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Metaverse Feasibility Analysis and Metaverse Impacts on Urban Social Sustainability (Case Study: Urmia)

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Abstract

Background and Objective: The advancement of digital technologies and the emergence of the metaverse have introduced new spatial and social dimensions to urban life, reshaping patterns of interaction, participation, and identity formation. Within this evolving context, social sustainability-one of the core dimensions of sustainable urban development-requires renewed analytical attention. This study investigates the impact of the metaverse on urban social sustainability, focusing on the city of Urmia as a case study.

Methodology: This research employs a mixed analytical methodology. In the first phase, the readiness of Urmia's technological and spatial infrastructures for the development of an urban metaverse was assessed, including Geographic Information Systems (GIS), Web-based spatial platforms, Internet of Things (IoT), big data infrastructures, and communication networks. In the second phase, empirical data were collected through a structured questionnaire to examine the relationship between the extent of metaverse use and key dimensions of social sustainability. Data analysis was conducted using linear regression models in SPSS. The examined dimensions of social sustainability include social cohesion, social participation, sense of place and urban identity, and social equity and accessibility.

Results and Findings: The results reveal that metaverse use has a positive and statistically significant effect on social cohesion, social participation, and urban identity, with the strongest impact observed on urban identity. Although the relationship between the metaverse and social equity and accessibility was positive, it did not reach statistical significance at the 95% confidence level. Overall, the findings suggest that the metaverse, if supported by inclusive infrastructure development and appropriate urban governance frameworks, can serve as an effective instrument for strengthening urban social sustainability.

Keywords:Metaverse, Social Sustainability,Sustainable Development,Emerging Technologies,Social Interactions,Urmia.

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EXTENDED ABSTRACT

Introduction

The metaverse, as the new generation of the internet, is a decentralized network of virtual spaces in which users engage in social interaction, learning, gaming, and forming human relationships. This space consists of three-dimensional, persistent simulations that are processed instantaneously. The identities of individuals, social relationships, physical objects, and even payment systems in the metaverse maintain their continuous connection.

The metaverse acts as a virtual space that allows a large number of people to be present in it simultaneously, without the need for physical presence in a specific location. In this digital world, users can interact with each other and with various components of their surrounding environment. In other words, in the metaverse, individuals engage in social interactions and role-playing online and virtually.

Social sustainability refers to the quality and type of presence of individuals in a specific place, such as a neighborhood or community. This concept is generally associated with social interactions, perception of the environment, and psychological comfort of individuals in that environment. Social sustainability includes the ability to establish effective communications and create healthy relationships among community members, which contributes to strengthening solidarity and social cohesion.

The metaverse, by providing the possibility of accessing these spaces and creating equal opportunities for social interactions, can play an important role in strengthening these dimensions of social sustainability. Although the metaverse can create an opportunity to strengthen urban social sustainability, at the same time, challenges such as security threats, privacy, and its negative social impacts must also be taken into consideration.

In many societies, especially in small and developing cities, challenges such as social inequality, lack of facilities and public spaces for social interactions, and economic problems have become the main obstacle to creating a sustainable and participatory society.

Methodology

The present study uses a mixed research method which consists of two main parts:

The first part is the assessment of spatial and urban infrastructures of Urmia city for the implementation of the metaverse, which includes virtual reality (VR), augmented reality (AR), geographic information systems (GIS), Internet of Things (IoT), big data (Big Data), and location-based services (LBS), and so on. The data of this part are extracted from urban sources, organizational reports, and spatial data analysis And in the second part, the relationship between the amount of metaverse use and urban social sustainability in Urmia city is examined using regression models. The independent variable is measured through standardized questionnaires and citizens' digital activities data. The dependent variable is also measured with indicators such as social interactions, sense of belonging to the community, and the level of urban participation.

The collected data from both parts, after processing, are analyzed using statistical analyses and regression modeling to determine the impact of the metaverse on urban social sustainability in Urmia.

Results and Findings

Urmia city is in a favorable situation in terms of digital and communication infrastructures, and these infrastructures can act as a pre-stage for entering the urban metaverse. The connection of existing systems to augmented reality, digital twins, and the Internet of Things can increase social sustainability through promoting participation, justice, and transparency.

Urmia city, by having platforms such as Shahrnama system, WebGIS system, and integrated data bank, has been able to take effective steps towards the realization of the smart city and preparation of the infrastructures for entering the urban metaverse. The results of this analysis show that Urmia city, having an extensive optical fiber network, a detailed database of parcels, and various information systems, has a high capacity for the implementation of the urban metaverse. However, there are challenges such as the lack of specialized human resources in the field of augmented reality and the metaverse, the lack of common data standards among institutions, and the weakness in public education of citizens for using modern technologies.

To assess the reliability of the questionnaire with 20 items in four indicators of social cohesion, social participation, urban identity, and justice and access, Cronbach's alpha coefficient was used. The Cronbach's alpha value for the whole questionnaire was equal to 0.710, which indicates the acceptable reliability of the research instrument. Based on this, it can be concluded that the developed questionnaire for measuring the impact of the metaverse on social sustainability has reliable stability, favorable internal consistency, and sufficient accuracy in measuring the studied constructs.

After examining the infrastructures of Urmia city, simple linear regression in SPSS software was used to measure the relationship between the metaverse and the dimensions of social sustainability. The independent variable is the amount of metaverse use, and the dependent variables are the four main dimensions of social sustainability including social cohesion, justice and access, social participation, and urban identity.

The Impact of the Metaverse on Social Cohesion

The regression results show that there is a positive and significant relationship between the metaverse and social cohesion. The coefficient of determination R^2 is equal to 0.191; that is, about 19.1 percent of the changes in social cohesion are explained by the metaverse. Regarding the significance level of 0.016, increasing the use of the metaverse significantly strengthens social cohesion, the sense of solidarity, and interpersonal communications of citizens.

The Impact of the Metaverse on the Dimension of Justice and Access

In the dimension of justice and access, the coefficient of determination R^2 is equal to 0.099; that is, about 9.9 percent of the changes in this dimension are explained by the metaverse. The significance level of 0.091 indicates that the relationship between the metaverse and justice and access is positive but weak and at the threshold of significance. This is probably due to limitations such as digital inequality, differences in access to high-speed internet, and weakness in policies for the fair distribution of virtual services.

The Impact of the Metaverse on Social Participation

The regression results show that there is a positive and significant relationship between the metaverse and social participation. The coefficient of determination R^2 is equal to 0.162; that is, about 16.2 percent of the changes in social participation are explained by

the metaverse. The significance level of 0.027 indicates that the use of the metaverse significantly increases the social participation of citizens.

The Impact of the Metaverse on Urban Identity

In the dimension of urban identity, the strongest relationship between the metaverse and the dimensions of social sustainability is observed. The coefficient of determination R^2 is equal to 0.344; that is, about 34.4 percent of the changes in urban identity are explained by the metaverse. The significance level of 0.001 indicates that the metaverse has a positive and strong impact on strengthening the urban identity of citizens.

Conclusion

The results of four regression models show that the metaverse has a positive and significant effect on social cohesion, social participation, and urban identity, and explains about 19.1, 16.2, and 34.4 percent of the changes in these dimensions, respectively. In the dimension of justice and access, the tendency of the relationship is also positive, but due to the significance level of 0.091, this relationship is not definitive at the 5% level and indicates more of an emerging effect than an established pattern.

The metaverse in Urmia has a significant capacity to strengthen social sustainability, especially in the dimensions of sense of belonging, solidarity, and collective participation. However, the relative weakness of the relationship between the metaverse and justice and access shows that without addressing digital inequalities, improving communication infrastructures for all social groups, and designing fair policies for the distribution of metaverse services, the use of the metaverse may itself become a new source of inequality.

Declarations

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Authors' Contribution

Authors contributed equally to the conceptualization and writing of the article. All of the authors approved the content of the manuscript and agreed on all aspects of the work declaration of competing interest none.

Conflict of Interest

The authors declare no conflict of interest.

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