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A STUDY OF PRACTICE AND APPLICATION IN DIGITAL PUBLIC ART IN THE CONTEXT OF METAVERSE

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ABSTRACT

Public art as a participatory art has become an important way of cultural shaping and urban marketing in cities, and the public is gradually becoming participants and shapers in urban public art practice, but the current public art field still faces problems such as temporary nature, high costs of exhibition venues or spaces, information blockage, slow circulation, and lack of consensus cognition of art values. With the booming development of emerging technologies such as big data, cloud computing, the Internet of Things, and artificial intelligence in recent years, the innovation of technology has also invariably catalyzed a change in the public's identity in the face of the constantly renewed concept of metaverse and the imminent shift of art demand and artistic expression to the digital expression of the future. As a new term, the definition and connotation of metaverse have not yet been officially unified and agreed upon. After a comprehensive analysis of the interviews, we believe that metaverse is a virtual space that can be interacted with by multiple people, parallel or intersected with the real world by using mixed reality technologies such as artificial intelligence, blockchain, AR and VR, in order to maximize users' creative ability and personalized expression. In this study, we propose for the first time the construction of a digital public art field architecture in the context of metaverse, which is built from three levels: technical application layer, technical support layer, and application practice layer, based on which we design an innovative art index system based on the relevant modules of the data layer, and participate in the future art construction. Taking digital public art as the research object, we discuss the influencing factors of public art through the method of expert evaluation, and try to realize the authenticity of virtual space through the construction of digital technology, further enhance the quality of public art, artistic productivity and strengthen the accuracy of artistic language, provide the new evaluation standard and practice path for digital public art, link the technical means with public demand, in order to It also provides a new evaluation standard and practice path for digital public art, linking technological means to public needs in order to enhance social participation, emotional links, and social cohesion between the public and their communities. At the academic research level, we focus on this aspect of new technological change in the art discipline, providing an independent and objective value system for public art research, as well as novel and optimized solutions.

Keywords: Public Art, Metaverse, Field Architecture, Hierarchical Analysis, Index System, Case Study

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1 INTRODUCTION

The current digital public art mainly contains two levels of conceptual content, including both the digital level of technical content, while taking into account the artistic level of content. The current digital technology is mainly interactive technology, holograms, animation and digital imaging in MR technology. On the other hand, there is no standardized expression of public art, nor is there a specific artistic school or division of expression style. Traditional public art is defined as art with public, artistic, and local characteristics, and its expression takes the form of artworks that meet people's needs for cultural aspects while enhancing public aesthetics in open and shared spaces, with strong artistic and cultural attributes, and in specific historical and cultural areas. Among the new types of public art works, there are more and more art works that use digital technology as an auxiliary means, thus extending the digital mode based on traditional public art with virtual, fast-sensitive, interactive and other artistic characteristics, and reducing the possibility of manual participation while displaying art in a convenient and efficient perspective.

With the booming development of emerging technologies, especially the concept of Metaverse in recent years, it is worthwhile to study and explore in depth what kind of experience and quality enhancement public art will bring in the future. From the perspective of the existence of the metaverse, the deep integration of virtual and reality is the most basic characteristic of the metaverse. The term "metaverse" was coined by science fiction author Neal Stephenson in 1992. In the book "Snow Crash", the book depicts a virtual world parallel to the real world, where people can communicate through simulated characters in a virtual world that spans space, the space where the virtual world is located is the metaverse. However, with the passage of time and the further development of emerging technologies, there is still no unified consensus on the definition of the metaverse concept. For example, futurist Luke Shabro believes that the metaverse is a fuzzy, digital hybrid reality with irreplaceable and infinite projects and roles that are not bound by traditional physical limitations and constraints; CEO and Chief Metaverse Officer Cathy Hackl believes that the metaverse is a fusion of the physical and digital worlds, and that one of the most important elements of the metaverse is decentralization, with blockchain projects Blockchain projects are seen as a fundamental element in the metaverse. The metaverse is not a company, nor does it represent only a technology that will connect people, places and things. In a metaverse, people, spaces and assets can be in a completely virtual synthetic environment; Dave Baszucki believes that a metaverse doesn't just have to look real, it has to give the human senses reality. So part of the expectation of creating a physically driven metaverse is actually to make it easier to program and create improvisational behavior; Zuckerberg sees a future where augmented reality is presented in full-image projection. The augmented reality glasses will allow users to quickly enter the meta-universe from existing platforms, extending the current means of typing and clicking on cell phone screens, making the operating procedures work through gestures, words, and even consciousness, linking people, linking people through digital space, and using digital technology to build a "digitally differentiated world" that is both based on and independent of the real world. "The interoperability of the digital and real worlds allows entertainment, games,

and Internet conversations to take place in the same public space, not just in front of a screen. Ultimately a fully integrated new digital system of social relations is called a metaverse. Collins sees the metaverse as a vast virtual world, or even a digitization of our real world, with its own productive and communicative activities that span both the physical and virtual worlds together.

Regarding the interpretation of the concept of metaverse, many international experts have made a comprehensive analysis from different perspectives. It can be seen that some experts believe that metaverse is a new virtual world type integrated with multiple technologies, some experts believe that metaverse is a replica of the real physical world, and some experts believe that metaverse is a new virtual world form with a completely different perceptual experience from the physical world. . Although the interpretation of metaverse has not been unified so far, in order to clearly demonstrate our logical structure in this study, we have organized the current international experts' interpretation of the application of metaverse technology into the framework structure schematic shown in Figure 1 below.

Figure 1 Schematic diagram of metaverse technology and application interpretation

AR, VR, MR and other integrated technologies in the metaverse are currently used in the entertainment industry for mixed reality games and immersive movies; in social life for remote meetings with 3D motion capture systems and realistic interaction effects; in medicine for remote diagnosis and remote surgery in the form of 3D previews, and in education and training

for simulated surgical practice; and in mining and other industries. In the secondary industry, the 5G network in metaverse technology with real-time audio and video communication technology can be used for remote control of dangerous projects and virtual training; meanwhile, mixed reality technology is also implemented in retail, exhibition halls, home scenes, education and art design, and instant communication. In addition, the integrated technology in the metaverse can be applied to virtual business in the retail industry, for example, using mixed reality technology for hands-on education and training of employees to create 3D models of reconfigured stores and broadcast multiple scenarios to train employees to adapt to multiple scenarios. In the education industry, metaverse's gesture recognition technology, 3D interaction technology, language interaction technology, haptic feedback technology, eye tracking technology and physiological computing technology can meet the needs of students and teachers in multiple scenarios such as multiple types of classroom content and multiple interaction behaviors, thus improving the user experience in multiple dimensions. In the medical industry, the 3D images displayed by the metaverse integration technology can be used for medical visualization. The MR glasses, an important hardware device in the metaverse technology, is applicable to many medical scenarios, including brain puncture navigation software, lung medical imaging, 3D mixed reality reconstruction software, etc. In addition, mixed reality technology can also render traditional image data such as CT and MRI through efficient and intelligent image segmentation algorithms for 3D reconstruction. In the exhibition hall, the digital exhibition hall built based on the reality technology in the metaverse incorporates many digital display devices, and the advantage of the digital exhibition hall is to enhance the original artistry on the basis of the traditional exhibition hall, and at the same time increase the interactivity, which not only solves the constraints of the display area in the traditional physical display space, but the advantage of the digital exhibition hall is to enhance the original artistry on the basis of the traditional exhibition hall, and at the same time increase the interactivity. The advantage of digital exhibition hall is to enhance the original artistry on the basis of traditional exhibition hall and increase the interactivity. Not only solves the traditional physical display area constraints, display form single, display material conditions of the limitations. In terms of art, the current interactive animation for the application of mixed reality technology is essentially just a simple interface and architectural model directly overlayed into the real scene, the degree of interaction is low, and there is a lack of systematic integration in time and space.

In summary, our specific contributions of this study are threefold: (1) We use the idea of functional requirement analysis in software science to build a field framework, use interdisciplinary fuzzy mathematical theory to conduct quantitative quality analysis, and further explore the analysis method of the practice path of metaverse technology in public art to achieve quantitative and qualitative integration. (2) The research results are based on the analysis of real data judged by several experts, and the construction of the index system clarifies the aesthetic system and value standards of digital public art for the first time. (3) The systematic structure designed for digital technology provides an effective solution to the problems of temporary nature, high cost of exhibition space, and lack of consensus recognition of art value in the field of public art, and provides a strong basis for urban planning and urban marketing through the implementation of digital technology, thus further stimulating social potential and creativity.

The rest of the paper is organized as follows: Part II is a literature review, in which we will review four specific aspects of public art research, the application of metaverse technology in the field of public art, and the study of fuzzy mathematical theory in the field of art. The third part is the basic theory, and this paper will introduce the operation process of hierarchical analysis method. In the fourth part, based on the digital technology in the metaverse, this paper discusses the differences in the application of mathematical theories in the field of digital public art and constructs an architectural design of the future metaverse-oriented public art space field

under the perspective of the digital technology in the metaverse. In the fifth part, the paper proposes a method to explore the practice path of metaverse technology in digital public art by using hierarchical analysis in the context of metaverse. In the sixth section, this paper discusses the practical strategies of metaverse technology in digital public art in the context of quantitative research. The seventh part of this paper introduces the significance and purpose of this study. The eighth section concludes the paper.

2 LITERATURE REVIEW

In this paper, we focus on the core issue of the intervention and application of metaverse technology in public art, analyze the hierarchical analysis method combined with the theoretical approach of stability, build a systematic structure for improving the quality of public art based on the new metaverse digital technology, establish a hierarchical model to assess the needs and importance of public art in terms of technology, and derive an evaluation system to analyze the importance of mixed reality technology in public art. The study also provides a system of indicators to analyze the importance of mixed reality technology in the field of public art, and explains the indispensability of the technology, and gives suggestions on how to promote the interaction between the public and art in the future in the context of a society facing constant technological iterations. In order to make the study more logical, we have developed a framework for the literature review as shown in Figure 2 below. Specifically, we will review the literature through three levels: public art research, metaverse technology application in art, and fuzzy mathematical theory in art.

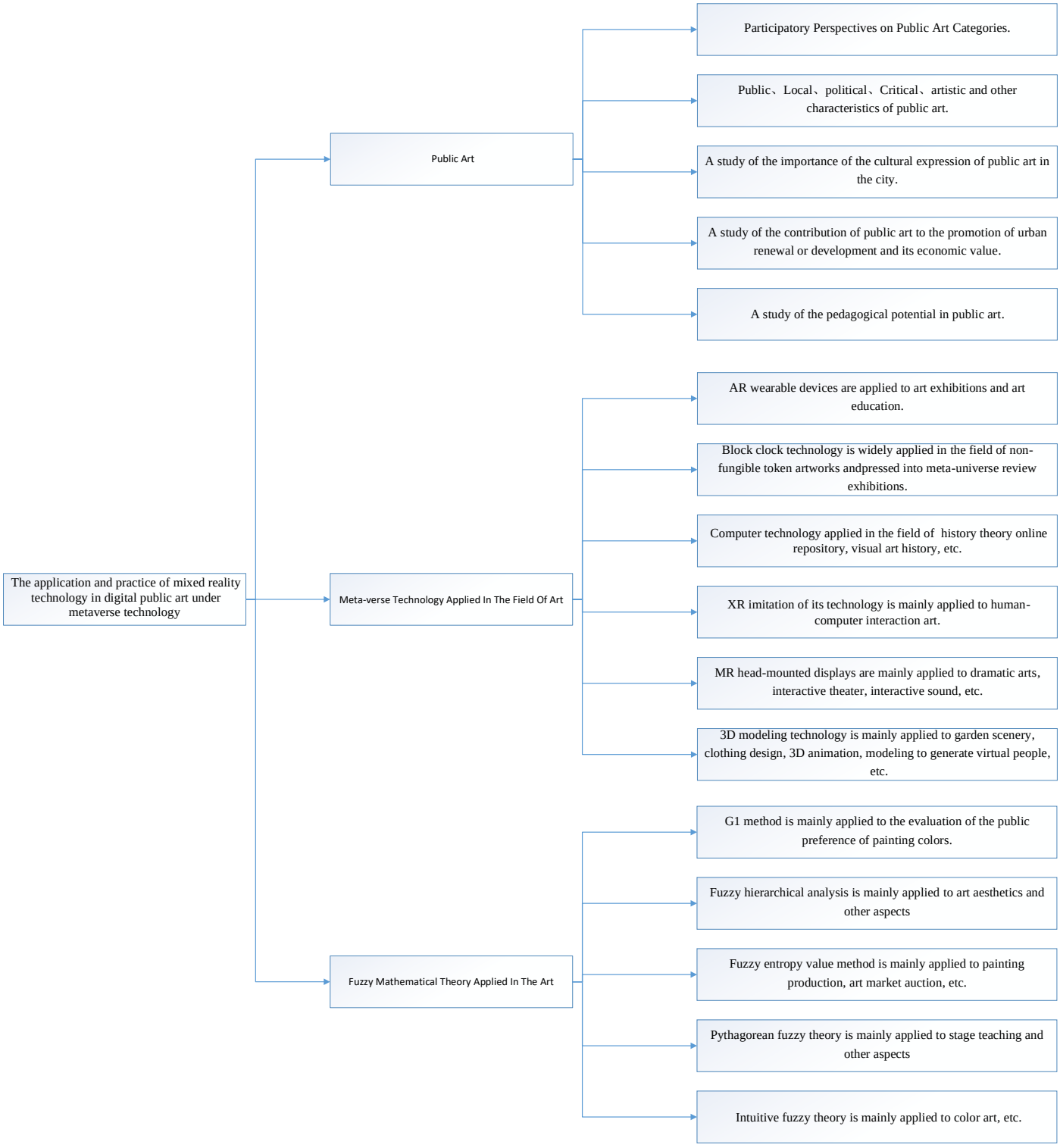

Figure 2 Framework of literature review ideas

It is well known that the emergence of the concept of public art accompanied the Second World War and was born in the United States; however, public art has a long history of having public attributes. Public art is generally considered to be artworks in public, shared open areas and is referred to as public art. Public art includes sculpture, urban architecture, murals, transportation facilities, gardens, advertising, street art, interactive performance art performances and other multi-disciplinary art concepts, but there is currently no unified definition of the domain of public art, in which scholars have discussed in depth the categories

of public art, art concepts and characteristics, public art However, there is no unified definition of the field of public art, and scholars have conducted in-depth discussions on the categories of public art, artistic concepts and characteristics, the unique urban contributions of public art among all types of art, and cultural expression. Pamela Geiger Stephens [1] argues that participatory public art is an invitation to public participation and expression, moving away from the traditional roles assigned to artists and audiences and exploring the extension of public art in the community. Amelia and Steffen [2] discuss street art as a form of expression in public art. Based on street art during a non-state epidemic, Cheryl McEwan [3] and others argue that street art is attempting to cultivate public perceptions by combating disinformation, revealing the political nature of street art. Kim Gurney [4] explores the political implications of public artworks, using the example of a former colonialist sculpture. The purpose is to reflect on the integration of the concept of the work. Joon-ho Kim and Seung-hye Jung [5] used structural equation modeling to analyze survey data of public art performance centers and showed that public art activities under corporate investment and operation have a positive impact on corporate performance, and that public art performances should be socially responsible and generate economic benefits through effective operation. John Mccarthy [6] uses public art in the Belfast Cathedral Quarter as an example to explore the path of urban regeneration and revitalization in contemporary urban cultural districts. Arguing that historical societies can provide a valuable means of incorporating more broadly detailed guidance and contextual design strategies that link public art to local identity, Martin [7] argues through an original critical discussion of the potential and challenges of teaching public art that using public art to teach sexuality can act as a slowdown, leading to culturally responsive and personalized pedagogies that aim to can allow students to think critically about the relationship between self, identity, and space. Based on the above research, contemporary public art has evolved from architecture and sculpture to street art to performance and participatory public art. In essence, contemporary public art is an extension of the "conceptual art" that has been spawned by the philosophical trends of postmodernism as popular cultural thought has shifted. The integration of new media has led to the evolution of art forms and the development of artwork from static to dynamic, providing urban citizens with an opportunity for open dialogue that breaks down identity boundaries. This will become the main trend in the future development of public art.

In terms of art concepts, scholars have analyzed the artistic characteristics of public art based on the content and values of urban public art. Martin [8] argues that public art should be interpreted as permanent or temporary artworks in public areas, linking the spatial characteristics of the artwork's location to the aesthetic proximity of the public and critically reshaping the relevance of public perception to public art. Studies such as Martin and Rob [9] have explored publicness in traditional definitions of public art, expressing art's reflection on the role of physical aesthetics, economic, social, and cultural symbols in urban public spaces while serving as an embodiment of ideas. Patricia C. Phillips [10] argues that public art is not only public, the concept of the public is also variable. Public art is temporal art, expressing collective ideas, dynamics, and temporal conditions by providing a visual language; being entertaining presupposes that expression must be supported by the acceptance of powerful variables.Shana and Brianna [11] incorporate new materialist and posthumanist theories into the creation of participatory public art, and argue that participatory public art must resonate with residents on the physical, memory Andrew and Salin [12] elaborate on the importance of cultural representation in urban public spaces and express that artists' voices can challenge the social status quo and that protecting the integrity of artists' voices, the expressive capacity that citizens possess, is an opportunity for citizens to engage in dialogue, deliberation, and be healed. Protecting the integrity of the artist's voice and the ability of citizens to express themselves is an opportunity for citizens to engage in dialogue, deliberation and healing. Based on the above research, we can summarize that public art should be public, artistic, local, temporary,

collective, political, critical, practical, and iconic, among which public, artistic, and local should be the three most basic characteristics of public art. For the temporary nature of public art, we in this paper will structure the future development of public art through the support of digital technology, expand the various ways of interaction between the public and the shared space in terms of sound, smell, and environment as well as the ways to use virtual space to meet the openness of art works, liberate space without taking up physical shared space, and optimize the time-sensitive characteristics of participatory public art. In terms of social function, scholars have expanded on the cultural expression and social potential of public art, and have discussed the renaissance and development of urban culture brought about by public art as follows: Gaye Green [13] has promoted social transformation through artworks formed through collective community interaction. Gaye Green [13] aims to evoke public empathy through the social concerns of art practitioners. Ricardo Campos [14] argues that public art has become the new norm in urban planning, that public art attracts new visitors by creating a new iconography, and that artistic expression is understood as a resource, rooted in art and culture, that becomes an important resource for urban development and urban marketing. Tim and Iain [15] discuss the potential contribution of public art to urban regeneration, revealing the underlying social contradictions that turn contemporary public art into a positive factor for social change, pointing out that the current shortcomings lie in the lack of complete evaluation criteria and rigorous critical institutions in the field of public art. Yui Motoyama and Kazunori Hanyu [16] investigated the impact of public art on the visual characteristics and emotional evaluation of the landscape, revealing that public art has a greater impact on the landscape than the compatibility of public art with the landscape, with the aim of making local open spaces more attractive and valuable. marine Tanguy and Vishal Kumar [17] Considering public art as works displayed in open public spaces, they emphasize the importance of public art projects for future city building as well as their economic value, and the studies show that public art increases people's happiness, heals social divisions, and increases well-being. From the above studies, we can fully understand the importance of public art to urban construction, and that public art is popular art, often existing as a symbol of the character of the city, and its unique interventions interact with the public life, thus aiming to meet the public's spiritual needs and improve the quality of life. The fullness of the art ecology and the means of art participation allows the public to become one of the important chains in art production. However, the implementation of public art projects is closely linked to enterprises, institutions, and local government departments, mainly because the production costs of public art are too high and art creation is difficult to accomplish independently. The future integration of metaverse technology can provide a low-cost way for public art creators to experiment, enhance the operability of public art, and improve the efficiency of information exchange between artists, the public, the system, and the environment. In terms of the future development of public art, interdisciplinary experimentation has brought more possibilities for art, and the embrace of new technologies and disciplines has given public art a humanistic value and more viable ideas. Darivemula [18] and others have attempted to address the relationship between women in medicine and their field through public art, discussing the existence of gender-specific oppression and bias in the workforce. Mitchell [19] discusses the political implications and violence behind public art, and that public symbols should be more than a single, calm utopian fantasy that the public accepts and projects, but rather a critical artistic expression. Tony and Sophie [20] investigated the effectiveness of public art in planning and delivery, primarily in Australia, arguing that public art is a place that promotes urban regeneration and increases social capital, and can objectively reflect the ideas, values, emotions and unique identity of a community. Thanks to the above research, the above studies provide ideas to inform the construction of this paper's indicator system from the perspectives of categories, characteristics, and social values. The focus of this section of the study examines the functions and contributions of existing public art as well as

the critical and socially engaged aspects of public art to analyze and study public art categories and existing artworks. However, our research will explore the unique aesthetic system of digital public art from the perspective of the future digital development of public art, providing art practitioners with a wider range of creative ideas and more convenient ways for the public to interact and view, as well as providing a strong basis for urban planning and urban marketing, while stimulating social potential and creativity.

The application of technology in the metaverse in the arts, starting in 2021 with the launch of the Urban Digital Arts Festival in Madrid; meanwhile on March 4, 2022 the city's Contemporary Creation Center opens the first digital art and virtual reality center in Europe, the Madrid Digital Art Museum, a creative space based on immersive experiments in audiovisual projects, augmented reality, virtual reality and holography, turning the metaverse technology with urban space, turning it into a window for the presentation of digital art. The advent of new metaverse technologies has provided new demands and directions for art language expression and art tools development. Garrett Lynch [21] used the Google3D application and SketchUp to create works, and used wearable devices to demonstrate performance, expressing that the "virtual" world itself is "real". "Yingjun Gong [22] introduces the application of virtual reality pedagogy in digital media art creation. Omobolanle R. Ogunseiju [23] and others introduce a mixed reality environment for learning sensing technologies. The aim is to equip construction engineering students with the ability to deploy sensing technologies in construction projects to improve task performance and effectively address the technology gap between the construction industry and construction engineering education. Bo Kang [24] et al. address the notion of complexity in the design of interactive device prototypes and build an AR-enhanced system to demonstrate dynamic interactive capabilities across physical and virtual domains. The potential of AR technology for interactive product development and capturing user needs is revealed. Focusing on artists with disabilities, Marylyn Alex [25] et al. discussed the contextual art therapy of designing virtual reality art for patients with stroke-related disorders, and argued the potential of VR art creation as a rehabilitation medium by helping artists with disabilities to create through digital technologies such as VR technology and 3D painting. Blockchain technology is widely used in the field of non-homogenized token artworks and access to metaverse exhibitions.Yohan Hwang [26] proposed a new model of creator education, aiming to perceive metaverse and non-homogenized token exhibitions through education and experience the technology, and eventually complete their own exclusive non-homogenized token artworks and access to metaverse exhibitions through online classes.Russell Belk [27] and others respond to questions such as the correlation between value and price of non-homogenized token digital art, showing that blockchain guarantees authenticity while the online purchase method allows artworks to expand their potential market beyond galleries and exhibition visitors. Computer technology is applied to online repositories, visual art histories, etc. in the field of historiography, and Elif Ayiter [28] proposes a virtual learning environment created by combining metaverse digital technologies. Natasha [29] argues that in media aesthetics, logical description cannot replace personal involvement in the expression of a work. Johanna Drucker [30] discusses the integration of the field of art history with digital technology in the context of metaverse technology, and analyzes online repositories of art history with the help of visual data mining theoretical research. can be significantly enhanced and expanded by making full use of large-scale visualization using computational techniques. xr simulation techniques are mainly applied to human-computer interaction art and other aspects. Through the production of interactive multimedia installations, Teresa Pimentel [31] argues that in the field of art, technology serves conceptual and poetics. Using technologies that incorporate sensors, multi-genre, multi-person interactions allow the viewer to clearly understand the philosophical conception of art as the individual interacts with the installation. Luca Tagliaferri [32] and others argue that digital

technologies such as augmented reality can greet patients with the beauty of art and become a prototype of digital humanism, and that digital art therapy can effectively provide humane services through immersive art spaces that alleviate symptoms, improve patients' ability to cope with pain, and reduce medical and social costs while promoting the sustainability of the healthcare system. Myounghoon Jeon [33] et al. argued that art and technology have similar origins - science and technology - and illustrated the close connection between interactive art and human-computer interaction, and pointed out the indispensability of integrating with technology in the digital age.MR head-mounted displays are mainly used in dramatic art, interactive theater, and interactive sound.MR is a further development based on augmented reality technology, unlike augmented reality as simply overlaying images on a display, but instead employs an immersive interactive interface to overlay onto physical reality and ultimately render it as a fully digital object that can be tracked in the user's environment. Eugene et al.'s study explored how artworks can better interact with audiences through a robust mixed reality interface using a fusion of physical and virtual techniques. Athanasios [34] et al. use perspective head-mounted displays and 3D ambient intelligence (AmI) systems in mixed reality with the aim of expanding traditional theatre art into a new type of interactive theatre that enables social and physical interaction between people, leading the audience to participate in a postmodern transformation of identity players. moisés and Po-Han [35] evaluate the mixed reality (MR) in architectural design review Joo Young Hong [36] et al. investigated the effect of natural sound and background traffic noise levels on the environment in a public environment when wearing a mixed reality head-mounted display, and assessed the effect of perceived loudness in The quality of the soundscape with enhanced natural sound was evaluated, demonstrating the acuity of the mixed reality head-mounted display in terms of interactive sound. Lucio Tommaso De Paolis [37] et al. used immersive virtual reality applications for museum displays of pre-classical civilizations and showed a strong correlation between high engagement and visual and audio fidelity, and that virtual reality applications were educational as well as absorbing for visitors to enhance attractiveness. Moisés and Po-Han [38] evaluated the effectiveness of mixed reality (MR) in architectural design review, demonstrating a direct linear relationship between the use of MR and the percentage of comprehension of design ideas, further demonstrating the advantages of mixed reality techniques over traditional two-dimensional methods.Alma Leopardi [39] focused on the visualization of archaeological digital replicas, focusing on the performance of XR techniques in specific application contexts. Alberto Cannavò [40] and others developed tools to generate 3D applications for interactive exhibitions, built to provide technical support for users without programming skills. It allows seamless interaction between the virtual world and the real world in space and time. The world as perceived by humans consists of space and time; mixed reality technology explores the path of integration between the space-time of the virtual world and the space-time of the real world by means of reflection, animation, retinal projection, etc. Through the expression of space, time and space-time, 3D modeling technology is mainly used in garden layout, clothing design, Internet art, archaeological digital replicas, museum interactive exhibitions, 3D animation and virtual human, Zhiyi Hu and Liangfang Liu [41] combined the 3D animation creation process with virtual reality technology and conducted a simulation study by digitizing character movements, verifying that virtual reality creation technology has good effects in 3D animation creation. lucio Tommaso De Paolis [42] et al. used immersive Li Peng [43] et al. proposed a 3-dimensional image evaluation technique based on 3D graphics and virtual reality, based on grid projection, with the aim of using 3D images Zhiyi Hu and Liangfang Liu [44] combined 3D animation creation process with virtual reality technology and conducted a simulation study by digitizing character movements, verifying the good effect of virtual reality creation technology in 3D animation creation. The above research proves that in the new media era of today's meta-universe, artworks have moved toward industrialization, art teaching has transformed to an

intelligent and immersive virtual education space, and the field of art history and theory will also establish a visual storage space in all aspects, breaking the traditional model and maximizing the service to collective needs. It is worth mentioning that the emergence of non-homogeneous token artworks based on blockchain technology maximizes the value of art through the transaction mode of copyright sales, and also better protects the value and specificity of artworks. In public art projects, blockchain technology has not been widely applied to the production and dissemination of works compared to AR wearable device technology and interactive technology, but the uniqueness of publicly certifiable artworks brought by blockchain technology can make public art projects with public participation become blockchain digital public artworks with copyright certification and online sales, bringing economic benefits to public artworks while giving them a more special meaning. At the same time, it gives the work a more special meaning. In addition, this paper will study the positive role, development direction and typical characteristics of digital advertising screens, digital interactive art and other public art projects in future city construction from the field of digital public art, and provide new path suggestions for future city construction.

Fuzzy mathematics can be explained as a mathematical theory and method for studying and dealing with fuzzy phenomena, using mathematical concepts for judgment, evaluation and decision making to provide feasible solutions for the field under study. For the application of fuzzy mathematical theory in the art industry, G1 method, hierarchical analysis, fuzzy entropy value method, intuitionistic fuzzy set and hooked fuzzy set are mostly used. Such logical frameworks are widely used in complex and uncertain multi-criteria solutions, which can optimize the solution path of art products or evaluate the creative approach and value attributes of artworks with the help of multi-criteria evaluation methods. In this paper, we classify the above five mathematical methods, the G1 method is mostly used in the assessment of the popular preference of painting colors, Sérgio M.C. Nascimento [45] et al. used the G1 method to paint colors with the degree of viewer's preference, arguing that it is the aesthetic value of painting does not depend on the physical laws of the law, with atypical natural scenes of color gamut orientation, and the study shows that the observer's preference are not limited by the degree of naturalness of the color gamut orientation. Fuzzy hierarchical analysis is used in a relatively wide range of fields, mostly in artwork evaluation, interior design, fashion design, aesthetic value modeling of artwork, feasibility assessment of multimedia creation, assessment of film and television platform treatment, and quality assessment of mural walls, etc. Jan Stoklasa [46] and others used the basic concept of hierarchical analysis to construct a multi-criteria assessment method aiming to help more artists themselves assess the artworks created. A means by which the peer review component can be incorporated into the evaluation process and combined with measurable evaluation criteria is provided.Jasmine A.L. Yeap [47] et al. used fuzzy hierarchical analysis to assess the quality of consumers' favorite electronic word-of-mouth platforms for film and television reviews, and the results demonstrated that the credibility of film and television sources is more important than the quality of information, and that the use of the analysis improves the quality of film and television Vincent [48] et al. discuss the applicability of hierarchical analysis in problem solving based on multimedia authoring, which clarifies the decision structure of multimedia authorization systems, and the study proves that hierarchical analysis provides a structured and logical means for comprehensive judgment of multimedia authoring.CH Lin and CH Twu [49] propose a fuzzy hierarchical analysis Mojtaba Ashour [50] et al. used hierarchical analysis to analyze the pathways to sustainable spatial design in interior architecture, analyzing the practical barriers to sustainable integrated area development involving interior W.A.P. Wickramasinghe et al. studied computational aesthetics based on hierarchical analysis to improve the aesthetic value of a given image by modeling the aesthetic value of artwork and combining it with image processing techniques to effectively help the public to make applicable aesthetic decisions.Lixiang Zhang [51] et al. used

Hierarchical analysis, fuzzy hierarchical analysis, and TOPSIS methods were used to evaluate the damage of the Mogao Caves wall paintings. The study showed that AHP can provide effective data reference for rockfall hazard assessment practices, protection of intangible cultural heritage, and effective suggestions for future management. The fuzzy entropy method has been applied to visual judgments of graphic arts such as animation and painting, and art market auctions, etc. Ata Assaf [52] used the entropy method to study the efficiency of art markets and found that most market evidence was inefficient by applying approximate entropy and fractal dimension. Art market inefficiencies and dysfunctional conditions are not related to quality, and collectors' ownership gains are the driving force to pay high prices for artworks.Yunyi Shang and Hon-Cheng Wong [53] focused on the generation of portrait pixel art and proposed an automatic pixelation algorithm for portrait images based on simple linear iterative clustering and fuzzy iterative self-organizing data analysis algorithms, innovating a method between Iria Santos [54] et al. used the entropy method to provide an exhaustive analysis of the use of artificial neural networks in the visual field, and proposed the use of artificial neural networks to detect elements in paintings and comics, and obtained data sets through transfer learning to solve the problem of subjective nature of artistic judgments. Hooked fuzzy sets are applied to the assessment of movement-based artistic gestures such as ballet. Sriparna Saha [55] proposed a novel strategy for e-learning ballet for art experiencers in remote areas based on hooked fuzzy theory, which helps novices in remote areas to identify and perform. Intuitionistic fuzzy sets are used in various art fields such as perceptual feedback assessment of color, designer career strategy evaluation, and feasibility analysis of fashion photography art.Pakizar Shamoi et al. proposed that based on intuitionistic fuzzy set theory in color perception people's subjectivity, sensitivity, and bridging the semantic differences between low-level color visual perceptions, through feedback mechanisms and comprehensive assessment, it was demonstrated that intuitionistic fuzzy set theory Zhang Yan-Song [45] applied intuitionistic fuzzy sets to the field of fashion photography art to study the multi-attribute decision problem and verified the feasibility of intuitionistic fuzzy sets in the aesthetics of photography. The aim was to evaluate the criteria of artistic photography, appealing to consumers and brand visual information through multi-attribute decision problems. In summary, the application of fuzzy mathematical theory is still relatively at the forefront of the art industry. In contrast, unlike other analytical methods, AHP can decompose and optimize complex decision problems, and its application in the art field encompasses design, film and television, public art, and aesthetics, helping the research subjects to make solution selection as well as aesthetic decisions.

The aforementioned studies have carried out a relatively rich discussion in three aspects: public art research, the impact of metaverse technology on public art, and the application of fuzzy mathematical theory in the art field. The research methods and experiences of the experts can provide corresponding support for the theoretical formulation, qualitative analysis, structural design, and quantitative research of this paper. However, the differences between this paper and existing research are mainly in three areas:

(1) While existing studies in the field of public art have analyzed boundary positioning and value contributions in the context of art cases, this paper focuses on the development direction faced by public art in the macroscopic new media era, linking technological means to public needs and allowing art to better serve the public. This paper proposes an implementation path to solve the current temporary and high-cost problems of public art.

(2) In the study of digital public art, this paper uses a functional demand analysis framework to build a field structure, uses interdisciplinary fuzzy mathematical theory to conduct quantitative quality analysis, and designs an innovative art index system to participate in the future construction of art, thus combining quantitative and qualitative aspects.

(3) Existing studies have concluded that public art in digital public space has a stronger public nature, but the art content production and display space will also be limited to a certain extent by Internet enterprises and big data capital. This paper uses hierarchical analysis to divide digital public art by target criteria, uses a standard system to regulate the cultural form of digital public art, ensures the enrichment of art means and art content while improving This paper uses hierarchical analysis to classify digital public art by target criteria, using a standard system to regulate the cultural form of digital public art, ensure the enrichment of artistic means and artistic content while improving artistic quality, and promote the development of public art in the direction of sustainable space.

3 ANALYTIC HIERARCHY PROCESS

Analytic Hierarchy Process (AHP) is a method to determine the weight of factors affecting the goal, which was proposed by Saaty, an American operations researcher, in the 1970s. It decomposes the elements related to decision making into objective level, criterion level and solution level, and analyzes the decision making method on this basis. The advantage is that it can make a more scientific and systematic evaluation of the information that contains information that presents ambiguity. The steps of AHP method are as follows.

Step 1: List the index system to be sought for the weight coefficient and set there are n indicators, in fact, in this study the index system is shown in Table 1, there are 27 indicators to be sought.

Step 2: The indicators are compared according to their relative importance, and the results are written into a n-order judgment matrix. The meanings of the specific scales in the judgment matrix are shown in Table 1 below.

Table 1 Judgment matrix scale and meaning

Scale a_{ij}	Meaning (comparison of the relative importance of two indicators)
1	Factor i is equally important as compared to factor j
3	Factor i is slightly more important than factor j
5	Factor i is generally important compared to factor j
7	Factor i is very important compared to factor j
9	Factor i is absolutely important compared to factor j
2,4,6,8	Intermediate value of two adjacent degrees

In this matrix, a_{ij} represent the relative importance rating according to index i and index j.

$$a_{ij} = 1 \Big/ a_{ji} \tag{1}$$

The diagonal elements of the matrix are all 1, and the following judgment matrix can be constructed.

$$A = (a_{ij})_{n\times n} = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} \tag{2}$$

Step 3: Calculation of weights

The row vectors of the judgment matrix are geometrically averaged and the normalized row vectors are the weight vectors. We can set the maximum eigen A of $\lambda_{\max}$, whose corresponding eigenvector is W ,then.

$$AW = \lambda_{\max} W \tag{3}$$

The calculation process is as follows.

$$M_i = \Pi_{j=1}^{n} a_{ij} \, (i = 1, 2, \cdots, \ n) \tag{4}$$

$$W_i = \sqrt[n]{M_i} \tag{5}$$

Normalize the vector $\left(W_1, W_2, \cdots, Wn\right)^{\mathrm{T}}$ and the vector $W = \left(w_1, w_2, \cdots, w_n\right)^{\mathrm{T}}$ is the indicator weight

$$w_i = \frac{W_i}{\sum_{i=1}^{n} W_i} \tag{6}$$

Calculate the maximum characteristic roots of the judgment matrix.

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(AW)_i}{w_i} \tag{7}$$

Step 4: Test of consistency of judgment matrix

It is indispensable to test the consistency of the judgment matrix, and the consistency indicators are.

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{8}$$

In order to judge whether the judgment matrices of different orders have satisfactory consistency, it is also necessary to introduce the average random consistency index values of the judgment matrices, and the consistency index values of the consistency indexes of the judgment matrices of orders 1-14 are shown in Table 3. The consistency ratios of the judgment matrix are

$$CR = \frac{CI}{RI} \tag{9}$$

When the order of the judgment matrix is greater than 2 and $CR < 0.10$, the judgment matrix can be considered to have satisfactory consistency; otherwise, the judgment matrix will need to be readjusted to make it have satisfactory consistency.

Table 2 Average random consistency index RI value

n	1	2	3	4	5	6	7
RI	0	0	0.58	0.89	1.12	1.26	1.36
n	8	9	10	11	12	13	14
RI	1.41	1.46	1.49	1.52	1.54	1.56	1.58

EAT (Experiments in Art and Technology) has built a bridge for interdisciplinary cooperation between artists and technicians, and the combination of art and meta-universe technology is an inevitable trend, for example, blockchain technology has built an online market for NFT artworks; the experience and participation of interactive technology has provided a new means of public participation and operation for digital public art. The experiential and participatory nature of interactive technology provides new means of public participation and operation for digital public art. This paper applies hierarchical analysis to the field of public art, with the aim of exploring the path of technological reform for digital public art. This paper examines the development path of digital technology in public art based on a multiplicative matrix of propensity strengths and weaknesses, and obtains the importance of each technological factor through pairwise comparisons in order to address the issue of evaluating art for technological purposes.

RESEARCH PROCESS DESIGN BASED ON IMPROVED HIERARCHICAL ANALYSIS

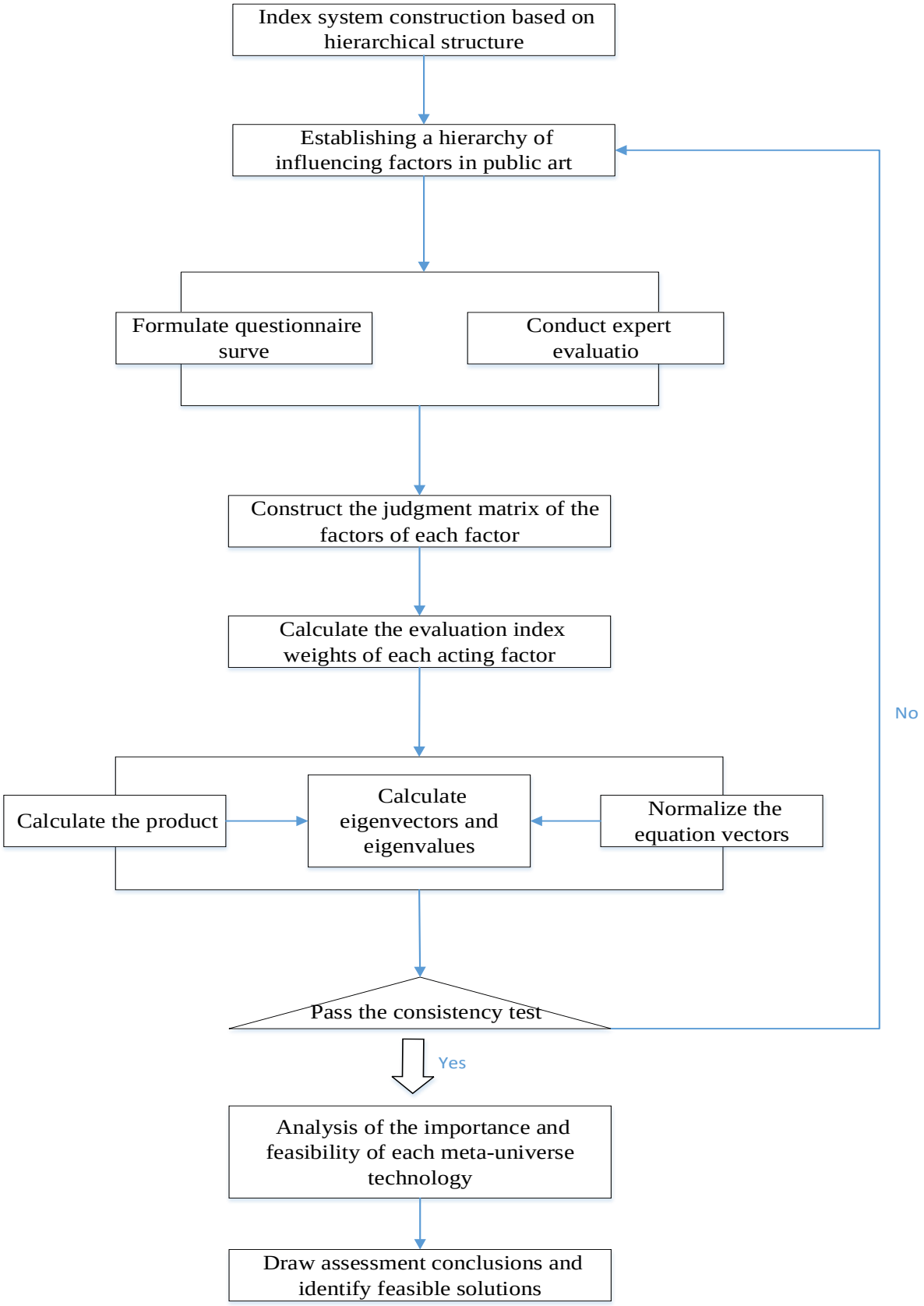

Figure 4 Schematic diagram of the research process of the improved hierarchical analysis method

4 ARCHITECTURE DESIGN OF PUBLIC ART SPACE FOR FUTURE METAVERSE: BASED ON MR TECHNOLOGY PERSPECTIVE

4.1 Architecture design diagram

In the face of the future meta-universe of public art space architecture design, as shown in Figure 5 this paper will analyze from three aspects: data layer, support layer, and application layer. The original data is called out from the SQL database using blockchain's hash algorithm technology and stored in the SQL distributed database for studying public art. The database consists of four aspects: art creator behavior data, public behavior data, public environment behavior data, and art dissemination behavior behavioral data. On this basis, as the underlying data support layer, the middle application support layer involves the development and application of network environment technology, resource production technology, data processing, encryption, and interaction technology; among them, network environment technology includes 5G, 6G and other technologies, resource production technology includes artificial intelligence and other technologies, data processing includes Internet of Things, cloud computing and other technologies, encryption technology includes blockchain and other technologies, and interaction technology includes holographic technology. The interaction technology includes hologram, sensor and other technologies. In addition, this paper builds a top application layer based on the virtual interaction, intelligent production and intelligent creation features of metaverse technology to briefly analyze the value and role of metaverse technology for future digital public art.

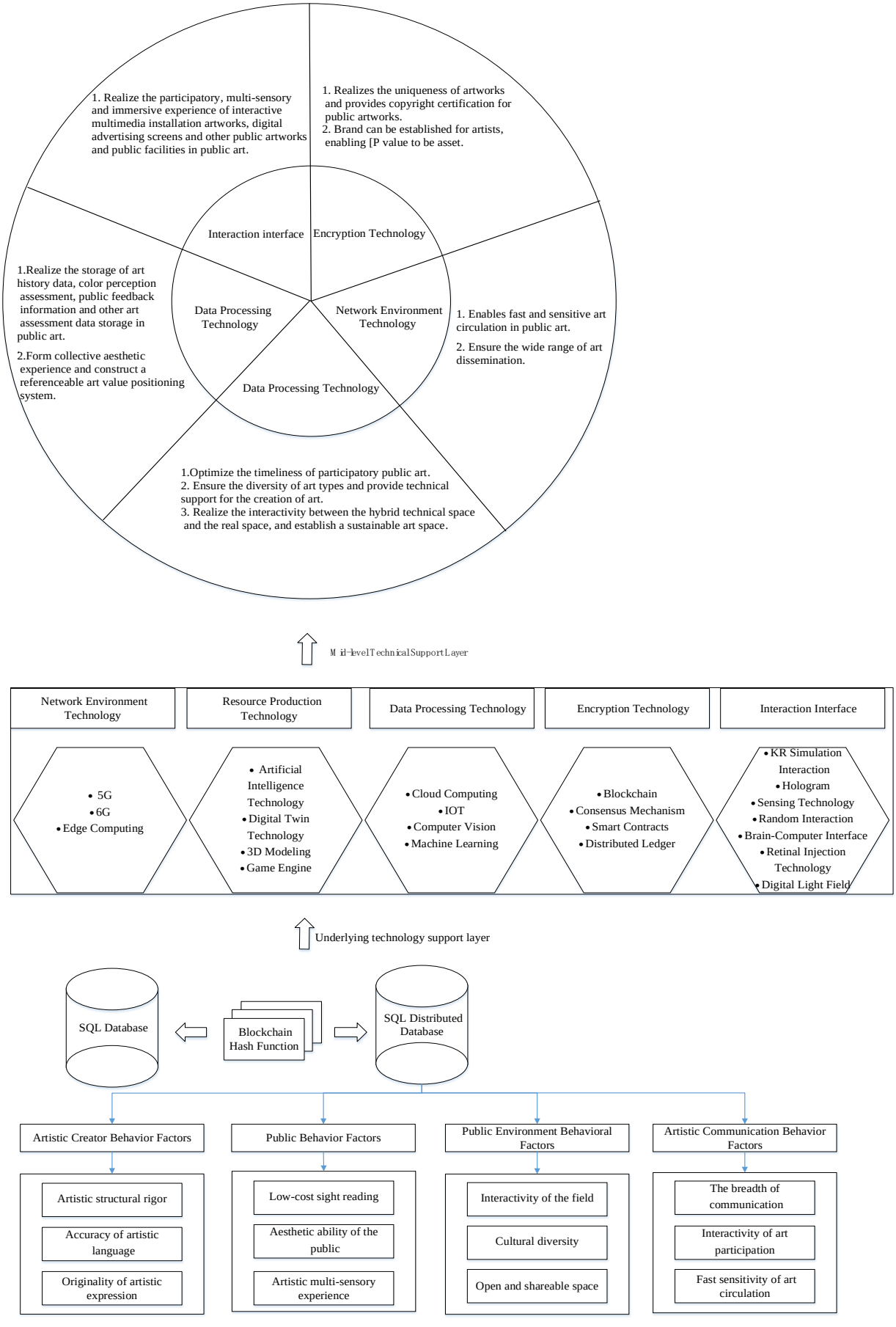

Figure 5 Schematic design of metaverse field architecture

4.2 Difference Analysis

Based on the data analysis of existing theoretical studies, this paper summarizes the following three differences between the public art field structure built by metaverse technology and traditional public art research.

(1) In terms of art dissemination and circulation, metaverse encryption technology creates exclusive content with scarcity for artworks in the public art field, which can build a long-lasting linking point for artworks, the public, and the urban environment, allowing the efficiency of the market supply and demand matching mechanism for spiritual consumption needs to be improved. In addition, along with the importance of art copyright, the use of blockchain technology to ensure the security and circulation of artists' copyright influences the change of the future direction of art collections.

(2) In terms of the public nature of public art, the interactive technology of the metaverse provides a new way to interact with the public for traditional public art. The openness and collaboration brought by interactive technology can fully mobilize the public's multi-sensory system, break the audience's inertial thinking, strengthen the audience's emotional feelings toward the work during the interaction process, visualize the concept while enriching the interactive experience and a strong sense of dynamics to better The public's creative potential is tapped, and the process of public art is realized from public acceptance to information simplification to information source reception and information exchange.

(3) In terms of storage and display of artworks, the necessary condition for traditional public art is to be in a public shared space and to have a relationship with the real urban environment, while in the mixed reality space constructed by the metaverse, mixed reality technology ensures public attributes without occupying shared space. The application of virtual technology brings new cultural forms and art evaluation standards, reduces the cost of creation and ensures the quick sensitivity of art circulation.

5 CASE STUDY: EVIDENCE FROM PUBLIC ART RESEARCH IN CHINA

5.1 Indicator system construction based on hierarchical analysis

(1) Principles of index system construction

In order to ensure the standardization and scientific of the index system, the construction of the index system includes the principles of wholeness, scientific rationality, typicality, and data availability. The specific content of each principle is explained as follows.

Integrity: Each indicator should have a certain logical connection and reflect the main characteristics and status of public art development in the context of the meta-universe from different perspectives, and each indicator should be independent of each other and interconnected, forming an organic unity together. The entire index system is built from three dimensions: objectives, guidelines and programs, and is hierarchical and top-down, from macro to micro, forming an inseparable evaluation system, which is the first and second science.

Scientific rationality: The design and evaluation of each index system must be based on the principle of scientificity, which can objectively and truly reflect the characteristics and conditions of public art evaluation in the context of the meta-universe, and can objectively reflect the true relationship between each index. At the same time, each evaluation index has typical representativeness, not too much and too detailed, making the indicators too cumbersome and overlapping with each other, and not too few and too sectioned, avoiding errors and untruthfulness in the omission of indicator information.

Typicality: accurately reflect the specific region, in the case of reducing the number of indicators, to facilitate data calculation and improve the reliability of the results. In addition, the setting of the indicator system, the weight in the allocation of each indicator and the division in the evaluation criteria should be compatible with the natural, social and economic conditions.

Data availability: The construction of the indicator system is for policy making and scientific management, the calculation of the indicators must be consistent and unified, the indicators should be as simple and clear as possible, microscopic, easy to collect, and the indicators should have a strong realistic operability and comparability. And the selection of indicators should also consider the possibility of quantitative processing, so as to facilitate mathematical calculation and analysis.

As can be seen, the above principles comprehensively consider the environmental, economic, social system and other influencing factors, avoid the information omission of indicators, and achieve the optimization of the evaluation process through the orderliness of the interrelationship among indicators.

(2) Methodology of index system construction

In this study, we refer to "China local data openness report-indicator system and provincial benchmark" by Fudan University Digital and Mobile Governance Laboratory [56], "Constructing slacks-based composite indicator of sustainable energy development for China: A meta-frontier nonparametric approach" by Qunwei Wang [57], and "An overview of sustainability assessment methodologies" by Rajesh Kumar Singh [58]. development for China: A meta-frontier nonparametric approach" by Qunwei Wang [57], "An overview of sustainability assessment methodologies" by Rajesh Kumar Singh [58], and "An overview of sustainability assessment methodologies" by Cornelissen [59]. and Cornelissen's [59] "Assessment of the contribution of sustainability indicators to sustainable development: a novel approach using fuzzy set theory The three-level indicator system is shown in Table 3.

(3) Content of the indicator system construction

Based on the top-level data analysis layer formed in the schematic design of the metaverse domain in Figure 5 and the above-mentioned principles and methods for constructing the indicator system, the following table 3 shows the contents of the indicator system for metaverse technology in public art.

Table 3 Illustrative table of the meaning of metaverse technology in public art practice indicators

Tier 1 indicators (target level)	Secondary indicators (guideline level)	Tertiary indicators (program level)
Metaverse Technology for Public Art Quality Assessment A_1	Artistic creation behavior factors B_{11}	Artistic structural rigor C_{111}
		Artistic language accuracy C_{112}
		Originality of artistic expression C_{113}
	Public behavior factors B_{12}	Low cost sight reading C_{121}
		Popular aesthetic ability C_{122}
		Artistic multi-sensory experience C_{123}
	Public environmental behavior factors B_{13}	Field interactivity C_{131}
		Cultural Diversity C_{132}
		Open and shareable space C_{133}
	Artistic communication behavior factors B_{14}	Wideness of dissemination C_{141}
		Interactivity of art participation C_{142}
		Art Circulation Fast Sensitivity C_{143}

5.2 Practice path evaluation and quantitative analysis based on improved hierarchical analysis method

(1) Expert identity information weight calculation method

The original evaluation data of the hierarchical analysis method needs to be evaluated by human experts, and the credibility of the experts is carried out specifically from the experts' working years, education, professional experience and titles.

Table 4 Expert's identity information weighting scale

Factors	Weight r_i	Level	Score s
Working years	2	38years	0.9
		36 years	0.8
		22 years	0.7
		7 years	0.4
		0 years	0.3
Education	3	PH.D	0.9
		PH.D	0.9
		MASTER	0.8
		MASTER	0.8
		MASTER	0.8
Major	1	New Media Art	0.9
		Space Performance Design	0.8
		Sculpture	0.7
		Oil painting	0.6
		Contemporary Art Theory	0.5
Experience	2	Extremely strong research experience in digital public art	0.9
		Strong research experience in digital public art	0.8
		Strong research experience in digital public art	0.7
		Strong research experience in digital public art	0.7
		Less research experience in digital public art	0.5
Title	2	Professor	0.9
		Professor	0.9
		Lecture	0.8
		Lecture	0.8
		Artists	0.7

As shown in the above table, to ensure the rigor of the data, the identity information of the five experts was scored and weighted according to their length of service, education, specialty, experience, and title. For the length of service, the experts were rated according to the difference of their length of service, and the higher the score, the longer the period of service. In terms of education, the scores were ranked from highest to lowest from doctoral to bachelor's degree; in terms of specialization, the scores were ranked according to the degree of relevance to the field of digital public art, for example, directly related specializations such as new media art had the highest scores; in terms of experience, the scores were based on the experts' participation in the exhibition specifications, technical level and academic achievements; in terms of title, the scores were ranked according to the positions of the five experts, from professor to lecturer. In terms of titles, the five experts are rated from professor to lecturer, so that the credibility of the five experts is finally obtained and the rationality of the rating is ensured.

The credibility of the experts can be calculated according to the expert weight rating table4, and the specific formula is as follows:

$$\lambda_{\max} = \frac{1}{\mathrm{n}} \sum_{i=1}^{n} \frac{(\mathrm{AW})_{\mathrm{i}}}{nW_1} \tag{9}$$

According to the expert credibility formula, the weights of the experts can be further calculated as follows:

$$W_i = \frac{\bar{W}_i}{\sum_{i=1}^{m} \bar{W}_i} \tag{10}$$

(2) Results of calculating the weights of experts' identity information

We found five experts from the University of Edinburgh, Musashino Art University, and Tokyo University of the Arts to quantitatively evaluate the indicators in this study on the issue of assessing the quality of public art in the context of metaverse, and the identity information of the experts is shown in Table 5 below.

Table 5 Expert identity information table

No.	Working years	Education	Major	Experience	Title
1	38years	PH.D	Sculpture	Extremely strong research experience in public art	Professor
2	36years	PH.D	Oil painting	Strong research experience in public art	Professor
3	22years	MASTER	Contemporary Art Theory	Less research experience in digital art	Lecture
4	7years	MASTER	Space Performance Design	Strong research experience in digital art	Lecture
5	0	MASTER	New Media Art	Strong research experience in digital art	Artist

Based on the credibility calculation formula and weight calculation formula of the experts, we obtained the credibility and identity information weight calculation results of five experts, as shown in Table 6 below.

Table 6 Credibility values and weight values of expert evaluations

No	Reliability value	Weighting value
1	0.88	0.24
2	0.81	0.22
3	0.69	0.19
4	0.62	0.17
5	0.63	0.17

(3) Calculation of the weight values of the improved hierarchical analysis method

In step 1, a hierarchical structure model of public art influencing factors was established based on the scores of five experts in the questionnaire, and the raw data of the scores of five experts in the hierarchical analysis method are shown in Tables 7a to 7e below.

Table 7a Raw data table for expert 1's hierarchical analysis scoring

	C_{111}	C_{112}	C_{113}	C_{121}	C_{122}	C_{123}	C_{131}	C_{132}	C_{133}	C_{141}	C_{142}	C_{143}
C_{111}	1	3/2	9/5	9/4	3/1	9/8	9/7	9/2	3/2	9/5	9/7	3
C_{112}	2/3	1	6/5	6/4	6/1	3/4	6/7	3	3	6/5	6/7	2
C_{113}	5/9	5/6	1	5/4	5/3	5/8	5/7	5/2	5/6	1	5/7	5/3
C_{121}	4/9	2/3	4/5	1	4/3	1/2	4/7	2	4/6	4/5	4/7	4/3
C_{122}	1/3	1/2	3/5	3/4	1	3/8	3/7	3/2	1/2	3/5	3/7	1
C_{123}	8/9	4/3	8/5	2	8/3	1	8/7	4	4/3	8/5	8/7	8/3
C_{131}	7/9	7/6	7/5	7/4	7/3	7/8	1	7/2	7/6	7/5	1	7/3
C_{132}	2/9	1/3	2/5	1/2	2/3	1/4	2/7	1	1/3	2/5	2/7	2/3
C_{133}	2/3	1	6/5	3/2	2	3/4	6/7	2	1	3/5	3/7	1
C_{141}	5/9	5/6	1	5/4	5/3	5/4	5/7	5/2	5/6	1.	5/7	5/3
C_{142}	7/9	7/6	7/5	7/4	7/3	7/4	1	7/2	7/6	7/5	1.	7/3
C_{143}	1/3	3/6	3/5	3/4	1	3/4	3/7	3/2	1/2	3/5	3/7	1.

Table 7b Raw data table for expert 2's hierarchical analysis scoring

	C_{111}	C_{112}	C_{113}	C_{121}	C_{122}	C_{123}	C_{131}	C_{132}	C_{133}	C_{141}	C_{142}	C_{143}
C_{111}	1	1	8/5	8/4	8/7	4/3	4/3	2/1	8/9	8/7	8/3	8
C_{112}	1	1	8/5	8/4	8/7	4/3	4/3	4/1	8/9	8/7	8/3	8
C_{113}	5/8	5/8	1	5/4	5/7	5/6	5/6	5/2	5/9	5/7	5/3	5
C_{121}	1/2	4/8	4/5	1	4/7	2/3	2/3	2	4/9	4/7	4/3	4
C_{122}	7/8	7/8	7/5	7/4	1	7/6	7/6	7/2	7/9	7/7	7/3	7
C_{123}	3/4	3/4	6/5	3/2	6/7	1	1	3	2/3	6/7	2	6
C_{131}	3/4	3/5	6/5	3/2	6/7	1	1	3	2/3	6/7	2	6
C_{132}	1/4	1/4	2/5	1/2	2/7	2/6	1/3	1	2/9	2/7	2/3	2
C_{133}	9/8	9/8	9/5	9/4	9/7	9/6	9/6	9/2	1	9/7	3	9
C_{141}	7/8	7/8	7/5	7/4	1	7/6	7/6	7/2	7/9	1	7/3	7
C_{142}	3/8	3/8	3/5	3/4	3/7	1/2	1/2	3/2	1/3	3/7	1	3
C_{143}	1/8	1/8	1/5	1/4	1/7	1/6	1/6	1/2	1/9	1/7	1/3	1

Table 7c Raw data table for expert 3's hierarchical analysis scoring

	C_{111}	C_{112}	C_{113}	C_{121}	C_{122}	C_{123}	C_{131}	C_{132}	C_{133}	C_{141}	C_{142}	C_{143}
C_{111}	1	1/3	3/7	3/5	3/6	3/4	3/8	3/2	3/5	3	3/4	3/1
C_{112}	3	1	9/7	9/5	9/6	9/4	9/8	9/2	9/5	9	9/4	9
C_{113}	7/3	7/9	1	7/5	7/6	7/4	7/8	7/2	7/5	7	7/4	7
C_{121}	5/3	5/9	5/7	1	5/6	5/4	5/8	5/2	1	5	5/4	5
C_{122}	2	6/9	6/7	6/5	1	3/2	6/8	3	6/	6	3/2	6
C_{123}	4/3	4/9	4/7	4/5	2/3	1	1/2	2	4/5	4	1	4
C_{131}	8/3	8/9	8/7	8/5	4/3	2	1	2	8/5	8	2	8
C_{132}	2/3	2/9	2/7	2/5	1/3	1/2	1/4	1	2/5	2	1/2	2
C_{133}	5/3	5/9	5/7	1	5/6	5/4	5/8	5/2	1	5	5/4	5
C_{141}	1/3	1/9	1/7	1/5	1/6	1/4	1/8	1/2	1/5	1	1/4	1
C_{142}	4/3	4/9	4/7	4/5	2/3	1	1/2	2	4/5	4	1	4
C_{143}	1/3	1/9	1/7	1/5	1/6	1/4	1/8	1/2	1/5	1	1/4	1

Table 7d Raw data table for expert 4's hierarchical analysis scoring

	C_{111}	C_{112}	C_{113}	C_{121}	C_{122}	C_{123}	C_{131}	C_{132}	C_{133}	C_{141}	C_{142}	C_{143}
C_{111}	1	6/7	2/3	3/2	2	6/5	6/5	6	3/4	3	2	1
C_{112}	7/6	1	7/9	7/4	7/3	7/5	7/5	7	7/8	7/2	7/3	7/6
C_{113}	9/6	9/7	1	9/4	3	9/5	9/5	9	9/8	9/2	3	9/6
C_{121}	4/6	4/7	4/9	1	4/3	4/5	4/5	4	1/2	2	4/3	2/3
C_{122}	3/6	3/7	1/3	3/4	1	3/5	3/5	3	3/8	3/2	1	1/2
C_{123}	5/6	5/7	5/9	5/4	5/3	1	1	5	5/8	5/2	5/3	5/6
C_{131}	5/6	5/7	5/9	5/4	5/3	1	1	5	5/8	5/2	5/3	5/6
C_{132}	1/6	1/7	1/9	1/4	1/3	1/5	1/5	1	1/8	1/2	1/3	1/6
C_{133}	8/6	8/7	8/9	2	8/3	8/5	8/5	8	1	4	8/3	8/6
C_{141}	2/6	2/7	2/9	1/2	2/3	2/5	2/5	2	1/4	1	2/3	2/6
C_{142}	3/6	3/7	1/3	3/4	1	3/5	3/5	3	3/8	3/2	1	3/6
C_{143}	1	6/7	2/3	3/2	2	6/5	6/5	6	3/4	2	2	1

Table 7e Raw data table for expert 5's hierarchical analysis scoring

	C_{111}	C_{112}	C_{113}	C_{121}	C_{122}	C_{123}	C_{131}	C_{132}	C_{133}	C_{141}	C_{142}	C_{143}
C_{111}	1	1	/6	/9	/2	/3	/7	/2	/8	5	/6	/4
C_{112}	1	1	/6	/9	/2	/3	/7	/2	/8	5	/6	/4
C_{113}	6/5	6/5	1	2/3	3	2	6/7	3	3/4	6	1	3/2
C_{121}	9/5	9/5	3/2	1	9/2	3	9/7	9/2	9/8	9	3/2	9/4
C_{122}	2/5	2/5	1/3	2/9	1	2/3	2/7	1	1/4	2	1/3	1/2
C_{123}	3/5	3/5	1/2	1/3	3/2	1	3/7	3/2	3/8	3	1/2	3/4
C_{131}	7/5	7/5	7/6	7/9	7/2	7/3	1	7/2	7/8	7	7/6	7/4
C_{132}	2/5	2/5	2/6	2/9	1	2/3	2/7	1	1/4	2	1/3	1/2
C_{133}	8/5	8/5	4/3	8/9	8/2	8/3	8/7	4	1	8	4/3	2
C_{141}	1/5	1/5	1/6	1/9	1/2	1/3	1/7	1/2	1/8	1	1/6	1/4
C_{142}	6/5	6/5	1	2/3	3	2	6/7	3	3/4	6	1	3/2
C_{143}	4/5	4/5	2/3	4/9	2	4/3	4/7	2	1/2	4	2/3	1

In step 2, the product of the elements of each row of the judgment matrix is calculated according to equation (5); the ranking weight vector W is obtained by applying the square root vector normalization of equation (6); and the consistency test is required. The weights obtained for each index are shown in Table 8a to Table 8e below.

Table 8a Results of the hierarchical analysis of expert 1

	W	AW
C_{111}	1.810	0.138
C_{112}	1.207	0.092
C_{113}	1.005	0.077
C_{121}	0.804	0.062
C_{122}	0.603	0.046
C_{123}	1.609	0.123
C_{131}	1.408	0.108
C_{132}	0.402	0.031
C_{133}	1.207	0.092
C_{141}	1.005	0.077
C_{142}	1.408	0.108
C_{143}	0.603	1.046

Table 8b Results of the hierarchical analysis of expert 2

	W	AW
C_{111}	1.695	0.121
C_{112}	1.695	0.121
C_{113}	1.060	0.076
C_{121}	0.848	0.061
C_{122}	1.175	0.084
C_{123}	1.271	0.091
C_{131}	1.271	0.091
C_{132}	0.444	0.032
C_{133}	1.998	0.144
C_{141}	1.554	0.112
C_{142}	0.666	0.048
C_{143}	0.222	0.016

Table 8c Results of the hierarchical analysis of expert 3

	W	AW
C_{111}	0.804	0.055
C_{112}	2.413	0.164
C_{113}	1.877	0.127
C_{121}	1.340	0.091
C_{122}	1.608	0.109
C_{123}	1.072	0.073
C_{131}	2.145	0.145
C_{132}	0.536	0.036
C_{133}	1.340	0.091
C_{141}	0.268	0.018
C_{142}	1.072	0.073
C_{143}	0.268	0.018

Table 8d Results of the hierarchical analysis of expert 4

	W	AW
C_{111}	1.419	0.101
C_{112}	1.656	0.119
C_{113}	2.129	0.153
C_{121}	0.946	0.068
C_{122}	0.710	0.051
C_{123}	1.183	0.085
C_{131}	1.183	0.085
C_{132}	0.237	0.017
C_{133}	1.892	0.136
C_{141}	0.473	0.034
C_{142}	0.710	0.051
C_{143}	1.419	0.102

Table 8e Results of the hierarchical analysis of expert 5

	W	AW
C_{111}	1.223	0.086
C_{112}	1.223	0.086
C_{113}	1.468	0.103
C_{121}	2.202	0.155
C_{122}	0.489	0.034
C_{123}	0.734	0.052
C_{131}	1.712	0.121
C_{132}	0.489	0.034
C_{133}	1.957	0.138
C_{141}	0.245	0.017
C_{142}	1.468	0.103
C_{143}	0.979	0.069

In step 3, the 12 tertiary indicators were calculated by formula (4) to construct the 12th order judgment matrix for the square root method of the AHP hierarchy study, in addition to which the random consistency RI value of the 12th order matrix was obtained as (1.540) in combination with table (2), followed by the CI value calculated using the maximum characteristic root through formula (4) and a one-time test. Consistency tests were used for each assessment data as shown in Table 8a to Table 9e below.

Table 9a Table of random consistency tests for expert 1

Maximum characteristic root	CI	RI	CR	Consistency test results
11.887	0.010	1.540	0.010	Pass

Table 9b Table of random consistency tests for Expert 2

Maximum characteristic root	CI	RI	CR	Consistency test results
12.102	0.006	1.540	0.004	Pass

Table 9c Table of random consistency tests for expert 3

Maximum characteristic root	CI	RI	CR	Consistency test results
12.000	0.000	1.540	0.000	Pass

Table 9d Table of random consistency tests for expert 4

Maximum characteristic root	CI	RI	CR	Consistency test results
11.974	0.013	1.540	0.002	Pass

Table 9e Table of random consistency tests for expert 5

Maximum characteristic root	CI	RI	CR	Consistency test results
10.967	0.005	1.540	0.003	Pass

Based on the analysis of the experts' scores in Table 8, the assessment results are that the weights of the 12 tertiary indicators of Expert 1 are 13.85%, 9.23%, 7.69%, 6.15%, 4.62%, 12.31%, 10.77%, 3.08%, 9.23%, 7.68%, 10.77%, 4.62%; the weights of the indicators of Expert 2 are 12.20%, 12.20%, 7.62%, 6.10%, 8.45%, 9.15%, 9.15%, 3.19%, 14.38%, 11.18%, 4.79%, 1.60%; the weights of the indicators of Expert 2 are 12.20% , 12.20%, 7.62%, 6.10%, 8.45%, 9.15%, 9.15%, 3.19%, 14.38%, 11.18%, 4.79%, 1.60%; the weights of the 12 tertiary indicators of expert 3 were 5.45%, 16.36%, 12.73%, 9.09%, 10.91%, 7.27 14.55%, 3.64%, 9.09%, 1.82%, 7.27%, 1.82%; the weights of the 12 tertiary indicators of expert 4 were 10.17%, 11.86%, 15.25%, 6.78%, 5.08%, 8.47%, 8.47%, 1.69%, 13.56%, 3.39%, 5.08%, 10.17% The weights of the 12 tertiary indicators for expert 5 were 8.62%, 8.62%, 10.34%, 15.52%, 3.45%, 5.17%, 12.07%, 3.45%, 13.80%, 1.72%, 10.35%, and 6.90%, respectively. Finally, each evaluation index of the above five experts was added up and the average value was calculated, as shown in the bar chart in Figure 6, to finally arrive at the total weight percentage of influencing factors of digital public art.

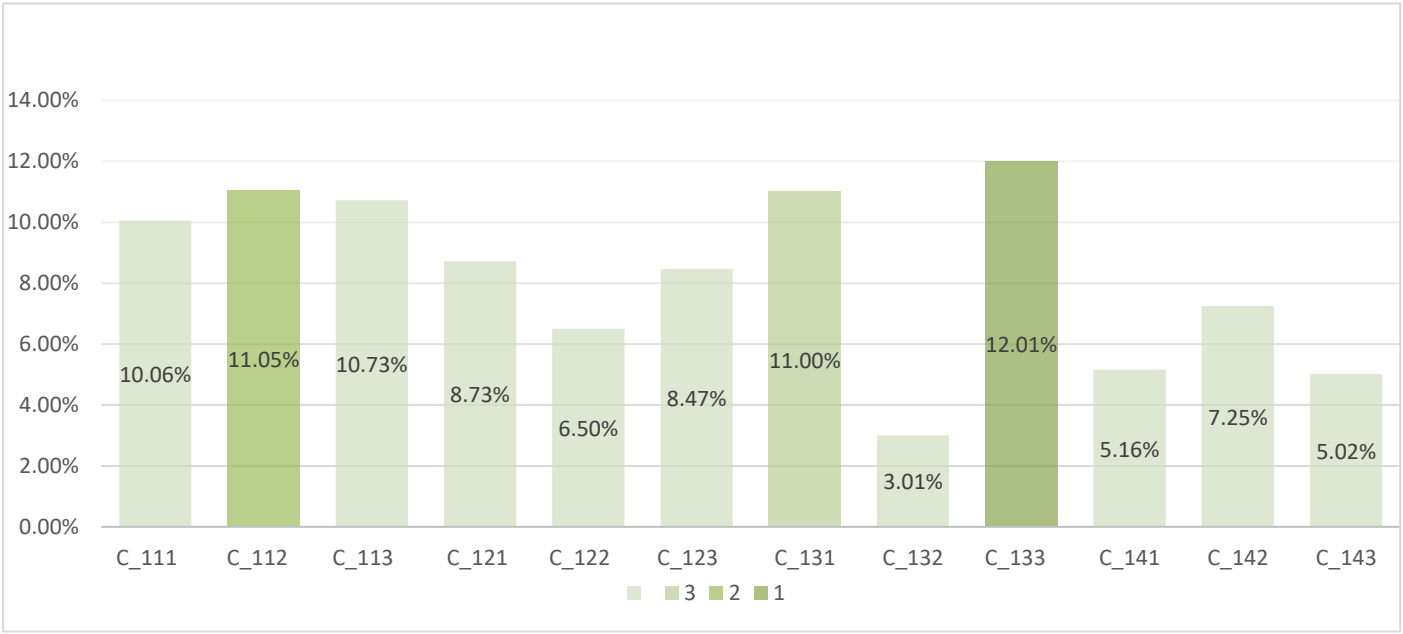

Figure 6 Histogram of the total weight of influencing factors of digital public art

5.3. Discussion of results and methodological analysis

The weighting results of the 12 indicators were calculated according to section 5.2. What can be seen is that in digital public art, the weighting results of each influencing factor are 12.01% for open shared space, 11.054% for accuracy of artistic language, 11.002% for interactivity of the field, 10.726% for originality of artistic expression, 10.058% for rigor of artistic structure, 8.728% for low-cost visual reading, 8.474% for multi-sensory experience, 7.25% for interactivity of artistic participation, and 6.502% for aesthetic ability of the public. 8.474%, interactivity of art participation 7.25%, aesthetic ability of the public 6.502%, breadth of dissemination 5.16%, quick sensitivity of art circulation 5.022%, and cultural diversity 3.01%. On the whole, the use of hierarchical analysis in the evaluation of the impact factors of art public art can propose clear and specific suggestions for that improvement while there are still some problems. On the one hand, in the process of expert evaluation, when there are more than nine image factors, the workload of the scale is obviously too large, which tends to cause confusion in judgment. On the other hand, the hierarchical analysis method has a strong subjectivity compared with the entropy value method fuzzy comprehensive evaluation method, and the rationality of each index is not considered enough. In various future studies, we will

continue to improve in the evaluation method and combine the hierarchical analysis method with the entropy value method, TOPSIS, GI and other objective analysis methods to improve the reliability of the scoring results and the scientific of the evaluated problem.

6 STRATEGIES AND SUGGESTIONS FOR THE PRACTICE OF MIXED REALITY TECHNOLOGY IN PUBLIC ART IN THE CONTEXT OF METAVERSE

According to the weighting of the 12 indicators in section 5.3, the top three indicators are open shared space, accuracy of art language, and interactivity of the field, and the following strategies and suggestions are proposed for the top three indicators.

① For the improvement path of shared space, consumerism and experience economy can give rise to a privatized virtual space different from the traditional public space under the condition of 5G Internet. For one, technologies such as digital twins can digitally replicate fixed art spaces such as museums and galleries in reality and move them to any space that can be communicated remotely. For two, technologies such as AR glasses can ensure that artists complete art projects in arbitrary natural spaces, allowing artistic creativity to be combined with user production, and public art works to be linked with ecological environments and regional industries, thus transcending linear narrative approaches and escaping from the single logic of reality.

② To address the problem of accuracy in art language expression, for one, artificial intelligence technology can effectively ensure the integrity of the communication structure in terms of art concepts. Second, the use of cloud computing and other data processing technologies can further store and count audience feedback and evaluation data from existing artworks, and optimize artistic expressions through collective aesthetic experiences so as to improve the quality of the works as much as possible.

③ In response to the problem of interactivity between public art and the field in which it is presented, technologies for interactive interfaces are now being used in urban environments such as digital advertising screens and multimedia installations in public spaces. For one, encryption technologies such as smart contracts can help artists establish independent artistic identities and achieve differentiation between artistic phenomena and life phenomena on the basis of ensuring the sameness of art and life. Second, future technologies such as brain-computer interface, hologram, and XR simulation interaction can interact public art works with the natural environment and different public fields, externalize the participant's mind through the participatory experience of color, sound, and light, and through the interaction between works and scenes, experience the process of expression, perception, and acceptance in the experience of artistic communication and scene information to achieve the purpose of psychological healing. The work and the scenes interact with each other to experience the process of expression, awareness, and acceptance through artistic communication and scenic information to achieve psychological healing.

7. WHY ARE WE CONDUCTING THIS RESEARCH?

The development of art cannot be separated from the progress of technology. In the era of information technology, the way of organizing clusters and the form of organizing cluster space are transforming, and the flexible and mobile qualities of networking and decentralization in virtual space have blurred the boundary between subjectivity and objectivity. The final stage of the future metaverse is to build an equal world without racial discrimination and class hierarchy, with multiple "selves" as the center. In this regard, metaverse technology will become an important medium for innovative thinking and will also create a new ecological environment for the transformation of new media art such as photography, film and games.

As an important direction for future development, we can introduce the concept of metaverse in public art to enrich our own language while achieving infinite extension in space and time, thus generating new fields, roles, and aesthetic perspectives under the integration of art and technology. In addition, the development and construction of metaverse cannot be separated from art. As a field and platform in a public network that exists in the form of a virtual world, the visual presentation of metaverse is not only its most significant feature, but also its quality is a key factor that affects metaverse. Therefore, we conducted a metaverse-based public art industry architecture design and quality assessment method, innovatively constructed a public art quality assessment index system applicable to metaverse technology, and provided some solutions and countermeasure suggestions for the future public art quality improvement in the context of metaverse.

8. CONCLUSION

This study explores the issue of improving the quality of public art for the future metaverse, uses the hierarchical analysis method to calculate the index weights, constructs a system of 12 3D indexes, obtains the index weight results through quantitative calculation, and gives targeted countermeasure suggestions for improving the quality of public art. The research of this paper specifically obtained the following three conclusions.

1. This study argues that digital public art needs to have the characteristics of interactivity, multi-sensory experience, extensive art circulation and fast sensitivity in addition to the three basic characteristics of public art: publicness, artistry and in situ. Meta-universe technology, as a medium for innovative thinking and expression, creates the user's right to express his or her own personality, which is the biggest advantage of the meta-universe, and the immersive form of online integration with offline participation will become the basic mode of public art's future development. In the meantime, the boundaries of creativity, curatorial design, performance and exhibition possibilities will continue to expand, thereby improving the quality of public art works in all aspects.

2. The current findings illustrate that the necessary condition for public art to move from static forms to new dynamic and interactive forms is open, polycentric digital spaces. In response to the current problems of effectiveness, high costs of exhibition venues or spaces, and lack of unified perception of artistic values faced in public art, digital technology under the metaverse can better fulfill the creative needs of interactivity, multisensory, quick sensitivity, and sustainability in public art, and digital space will become an important support for public art to complete its display as well as performance.

3 This paper concludes through hierarchical analysis that public environment factors as the basic factors of public art, shared space and field interactivity can break the current two-dimensional perception model through metaverse technology, providing a low-cost way to try and an open dialogue space that breaks the boundaries of identity. Blockchain technology-based non-homogeneous token artworks can also maximize the artistic value in terms of accuracy of artistic expression and transactions of copyright sales through decentralized arithmetic and data processing capabilities, allowing public artworks to become digital public artworks with copyright certification. It provides a strong basis for urban planning and urban marketing, thus further stimulating social potential and creativity.

In summary, this study realizes a new application of the concept of metaverse in public art, and proposes preliminary ideas for improving the construction of scenarios and theoretical methods, which can provide relevant experience and suggestions for improving the quality of public art under metaverse technology in China and abroad.

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