. Just as modern homes typically include extensive internet infrastructure, it can be anticipated that similar principles will apply in the future, with high-quality internet installations, VR and AR devices for metaverse engagement, and specialised rooms for virtual meetings or gaming (media rooms).

6.2 Disappearance of certain traditional room types

Kitchens, which have traditionally occupied a significant portion of residential space, may be significantly reduced or entirely eliminated as a room type in residential structures. The concept of “kitchenless” apartments, explored by Anna Puigjaner, involves reducing kitchen areas to a minimal size (often referred to as a mini-kitchen), frequently integrated into other living spaces or as part of multifunctional furniture. This approach allows for more efficient use of space, enabling residential units to be smaller without sacrificing functionality. The concept of kitchenless apartments already suggests the potential disappearance of traditional kitchens in favour of multifunctional spaces that incorporate food preparation functions into other

areas of the home (Puigjaner, 2016). Spaces traditionally designated for entertainment and socialising may evolve or even disappear in favour of virtual spaces that support interactions via the metaverse. This could lead to smaller but more functional and technologically equipped residential units. Specialised rooms for virtual activities, such as media rooms or VR rooms, will become standard in modern apartments. These spaces will be designed to support optimal conditions for virtual interactions, with appropriate soundproofing, lighting, and technology. This adaptation contributes to reducing the need for large social areas, as social activities increasingly shift online. The disappearance of certain traditional room types, such as kitchens and living rooms, under the influence of the metaverse and contemporary technological trends, represents a significant evolution in residential architecture. This change reflects the adaptation of living spaces to new needs and lifestyles of users in the digital age, creating more efficient, functional, and technologically advanced residential units. As technology advances, the metaverse is likely to become "a second form of life" for many (Feng, Lyu, 2022:55).

6.3 Reduction in the area and dimensions of certain rooms

As social interactions increasingly shift to the virtual realm, physical spaces designated for communal living are likely to trend towards reduction or transformation. Social spaces for entertainment and socialising, as well as rooms such as kitchens or home offices, may be diminished to optimise space according to the altered needs of users. For example, traditional living rooms, which once served as the centre of family gatherings, may be transformed into smaller, multifunctional spaces that support virtual activities. Instead of large kitchens, the trend is towards small kitchen niches or multifunctional furniture that performs the kitchen's role, thereby freeing up valuable space for other uses. Home offices, which were previously separate rooms, are now increasingly being integrated into living spaces or even bedrooms, with a focus on compact and functional workstations that facilitate virtual work and communication. These changes not only enable more efficient use of space but also adapt the residential environment to new needs and lifestyles influenced by the metaverse and other digital technologies. The reduction in the area and dimensions of certain rooms does not necessarily imply a loss of functionality; rather, it can lead to better spatial organisation and adaptation to contemporary requirements (Alfirević, Simonović Alfirević, 2020).

6.4 Transformation of physical spaces into virtual entities

The introduction of the metaverse into physical spaces may lead to their transformation into virtual entities, meaning that real spaces can be digitally replicated or fully integrated into the virtual world. Creating virtual replicas of physical spaces involves digital modelling and the creation of virtual versions of apartments or houses that are identical to or closely resemble their physical counterparts. Users might enter these virtual replicas to explore, customise, or utilise them for various purposes within the metaverse.

The integration of virtual elements into physical spaces refers to the addition of digital components to support interactions via the metaverse. For instance, through the use of augmented reality (AR) or virtual reality (VR), it is possible to overlay digital objects, information, or interactive elements onto the physical world. This may involve designing virtual screens, information panels, interactive games, or virtual simulations within real spaces.

Users can employ their mobile devices or AR/VR headsets to view additional information about their surroundings, interactive elements, or even virtual objects that are part of the metaverse. This technology allows users to virtually rearrange their space, add decorative elements, or create entirely new environments without physical alterations to the real world. Furthermore, virtual meetings and events can be held within these digital spaces, thereby expanding the functionality of residential environments and enabling users to interact within a virtual setting integrated with their daily living spaces. This transformation facilitates the creation of flexible and adaptable spaces that can evolve and change alongside the needs of users, achieving a high level of personalisation and interactivity in everyday life.

7. Discussion

The research findings indicate clear signs that the metaverse has the potential to significantly alter the use and organisation of residential spaces. Given the growing influence of digital technologies, particularly AR and VR, these changes are anticipated and align with the needs of contemporary users. The first key finding is the observed trend towards the miniaturisation of spaces, which addresses the increasing population density in urban areas and the need for more efficient use of limited resources. Evidence for this is found in examples of "kitchenless" apartments, where traditional kitchens are already being replaced by multifunctional solutions, thereby freeing up space for other uses in the future. The second significant result concerns the potential disappearance of certain traditional rooms, such as large living areas that previously served as the centre of

family gatherings. Changes in social interactions, which are increasingly shifting to virtual worlds, suggest that physical rooms may be replaced by smaller, multifunctional spaces specifically designed for virtual activities. These spaces enable users to utilise their residential area more efficiently, tailored to the needs of a digital environment. The third finding highlights the emergence of specialised rooms for virtual activities, as evidenced by the concept of "Hampton Hall," where digital versions of residential spaces are becoming an important aspect of property sales strategies. While this does not constitute definitive proof of a shift in residential design, such examples indicate potential long-term impacts of the metaverse on residential architecture. The integration of VR and AR technologies provides homeowners with new ways to utilise their spaces, adapted to the contemporary needs of a digital society.

All these results clearly support the initial hypothesis that metaverse technology will transform residential space, and the interpretation of the results is substantiated by evidence from cases such as "Mars House," "The Crystal Residence," and "Hampton Hall." These changes not only adapt residential units to modern needs but also redefine the way space is used. The emergence of specialised rooms, such as virtual meeting rooms or media rooms, represents a response to the increasing impact of the metaverse on our daily lives. These rooms are designed to support interactions within the virtual world, further confirming the transformation of physical spaces in accordance with the needs of a digital society.

8. Conclusion

The objective of this research was to investigate the potential changes in residential space resulting from the implementation of metaverse technology, with a focus on identifying the key aspects of these changes and their potential impact on lifestyle and the use of residential spaces. The results clearly indicate that the metaverse not only affects the transformation of residential spaces but also redefines the entire concept of living. Miniaturisation, the integration of virtual elements, and the disappearance of traditional rooms are key aspects of the changes that logically emerge from the data.

Assumptions regarding the complete transformation of physical space into virtual entities remain partially constrained by current technological capabilities. Although the transformation of residential spaces into virtual worlds has already commenced, the total elimination of physical elements remains a challenge due to the need to maintain a balanced living environment that supports digital, social, and physical aspects of daily life. The research findings align with existing knowledge on the impact of digital technologies on architecture but open avenues for further investigation into the long-term consequences of these changes on residential space design.

Future research directions that could build on the theme of the metaverse's impact on residential space include examining how continuous interaction with virtual worlds affects users' mental health and their relationship with physical space. The development of a legal framework regulating ownership of virtual residential spaces represents an important area for further research, specifically regarding how legal regulations governing digital versions of residential spaces will evolve and the implications for the traditional real estate market. The advancement of the metaverse may also influence communal living arrangements, such as cohousing and coliving models, and how digital communities are formed within the metaverse and their potential effects on the organisation of physical communities and space-sharing practices. These research directions provide opportunities for a deeper understanding of the broad impact of metaverse technologies on various aspects of life, architecture, and society, as well as the potential challenges and opportunities arising from their increasing application.

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References

- Adamski, D. (2018). The Influence of New Technologies on the Social Withdrawal (Hikikomori Syndrome) Among Developed Communities, Including Poland. *Social Communication*, Vol. 1, pp. 58-63. (<https://doi.org/10.2478/sc-2018-0007>)
- Adorno, J. (2018). *Micro-Dwelling as Housing for Young Adult Professionals*. Master Thesis. Greensboro: Faculty of The Graduate School at The University of North Carolina.
- Allam Z., Sharifi A., Bibri S.E., Jones D.S, Krogstie J. (2022). The Metaverse as a Virtual Form of Smart Cities: Opportunities and Challenges for Environmental, Economic, and Social Sustainability in Urban Futures, *Smart Cities 2022*, 5(3), 771-801. (<https://doi.org/10.3390/smartcities5030040>)

- Alfirević, Đ., Simonović Alfirević, S. (2022). Micro-Apartments: Achieving Spatial Comfort in Substandard Housing Conditions. *Arhitektura i urbanizam*, No. 55, pp. 5–23. (<https://doi.org/10.5937/a-u0-36566>)
- Alfirević, Đ., Simonović Alfirević, S. (2020). Achieving Use Value of a Living Space. *Spatium*, No. 44, pp. 22–28. (<https://doi.org/10.2298/SPAT2044022a>)
- Artaud A. (1938). *The Theater and its Double*, Grove Weidenfeld, New York
- Asins, M. (2023). Andrés Reisinger Has Designed a Virtual House in the Middle of the Desert. August 18, 2023. (<https://www.admiddleeast.com/>, accessed 21.07.2024.)
- Aureli, P. V., Tattara, M., Korbi, M. (2018). *Loveless: A short history of the minimum dwelling*. London: Design Museum.
- Barreda-Ángeles, M., Hartmann, T. (2022). Hooked on the metaverse? Exploring the prevalence of addiction to virtual reality applications. *Frontiers in virtual reality* 3/10. (<https://doi.org/10.3389/frvir.2022.1031697>)
- Biswas S. (2023). Impact Of Metaverse Technology: An Explanation And In-Depth Guide, <https://elearningindustry.com/impact-of-Metaverse-technology-an-explanation-and-in-depth-guide>, accessed on 11th September 2023
- Bojic, Lj. (2022). Metaverse through the prism of power and addiction: what will happen when the virtual world becomes more attractive than reality?. *European Journal of Futures Research* 10, 22. (<https://doi.org/10.1186/s40309-022-00208-4>)
- Brysch, S. (2019). Reinterpreting Existenzminimum in Contemporary Affordable Housing Solutions. *Urban Planning*, 4/3, 326-345.
- Carswell, A. (2012). *The Encyclopedia of Housing*, Second Edition, *Thousand Oaks*, Sage.
- Cash, H., Cosette, D. R., Steel, A. S., Winkler, A. (2012). Internet Addiction: A Brief Summary of Research and Practice. *Current Psychiatry Reviews* 8, pp. 292-298. (<https://doi.org/10.2174/157340012803520513>)
- Chou, C., Condrón, L. & Belland, J.C. (2005). A Review of the Research on Internet Addiction. *Educational Psychology Review* 17, pp. 363–388. (<https://doi.org/10.1007/s10648-005-8138-1>)
- Davies, S. (2022). The “Kitchenless House”: Radical Changes in Home Design and Their Impact on Human Well-Being. in: Russo M. T., Argandona A., Peatfield. (eds.) *Happiness and Domestic Life: The Influence of the Home on Subjective and Social Well-Being*. London: Routledge.
- Dorostkar E., Najarsadeghi M. (2023). Sustainability and urban climate: How Metaverse can influence urban planning?, *Environment and Planning B: Urban Analytics and City Science*, OnlineFirst. (<https://doi.org/10.1177/23998083231181596>)
- Dwivedi, Y., Hughes L., Baabdullah A., Ribeiro-Navarrete S., Giannakis M., Al Debei M., et al (2022). Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy, *International Journal of Information Management*, Vol 66, October 2022, 102542
- Dwivedi, Y.K., Kshetri, N., Hughes, L. et al. (2023). Exploring the Darkverse: A Multi-Perspective Analysis of the Negative Societal Impacts of the Metaverse. *Information Systems Frontiers* 25, pp. 2071–2114. (<https://doi.org/10.1007/s10796-023-10400-x>)
- Fischer, A. (2022). *Architecture as Art in Metaverse*, Master thesis. Zurich: University of Zurich.
- Feng, W., Lyu, N. (2022). Dissolve of Living Space: Living Space Under the Development of Metaverse. *Architecture Thesis Prep*. 432. Syracuse: Syracuse University. (https://surface.syr.edu/architecture_tpreps/432)
- Ferré da Ponte, S. (2016). *Saving Space With Furniture Design: Focusing on Worldwide Micro Living and the Traditional Japanese Home as Case-Studies*. Master Thesis. Lisbon: University of Lisbon, Faculty of Architecture.
- Geffner, T. (2018). *Towards a Smaller Housing Paradigm: a Literature Review of Accessory Dwelling Units and Micro Apartments*. *University Honors Theses*. Portland: Portland State University. Paper 515.
- Gent, E. (2022). Lessons from a second life> before meta, philip rosdale created an online universe, *IEEE Spectrum*, 59 (1) (2022), p. 19
- Harrouk, C. (2021). Mars House, First Digital Home to be Sold on the NFT Marketplace. March 23, 2021. (<https://www.archdaily.com/959011/mars-house-first-digital-home-to-be-sold-on-the-nft-marketplace>, accessed 26.07.2024.)
- Hein, S., Nießen, J. (2020). *Micro Housing: No Contribution to Affordable Housing - A Berlin Case Study*. Proceedings from REAL CORP 2020 - Shaping Urban Change. Livable City Region for the 21st Century. Aachen, 15-18 September, 565–574.
- Henz, P. (2022). The Psychological Impact of the Metaverse. *Discover Psychology* 2(47). (<https://doi.org/10.1007/s44202-022-00061-3>)
- Iglesias, T. (2014). The Promises and Pitfalls of Micro-Housing. *Zoning and Planning Law Report*, 37.10, 1–12.
- Joshua J. (2017). Information Bodies: Computational Anxiety in Neal Stephenson's Snow Crash. *Interdisciplinary Literary Studies*, 19 (1), pp. 17-47

- Kholid, M. F., Zaharin, P. M. B. (2019). Micro Housing: Typological study and implementation in Malaysia. *Environment-Behaviour Proceedings Journal*, 4/12, 265–278.
- Kilman, C. (2016). Small House, Big Impact: The Effect of Tiny Houses on Community and Environment. *Undergraduate Journal of Humanistic Studies*, 2, 1–12.
- Kye B., Han N., Kim E., Park Y., Jo S. (2021). Educational applications of metaverse: possibilities and limitations, *J Educ Eval Health Prof* 2021;18:32, DOI: <https://doi.org/10.3352/jeehp.2021.18.32>
- Lee, T. Braud, P. Zhou, L. Wang, D. Xu, Z. Lin, ..., P. Hui. (2021). All one needs to know about Metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda, arXiv, 2110, p. 05352.
- Lian, Y. (2019). „Kitchenless” City: Collective Urban Kitchen as Supplement to Kitchenless Apartment, Master Thesis. Göteborg: Chalmers tekniska högskola.
- Ludlow P, Wallace M. (2007). *The second life herald: The virtual tabloid that witnessed the dawn of the METAVERSE*, MIT press
- Liu Z., Xie S., Li Y., Hossain M.S., El Saddik A. (2022). Building the metaverse using digital twins at all scales, states, and relations. *Virtual Reality & Intelligent Hardware*, Volume 4, Issue 6, December 2022, Pages 459-470, <https://doi.org/10.1016/j.vrih.2022.06.005>
- Mirka, S. (2023). *The Evolution of Kitchen Design: Exploring the Development of Kitchen Spaces and its Progression Towards the Future*, Master Thesis. Espoo: Aalto University.
- Mitrushchenkova, A. (2022). Personal Identity in the Metaverse: Challenges and Risks. *Kutaafin Law Review*, 9(4), pp. 793–817. (<https://doi.org/10.17803/2313-5395.2022.4.22.793-817>)
- Morgan R. (2023). *How The Metaverse Impacts The eLearning Industry*, <https://elearningindustry.com/how-the-metaverse-impacts-the-elearning-industry>, accessed on 12th September 2023
- Nenković-Riznić M. (2023). Metaverse – a powerful new instrument for urban planning or yet another unfulfilled tech-promise?, *Book of Proceedings “On Architecture – Challenges in Design” Strand 2023*, pp.92-99
- Osborne, R. (2018). *Best Practices for Urban Coliving Communities*, Master Thesis, Lincoln, University of Nebraska.
- Pagh, C., Williams, J., Braskov, R. S., Christensen, C. V. (ed.) (2018). *Imagine: Exploring the Brave New World of Shared Living, Copenhagen, Space 10, Urgent.Agency*.
- Petkov M. (2023). Exploring the potential of the Metaverse in urban planning, <https://landvault.io/blog/METAVERSE-urban-planning>, accessed on 3rd September 2023.
- Puigjaner, A. (2016). The ‘Kitchenless’ House: A Concept for the 21st Century. entrevista realizada por Cati Bestard. Archdaily, Accessed 18 Jul 2024. (<https://www.archdaily.com/793370/the-kitchenless-house-a-concept-for-the-21st-century>)
- Raad, H., Rashid, F. K. M. (2023). The Metaverse: Applications, Concerns, Technical Challenges, Future Directions and Recommendations. *IEEE Access*, vol. 11, pp. 110850-110861. (<https://doi.org/10.1109/ACCESS.2023.3321650>)
- Richmond, S. (2012). *Micro-Living: Learning to Live Large in Small Spaces*. Master thesis. Wellington: Victoria University, School of Architecture.
- Rodgers, R., Melioli, T., Laconi, S., Bui, E., Charbol, H. (2013). Internet Addiction Symptoms, Disordered Eating, and Body Image Avoidance. *Cyberpsychology, Behavior, and Social Networking* 16/1. (<https://doi.org/10.1089/cyber.2012.1570>)
- Soub, N. M., Memikoğlu, İ. (2020). Exploring the Preferences for Micro-Apartments. *Online Journal of Art and Design*, 8/2, 88–99.
- Steding, D. (2019). *Coliving: An Emerging Term Without a Common Definition*, Master thesis, KTH, School of Industrial Engineering and Management.
- Stephenson, N. (1992). *Snowcrash*, New York, Bantam books
- Teige, K. (2002). *The minimum dwelling*. Cambridge: MIT Press.
- Thøgersen, K. 2017. *Small Spaces Need Smart Solutions: Designing Furniture for Small Spaces, in Connection with Human Wellbeing*. Trondheim: Norwegian university of science and technology, Department of design.
- Widyanto, L., Griffiths, M. (2006). ‘Internet Addiction’: A Critical Review. *International Journal of Mental Health and Addiction* 4, pp. 31–51. (<https://doi.org/10.1007/s11469-006-9009-9>)
- Williams, Jo. (2005). *Designing Neighbourhoods for Social Interaction: The Case of Cohousing*, *Journal of Urban Design* 10/3, pp. 195–227.
- Yaqoob I., Salah K., Jayaraman R. Omar M. (2023), Metaverse applications in smart cities: Enabling technologies, opportunities, challenges, and future directions, *Internet of things vol 23.*, <https://doi.org/10.1016/j.iot.2023.100884>
- Zallio M., Clarkson P.J. (2022). Designing the metaverse: A study on inclusion, diversity, equity, accessibility and safety for digital immersive environments, *Telematics and Informatics* 75 101909