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Beyond Reality: Exploring User Experiences in the Metaverse Art Exhibition Platform from an Integrated Perspective

Junping Xu , Sixuan Liu , Wei Yang, Meichen Fang and Younghwan Pan * 

Department of Smart Experience Design, Kookmin University, Seoul 02707, Republic of Korea; xjp1110@kookmin.ac.kr (J.X.); liusixuandesign@kookmin.ac.kr (S.L.); wytheyw@kookmin.ac.kr (W.Y.); fangmeichen@kookmin.ac.kr (M.F.)

* Correspondence: peterpan@kookmin.ac.kr; Tel.: +82-2-910-4769

Abstract: With the rise of the metaverse, digital transformation is profoundly affecting the field of art exhibitions. Museums and galleries are actively adopting metaverse technologies to present artworks through virtual platforms, providing audiences with novel opportunities for immersive engagement and art experiences and shaping high-quality user experiences. However, the factors influencing user engagement in the metaverse art exhibition platform (MeAEP) remain unclear in the current research. This research combines the information systems success model (ISSM) and the hedonic motivation system adoption model (HMSAM) to construct a theoretical model that provides insights into the factors influencing MeAEP users' intention to engage and their immersion behavior, with a focus on the sustainability of the art exhibition. We quantitatively analyzed 370 users that experienced MeAEP and analyzed the data and measurement model using SPSS 27 and partial least squares structural equation modeling (PLS-SEM). The results showed that information quality (IQ), system quality (SQ), and perceived ease of use (PEOU) significantly and positively influenced perceived usefulness (PU), curiosity (CUR), joy (JOY), and control (CON). PU, JOY, and CON have a positive and significant effect on Immersion (IM). Finally, PU, CUR, JOY, and CON had a positive effect on behavioral intention (BI). In conclusion, only one of the twenty hypotheses was not supported. The research findings not only enrich the academic and managerial theories related to the metaverse and art exhibition platforms, but also provide practical insights for administrators, developers, and MeAEP designers to create higher-quality and more immersive art content, as well as provide constructive ideas for the sustainability of art exhibitions to further enhance user experience.

Keywords: metaverse; metaverse art exhibition platform (MeAEP); information systems success model (ISSM); hedonic motivation system adoption model (HMSAM); user experience



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1. Introduction

The word metaverse consists of the words “meta” and “verse”, which denote transcendence and universe, respectively. The whole term refers to the universe beyond the physical world [1]. The term was first mentioned in Neal Stephenson’s science fiction novel *Snow Crash*, which vividly describes the metaverse as a virtual world perspective [2]. Metaverse as the next big technology platform could see global metaverse revenues approach \$800 billion by 2024, according to Bloomberg Intelligence, Newzoo, IDC, PWC, Statista, and Two Circles [3]. With the wave of the metaverse, every major company is paying close attention to it. Significant changes have already occurred, such as Bytedance (Tik Tok) spending \$1.3 billion to acquire VR headset company Pico [4]; Facebook renaming the company Meta [5]; Microsoft launches Mesh for Microsoft Teams combined with mixed reality capabilities [6]; Niantic building on Pokémon GO with a \$300 million push for metaverse-related development [7]; and NVIDIA creating Omniverse, a revolutionary new platform for virtual collaboration and simulation for the metaverse [8]. Also of note is the launch of Apple’s Vision Pro mixed reality headset on June 5 of this year (2024), bringing

anticipation for a more immersive entertainment experience [9]. The heavy investment by these companies has sparked heightened interest in the metaverse as the next major technological advancement.

As a basic system that supports various real services in the virtual world, the metaverse platform provides realistic and accurate images through the expansion of smartphones and the Internet, and is connected to art exhibitions to build a new ecosystem [10]. Metaverse art exhibitions are not just a simple copy and transfer of physical exhibitions, but realize a new way of exhibition, creating a new virtual exhibition dimension and interactive space and providing users with informative and interesting user experiences [11]. Some scholars consider virtual art exhibitions as a potential medium for displaying art [12].

This research defines metaverse art exhibitions as non-physical exhibitions that are limited to art exhibitions in a web-based virtual space accessed through desktop or handheld devices. With the advantages of high accessibility, immersive experience, large flexibility, low cost, and continuity, the metaverse art exhibition platform (MeAEP) has become the current favorite choice of artists, curators, and art lovers [13]. Current MeAEPs include The Sandbox, Cryptovoxels, Somnium Space, and Spatial. These platforms offer a wealth of functionality.

The information systems success model (ISSM), also known as the DeLone and McLean success model, focuses on six main dimensions: system quality, information quality, usage, user satisfaction, individual impact, and organizational impact [14]. Among these six dimensions, system quality is used to measure technical success and information quality is used to measure semantic success [15], with a decisive impact on user satisfaction and acceptance. However, ISSM has not yet been applied to MeAEP. The hedonic motivation system adoption model (HMSAM) is a combination of two models that include seven variables. First, the hedonic system acceptance model (HSAM) is based on the technology acceptance model (TAM) [16], which contains three variables of perceived ease of use, perceived usefulness, and behavioral intention. Secondly, Lowry et al. [17] introduced the cognitive focus theory (CA) and the flow theory of mind to form the basis of cognitive focus on the basis of the previous model [18], which contains the four variables of curiosity, joy, control, and immersion, which explain the user's internal motivation to engage and focus.

The ISSM focuses on assessing the quality of functional interactions in MeAEP. Based on previous research, Wu et al. stated that the system and information quality of a virtual costume museum can enhance users' intention to use it and contribute to their perceptions, thus meeting their expectations and emotional needs [19]. Gim et al. showed that the information and system quality of metaverse education affects learners' satisfaction [20]. Wang et al. mentioned that since metaverse exhibition is still in the early stage of development, with the continuous development and updating of technology, information and system quality can be considered key factors affecting users' utilization in future research [21]. While the HMSAM allows for more in-depth research on users' intrinsic motivation and immersion behaviors, related scholars extended the HMSAM for explaining tourists' continuous intention to use virtual reality for tourism [22] and confirmed that intrinsic motivation plays a key role in increasing users' cognitive beliefs about metaverse tourism [23]. In this paper, combining these two models can help developers design more engaging and high-quality MeAEPs. It can provide a deeper understanding of users' motivations and experience expectations, providing features and content that better meet users' needs, thus enhancing users' motivation to engage and immerse themselves. The choice to combine the two models can provide more comprehensive user insights into MeAEP and facilitate the continuous development and improvement of the platform.

Since research on MeAEP is still in its infancy, there is a noticeable lack of research in the field and previous studies have mainly explored it from a technological perspective, with a focus on virtual reality (VR), augmented reality (AR), and mixed reality (MR) [11]. Some scholars have argued that visitors are at the heart of the virtual experience and web development process, therefore it is critical to understand user motivations and behaviors. Given the role of user experience as a key factor in the success of the metaverse [24],

researchers should focus on understanding user interactions and experiences in metaverse art exhibition environments by optimizing engagement, satisfaction, and happiness for positive outcomes. Despite the rapid popularity of MeAEP, the factors that influence user engagement and immersion are currently unclear. Therefore, there is a need to fill the research gap in this area and conduct in-depth empirical research on this aspect. Based on previous research, data collection in the field of the metaverse is mainly conducted through questionnaires. Smart-PLS 4.0(PLS-SEM) is the most commonly used software for this data analysis [25].

This research aims to integrate the ISSM and HMSAM models by conducting an empirical study with online questionnaires on 370 users who have used metaverse art exhibition platform (MeAEP) with factor and path analyses using SPSS 27 and Smart-PLS 4.0 in order to explain the factors that drive user engagement in MeAEP and the complex relationships between them. In this study, we endeavor to answer the following research questions: (1) What are the main factors that influence users' participation in MeAEP? (2) How do these factors influence each other? (3) Based on a deeper understanding of these factors, how can we extract targeted insights to guide the development and improvement of MeAEP?

The remainder of the paper is structured as follows: Section 2 summarizes the literature on the metaverse and MeAEP, ISSM, and HMSAM, from which 20 theoretical hypotheses are formulated. Section 3 details the research methodology, including the questionnaire scales, participants, data collection procedures, and statistical methods. Section 4 presents the results of the data analyses, containing the reliability and validity and testing the hypotheses. Section 5 presents the discussion. Section 6 presents the limitations of the research, future research directions, and conclusions. The findings from this study help MeAEP gain a deeper understanding of user preferences and motivations, providing a substantial contribution to future MeAEP research and design. In addition, it also helps to advance the field of the metaverse and provide a guiding direction for the optimization and innovation of related metaverse platforms based on the factors that have a significant impact on user immersion.

2. Literature Review and Hypothesis Development

2.1. Metaverse and Metaverse Art Exhibition Platform (MeAEP)

The concept of the metaverse has been repeatedly discussed many times, and its definition has been redefined depending on the content needs of the researchers [26]. Table 1 lists the definitions of metaverse by various related scholars, which reflect the personal views, opinions, and ideas of the researchers. Dionisio et al. categorized the features of the metaverse into four primary groups: immersive realism, ubiquity, interoperability, and scalability [1]. Gao et al. also summarize five priorities of metaverse worlds: sociality, immersion, openness, economy, and compatibility [27]. Furthermore, metaverse worlds can be grouped into four scenarios: virtual worlds, mirror worlds, augmented reality and lifelogging [10].

Table 1. Different definitions of metaverse.

Authors	Definition
Park and Kim [28]	Metaverse is primarily defined as a place, a space, or a world, emphasizing its physical nature.
Dolata and Schwabe [29]	Metaverse is a new and evolving socio-technical phenomenon and calls for its study as a dynamic and moving target.
Díaz et al. [30]	Metaverse is considered an immersive, three-dimensional, virtual, and multi-user online environment.
Ng [31]	Metaverse is an immersive, advanced computing, social, decentralized space.

Table 1. Cont.

Authors	Definition
Abilkaiyrkyzy et al. [32]	Metaverse is considered to be a fully immersive, hyper-temporal, self-sustaining virtual shared space that blends the triad of physical, human, and digital worlds.
Y. Wang et al. [33]	Metaverse is a self-sustaining, hyperspace, three-dimensional immersive virtual shared space.
Dionisio et al. [1]	Metaverse is an immersive reality environment that enables ubiquitous access, identity, interoperability, and scalability.
Wright et al. [34]	Metaverse is an extensive three-dimensional virtual world that can support multiple people at the same time.

The metaverse is a concept that is still under development but has broad application prospects [35], showing the potential for unlimited growth of platforms in various fields. It is used in education, online tourism, E-commerce, marketing logistics, automated driving, healthcare, smart cities, banking services, and cultural heritage [36], in addition to its expansion into the arts [37]. Despite the growing interest and focus on the metaverse, it is still not fully understood by many users and key aspects still need to be taken into account [38], hence the need for a detailed compendium of the metaverse [39].

The metaverse art exhibition platform (MeAEP) is an application of the metaverse in the field of art where users can fully immerse themselves in art exhibitions using virtual reality devices [40]. On the one hand, users are able to create personalized art exhibitions in virtual environments, display their artworks, experiment with creative ideas that are difficult to realize in the real world, and interact, share, and trade their works with audiences around the globe. On the other hand, ordinary users can take on the role of virtual digital characters [41] and visit art exhibitions by artists with different characteristics. As the platform is more interactive, users can be more immersed in experiencing, contacting, and interacting with the artwork [42]. MeAEP ensures the ability to continuously update, iterate, share, and disseminate artworks, and can comprehensively record and archive artists' works, forming a unique cloud-based database that makes art resources digital, more secure [43], sustainable, and permanent. Therefore, as the experiences of users continue to improve, the more likely they are to use MeAEP [21].

Through a systematic literature review, a number of scholars summarized previous research on metaverse orientation and concluded that ISSM and TAM are theories commonly used to assess and study metaverse system adoption and acceptance. The technology acceptance model (TAM) was first proposed by Fred Davis, based on the theory of reasoned action (TRA) and the theory of planned behavior (TPB), in which he developed and validated two key variables: perceived usefulness (PU) and perceived ease of use (PEOU) [44]. Over time, researchers conducted in-depth theoretical studies and empirical tests on TAM in order to better understand users' acceptance of different new technologies. Through these studies, TAM was gradually upgraded and extended by adding relevant independent and determinant variables to modulate the classical model form, and versions such as TAM2, TAM3, HMSAM, RATAM, UTAUT, and UTAUT 2 were developed.

2.2. Information Systems Success Model (Information Quality and System Quality)

ISSM is often used to comprehensively assess the effectiveness and success of information systems [45], while system quality and information quality have been repeatedly validated as the main factors influencing the success of information systems [46], with a decisive impact on user satisfaction and acceptance. It has also been widely used in different research areas to explain the factors affecting user usage such as smart museums, virtual communities, learning platforms, digital libraries, online shopping, and virtual showrooms. Table 2 summarizes previous empirical research on ISSM.

Table 2. Previous empirical research on ISSM models.

Authors	Object	Model/Theories	Sample	Find	Methods
Wang (2008) [46]	E-commerce System	ISSM + TAM + perceived value	240	Intention to use is influenced by PV and SAT. PV and SAT influenced by IQ, SyQ, and SeQ.	CB-SEM
Cheng (2014) [47]	Digital Library	ISSM + TAM + ECM	525	IQ, SyQ, and technical support play a key role in interpreting users' intentions to continue using the digital library through beliefs.	CB-SEM
Aeni Hidayah et al. (2020) [48]	Academic Information Systems	ISSM + TAM	237	IQ and SyQ have an effect on both PU and PEOU, and IQ, SyQ, SeQ, PEOU, and PU affect the ATT of application users.	PLS-SEM
Gim et al. (2022) [20]	Metaverse Education	ISSM + TAM + self-determination theory	532	Most variables of SDT and IS in metaverse education affect SAT. Learner flow is an important mediating variable in learner SAT.	PLS-SEM
Wu et al. (2022) [19]	Digital Clothing Museums	ISSM + TAM + information richness (IR), perceived playfulness (PP), perceived convenience (PC)	265	IQ positively affects PC and PEOU, and IR positively affects PU and PEOU. PU and PP are important predictors of users' use of BI in digital clothing museums	CB-SEM
Zhang and Abd Rahman (2022) [49]	Smart Museum	ISSM + flow theory	519	Millennials' tech savvy, IQ, and SQ of smart museums significantly influence visitor SAT and loyalty through the mediating role of the stream experience.	PLS-SEM
Cheng et al. (2023) [50]	Virtual Museum	ISSM + TAM + aesthetic experience (AE) + escapist experience (EE)	295	IQ has an effect on AE and EE, AE has a positive effect on EE and AE, EE affects PU, AE affects PEOU	PLS-SEM

Information quality (IQ) refers to the quality characteristics of the information content output by the metaverse art exhibition platform (MeAEP), including accuracy, usefulness, and timeliness [50]. In the study of Gim et al. it was found that IQ and system quality (SQ) had a positive impact on perceived usefulness (PU) in the context of the metaverse [20]. Previous research has shown that users' perception of the IQ provided by a service or platform will determine its PU [51]. In addition, a high level of IQ can also provide users with higher levels of interest [52]. In virtual exhibitions, by regularly updating rich, high-quality content and providing a large amount of relevant information, when the level of this information meets user needs, users will feel happy and consider it a useful means to find and browse artworks [47] while improving the accessibility of relevant information and user experience [53]. MeAEP provides sufficient information through text and graphics to identify different artworks, while also providing easy-to-understand descriptions of artworks [19]. Users are always curious and eager to seek new and different experiences [54], therefore, we hypothesize that when MeAEP publishes interesting and useful exhibition information content, users are more likely to be curious and more willing

to enjoy and experience MeAEP. In addition, MeAEP's high information quality may imply that the platform provides more accurate and clear information about art exhibitions, making it easy for users to comprehend and control, saving them time and effort and increasing their confidence [19]. On the contrary, low information quality may result in unclear, incomplete, and misleading information about art exhibitions, which reduces the users' sense of control over the platform and loses their engagement and interaction. Therefore, we propose the following hypotheses:

H1a. *MeAEP's IQ will positively influence the PU.*

H1b. *MeAEP's IQ will positively influence the user's CUR.*

H1c. *MeAEP's IQ will positively influence the user's JOY.*

H1d. *MeAEP's IQ will positively influence the user's CON.*

System quality (SQ) encompasses the quality of MeAEP's own functionality, including the performance of the platform's technical architecture, stability, accessibility, convenience, flexibility, reliability, and response time [47]. Lin's research confirms that SQ affects user satisfaction in virtual communities [15]. According to previous research, SQ has positively influenced both PUs of e-learning platforms [55]. For virtual museum platforms, it is especially important to provide an intuitive interface. Otherwise, users may not be clear about where to find and how to use it, which may ultimately reduce their hedonic motivation and lead to a decrease in user interest [56]. A user-friendly system interface design will make users more comfortable, meaning that they may find it more useful [20]. In addition, the response time of the platform is also one of the important factors that affects user perception [57]. For the ease of accessibility, users will find the digital platform useful if they perceive that it provides them with instant access and easy visit to online service information [58]. In virtual exhibitions, the combination of system technology with different media has brought about richer interactive exhibitions and more diverse ways of presenting artworks, including Web3D, VR, and AR [59]. Meanwhile the innovation of browsing methods makes it easier for users to be curious. Polys et al. argued that for virtual art exhibitions, the improvement of the system should be devoted to improving the user's interactions and experiences so that it will be easier and more fluid for users to control [60]. Thus, we propose the following hypotheses:

H2a. *MeAEP's SQ will positively influence the PU.*

H2b. *MeAEP's SQ will positively influence the user's CUR.*

H2c. *MeAEP's SQ will positively influence the user's JOY.*

H2d. *MeAEP's SQ will positively influence the user's CON.*

2.3. Hedonic Motivation System Adoption Model (Perceived Ease of Use, Perceived Usefulness, Curiosity, Joy, Control, Behavioral Intention, and Immersion)

In HMSAM, it has been argued that if users are intrinsically motivated, they will have a sense of immersion and be fully engaged in the ongoing virtual activity [24]. The model emphasizes users' internal motivation rather than external motivation and focuses on analyzing their intrinsic motivation for entertainment. HMSAM is often used in the research process of hedonic motivation systems, covering areas such as short video platforms, gaming classrooms, online learning, e-wallets [61], and metaverse games. Table 3 summarizes previous empirical research on HMSAM.

Table 3. Previous empirical research on HMSAM models.

Authors	Object	Model/Theories	Sample	Find	Methods
Kim and Hall (2019) [22]	Virtual Reality Tourism	HMSAM + enjoyment, flow state, subjective wellbeing (SW)	469	Results identified the highly significant effect of consumers' perceived enjoyment on flow state and of flow state on SW. Continued use was greatly influenced by flow state and SW.	PLS-SEM
Sidek et al. (2020) [62]	E-Learning	HMSAM	168	JOY, CON, PU, and CUR were significantly correlated with IM, while PU, JOY, and CUR were significantly correlated with BIU.	Multiple regression
Chen et al. (2021) [63]	Green Eating	HMSAM + TRA	786	Social recognition and environmental ethics have significant effects on CUR, JOY of purchase, PU, subjective norm, and perceived behavior control.	CB-SEM
Ertz et al. (2022) [64]	Mobile Shopping	HMSAM	311	Intrinsic motivation for JOY and CON is strongly influenced by PEOU. JOY has an indirect effect on mobile shopping intentions	CB-SEM
Palos-Sanchez et al. (2022) [65]	Game-Based Student Response System	HMSAM	214	The application of the HMSAM is adequate for the adoption of a game-based student response system tool	PLS-SEM
Deng and Yu (2023) [66]	Short Video	HMSAM + perceived boredom (PB), personal innovativeness (PI)	246	CUR and perceived boredom significantly mediated the positive relationships between PEOU and BI.	PLS-SEM
Perez et al. (2023) [67]	NFT Game	HMSAM + TPB	1082	HM positively and significantly influenced PU, CUR, JOY, ATT, subjective norms, and PBC. Subjective norms had a significant effect on PEOU.	PLS-SEM

Perceived ease of use (PEOU) in this research refers to the user's perception that using MeAEP is easy to perform without much mental and physical effort [16]. Meanwhile, PU in HMSAM places more emphasis on the pleasure-seeking process on usefulness [18]. Oluwajana et al. showed that PEOU had a significant positive impact on PU in a gamified learning platform [61]. Since users desire efficiency, platforms that are easy to use become preferred and are seen as useful. Therefore, when a platform is difficult to use, it may lead to user fatigue and eventual abandonment [18]. Previous research has shown that platforms that simplify operations also offer opportunities to attract new users and maintain long-term users as they become progressively more engaged with the gaming platform [68]. Huda et al. confirmed the positive impact of PEOU on user curiosity (CUR) from the experience of online on-demand platforms [69]. For the effect of PEOU on Joy (JOY), Lowry et al. developed a different theoretical framework and the results showed that PEOU has a significant positive effect on JOY [70]. Ertz et al. showed in a mobile shopping platform that PEOU is an important prerequisite for JOY and helps to provide an enjoyable experience for users [64]. Other research has found that over time, platforms that are convenient

and easy to use reassure users [71], making them feel in full control of the platform's interactions. Research by Agarwal and Karahanna has found a strong correlation between PEOU and CON in the field of information technology [72]. Therefore, if MeAEP is easy to use and the art exhibitions displayed on the platform can attract users, users are more likely to use MeAEP and focus on appreciating the artworks and pleasurable aspects. Users can independently choose the content of the exhibitions they are interested in and enjoy the process of visiting them. At the same time, it can increase the CON of the strong users to the platform, which can stimulate the CUR. Consequently, we propose the following hypotheses:

H3a. *MeAEP's PEOU will positively influence PU.*

H3b. *MeAEP's PEOU will positively influence the user's CUR.*

H3c. *MeAEP's PEOU will positively influence the user's JOY.*

H3d. *MeAEP's PEOU will positively influence the user's CON.*

Perceived usefulness (PU) refers to users' belief that using MeAEP will improve their artistic and work abilities [61]. Previous research has demonstrated that PU acts as an antecedent to BI and positively influences BI in different novel environments [62]. For users, if a digital platform has several advantages, they will be interested and find it useful, and will use it with a positive attitude [73]. Curiosity (CUR) refers to the extent to which a user's experience stimulates sensory and cognitive curiosity about MeAEP [61]. According to previous research, users' curiosity positively predicts, among other things, their job performance and academic achievement [74]. As humans' natural curiosity about the unknown drives them to actively explore new things, related scholars have explored the relationship between CUR and BI in virtual tourism platforms. Park et al. showed that when users are curious about a new platform, they are more inclined to adopt the expected behaviors and actively use the platform [75]. Such curiosity also drives users to learn more about and engage with MeAEP, which enriches their experience and fulfills the needs of the CUR. JOY is usually highly enjoyable and refers to the pleasure and fun users feel during pleasant interactions with MeAEP. The JOY that users get from new systems and platforms is an important factor in determining acceptance and continuous use [76]. Related research also confirmed that JOY has a significant effect on BI [68], and in HMSAM, CUR and JOY are factors that positively influence BI [64]. He et al. proposed that if platforms give users a sense of control, they will spend more time and show stronger sticky behaviors [77]. This is conducive to fostering user loyalty and continuous use of the platform. Accordingly, we propose the following hypotheses:

H4a. *MeAEP's PU will positively influence the BI.*

H4b. *User's CUR will positively influence the BI.*

H4c. *User's JOY will positively influence the BI.*

H4d. *User's CON will positively influence the BI.*

Immersion (IM) refers to the degree to which a user is fully engaged in a MeAEP [18]. North and North confirmed that users are more deeply immersed and experience a higher sense of presence if more comprehensive functionality is available in virtual reality [78]. Cadet and Chainay also showed that the more immersive the system, the more pronounced the sense of presence [79]. It has been shown that users' PU and CUR may affect concentration on IM when using a gamified platform for learning [61]. If users show more curiosity about art exhibitions in MeAEP, they will be more willing to devote more attention

to pursuing and satisfying that curiosity. CUR motivates users to immerse themselves in new environments and triggers interest in the virtual scenarios within them [80]. In the HMSAM environment, an increase in CUR should lead to an increase in IM [18]. In the virtual gaming platform scenario, JOY as a state of mind-flow has a positive effect on IM, influencing users' BI for continuous use of the virtual game [18]. If users fail to experience JOY while using MeAEP, they will have difficulty enjoying the platform and becoming immersed. Lim and Park suggest that JOY significantly affects users' IM and viewing intentions [81]. Control (CON) refers to the user's ability to control the MeAEP. Researchers have argued that threats to either control or autonomy have a direct negative impact on BI. Virtual art exhibitions not only improve user social interactions, but also make the exhibition space easier to control and manipulate [60]. In HMSAM, it has been shown that CUR, JOY, and CON are important factors in IM [18].

H5a. User's PU will positively influence the IM.

H5b. User's CUR will positively influence the IM.

H5c. User's JOY will positively influence the IM.

H5d. User's CON will positively influence the IM.

2.4. Proposed Research Model

Based on the information system success model (ISSM) and the hedonic motivation system adoption model (HMSAM), this research constructs a new theoretical model aimed at exploring the impact of MeAEP experience factors on users' intention to use the platform and their sense of immersion. Through an in-depth study of the above theory, Figure 1 shows the proposed research model. The model covers the following nine constructs: the information quality (IQ) and system quality (SQ) are from the information system success model, and the other perceived ease of use (PEOU), perceived usefulness (PU), curiosity (CUR), joy (JOY), control (CON), behavioral intentions (BI), and immersion (IM) are from the hedonic motivation system adoption model.

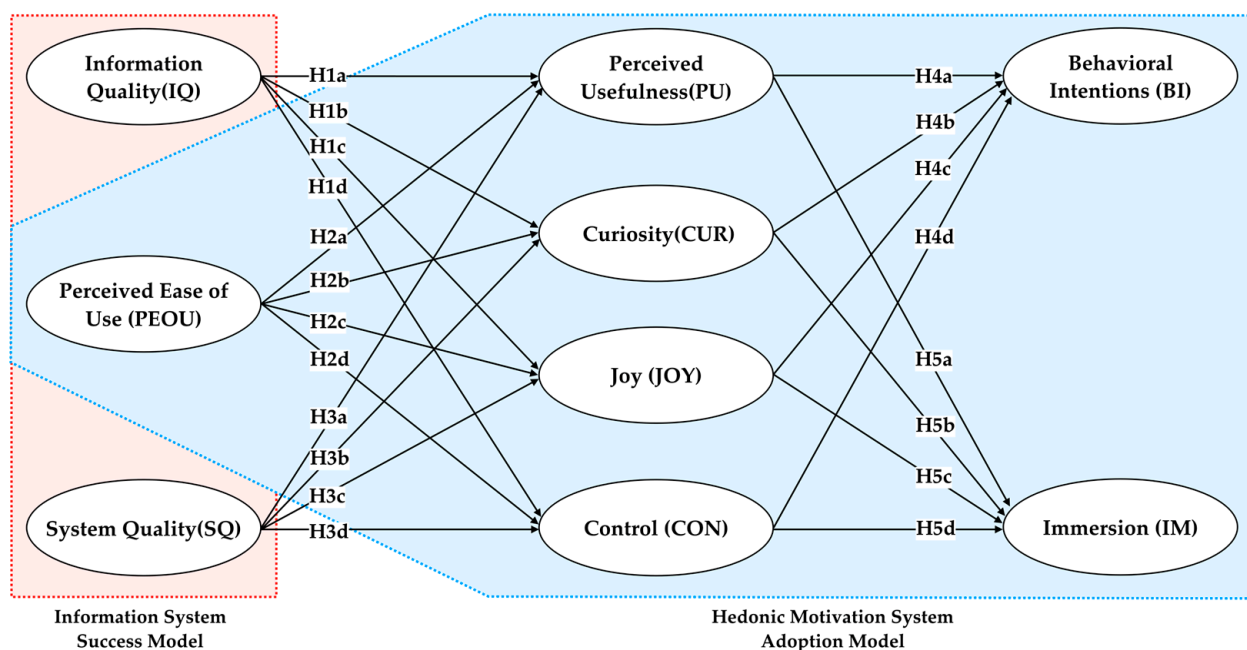


Figure 1. Proposed conceptual model.

3. Research Methods

In this study, a questionnaire was used to collect data to test the research model and hypotheses. The collected data were analyzed using SPSS and PLS-SEM.

3.1. Questionnaire Development

In the first part of the questionnaire, we consider that users do not yet have a comprehensive understanding of the metaverse art exhibition platform (MeAEP). In order to give them an intuitive and comprehensive introductory understanding, we briefly introduced MeAEP and chose the art exhibitions of Spatial (a free of charge platform) as the object of research (Figure 2). Spatial is a metaverse cultural platform that has been online since December 2020, and its rich features include art galleries, art exhibitions, and art events [82]. This powerful platform supports multiple devices including mobile, desktop, or VR, offering diverse possibilities for users to create immersive and interactive worlds [83]. In Spatial, users can personalize avatars, interact socially, and visit a variety of art exhibitions with different styles, themes, and presentations. Artists are free to curate and create virtual exhibitions to showcase their artworks on the Spatial platform. As a result, Spatial offers broader accessibility, a superior user experience, and a new way to appreciate emerging artwork for users. To make it more intuitive and accessible to users, we shared the URL of the art exhibition at Spatial, where users can simply click on the link in the questionnaire (<https://www.spatial.io/s/NFTNYC-6428a02bf7f68ef1ab70f5e1?share=3884768696327064776> (accessed on 9 December 2023)). To visit MeAEP, users can enter the virtual platform where they will then experience different artists with representative NFT artwork, all-round experience, and feel the online metaverse art exhibition platform. After the experience, a more intuitive and comprehensive introductory understanding will have been achieved. A follow-up questionnaire will be conducted after the experience is completed.



Figure 2. Art exhibitions on the Spatial platform, image source: <https://www.spatial.io/blog/what-is-an-nft-gallery-and-5-galleries-to-visit-in-spatial> (accessed on 9 December 2023).

The second part of the questionnaire was devoted to the demographic characteristics of the respondents such as gender, age, education, occupation, frequency of use, and duration of use. To increase the reliability of the questionnaire, the first question in this part was set as “have you completed the experience of visiting the metaverse art exhibition platform (MeAEP)?” If the respondent fills in “No”, the questionnaire will be terminated and invalidated. The third part presents 44 item questions on 9 measured

variables, namely information quality (IQ), system quality (SQ), perceived ease of use (PEOU), perceived usefulness (PU), curiosity (CUR), joy (JOY), control (CON), behavioral intention (BI), and immersion (IM). All questionnaire items were measured on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). All variable item questions in this section were derived from existing literature, which we adapted and refined to fit the themes and objectives of this research. Appendix A shows the content of the variable items and literature sources.

Since most of the scales used in this research were developed in English, to ensure that the questionnaire was expressed accurately, four professional translators were invited to translate these scales into Chinese. At the same time, three professional experts in the metaverse were invited to scrutinize the wording and structure of the questionnaires and to make revisions to ensure that respondents would have no objections to the content of the questionnaires. In terms of academic ethics, all respondents were asked to sign a consent form before answering the questionnaire in order to protect their rights and interests. We explicitly informed respondents that all data collected would be used for academic research only without any commercial use, and that the privacy of all respondents would be strictly protected. Additionally, to further ensure the quality of the questionnaire, we conducted a pre-survey where we invited 50 users who had experienced MeAEPs to participate. Respondents were asked to point out possible ambiguities in the questionnaire, and an exploratory factor analysis (EFA) was then conducted on this small sample. The Cronbach's alpha values for each item in the questionnaire (ranging from 0.89 to 0.97) exceeded the common requirements for exploratory research and showed excellent reliability.

3.2. Data Collection and Analysis

We used a combination of online and offline methods between 10 November 2023 and 15 December 2023, resulting in 421 questionnaires being returned. Questionnaire data mainly came from two channels. First, we collected 114 questionnaires offline from students and researchers in art-related majors. Second, we used Questionnaire Star, a professional questionnaire data platform in China, to generate the links and QR codes of the questionnaires online, and then invited the users to fill in the questionnaires by going to the social media platforms WeChat, QQ, Xiaohongshu, and Weibo. A total of 307 questionnaires were collected via this method. After the final screening, excluding invalid questionnaires and duplicates, 370 valid questionnaires remained with a recovery rate of 87.9%. According to the experience of previous research on structural equation modeling, the sample size for data analysis should be 10 times larger than the equation being tested, so the 370 questionnaires we obtained satisfy the measurement and evaluation of structural equations.

Of the 370 respondents, 181 (48.90%) were male and 189 (51.10%) were female. Regarding the age distribution, 286 (77.3%) of the main respondents were between the ages of 18 and 40 years, followed by 51 (13.80%) between the ages of 40 and 50 years, 26 (7.00%) between the ages of 51 and 60 years, and 7 (1.90%) above the age of 60 years. Regarding educational attainment, 204 (55.10%) respondents had a bachelor's degree, followed by 92 (24.90%) with high school education, 61 (16.50%) with graduate education, and 13 (3.50%) with a doctoral degree. Regarding occupation, 35 (9.5%) were art students, 109 (45.70%) were art industry practitioners, 97 (26.23%) were related workers in the art field, and 129 (34.90%) were art lovers. Regarding the frequency of use, 169 (45.70%) respondents used MeAEP at least once a week, followed by 111 (30.00%) who used it at least once a month, and 75 (20.30%) who used it at least once a day. Regarding the time of use, 291 (78.70%) respondents used MeAEP for more than or equal to 1 h and less than 3 h in a single time. This indicates that most of the respondents are willing to use MeAEP and are willing to invest more time. Table 4 shows the demographic information of the respondents.

Table 4. Statistical information on the demographic sample of participants, n= 370.

Variable	Category	Frequency (n = 370)	Percent %
Gender	Male	181	48.90
	Female	189	51.10
Age (years)	18~25	84	22.70
	26~34	102	27.60
	35~44	100	27.00
	45~54	51	13.80
	55~64	26	7.00
	≥65	7	1.90
Education	Less than undergraduate	92	24.90
	Undergraduate	204	55.10
	Post-graduate	61	16.50
	Doctor	13	3.50
Occupation	Art Students	35	9.50
	Art industry practitioners	109	29.50
	Art field related Researcher	97	26.20
	Art enthusiasts	129	34.90
Frequency of use of MeAEP	At least once a day	75	20.30
	At least once week	169	45.70
	At least once month	111	30.00
	Other	15	4.10
Time to use MeAEP	0 h < T < 1 h	31	8.40
	1 h ≤ T < 2 h	139	37.60
	2 h ≤ T < 3 h	152	41.10
	3 h ≤ T < 4 h	36	9.70
	4 h ≤ T < 5 h	12	3.20
Total of participants		370	100.0

4. Results

In this study, SPSS 27 and Smart PLS 4 were used for data analysis and model measurement. PLS-SEM, as a variance-based method, does not require a normal distribution for its data, is suitable for small samples, has a wide range of applicability, and excels in dealing with relatively complex models. Meanwhile, PLS-SEM is not only suitable for exploratory studies but is also commonly used in validation research [84].

4.1. Model Fit

In the structural modeling of PLS-SEM, goodness of fit is used to measure the residuals and bias of the covariates to assess the fitness of the whole model. The standardized residual mean root (SRMR) and the normed fit index (NFI) are used to assess the fit of the structural model. Research scholars consider that when $SRMR \leq 0.08$ and $NFI \geq 0.90$, the model has a good fit [85]. In this study, the NFI value of the model is 0.93 and the SRMR value is 0.07, which are within the standard thresholds. The structural fit indices of this model are visible in Table 5.

Table 5. SEM fit indices.

Fit Index	Computed Values	Threshold	Reference
SRMR	0.07	≤ 0.08	Henseler et al. [86]
NFI	0.93	≥ 0.90	Gupta and Singharia [85]

4.2. Common Method Bias

Common method bias (CMB) is a potential problem in all questionnaire items, and Variance inflation factor (VIF) is commonly used as an indicator of multicollinearity in assessing formative properties. High VIF values indicate high covariance. Ideally, VIF values should be close to 3.0 or lower [87], however in this study, the range of VIF values for all items was 1.542 to 2.016. This is below the threshold of 3.0, meaning there was no multicollinearity.

4.3. Reliability and Validity Analysis

In this study, SPSS 27 software was used to analyze the data for reliability. We tested composite reliability (rho_a) and (CR), and Cronbach's alpha (CA) for all items. As shown in Table 6, all values exceeded the recommended threshold of 0.80 [88], indicating that the measured items are reliable and can be used for further analysis. For the assessment of convergent validity, we examined the average variance (AVE) values extracted from the items, all of which exceeded the threshold of 0.5. In addition, the standardized factor loadings of all items exceeded the threshold of 0.7, and all showed $p < 0.001$, indicating a good level of convergent validity [89].

Table 6. Reliability and validity analysis.

Variables	Items	Factor Loading	CA	Rho(A)	CR	AVE
Behavioral Intentions (BI) (5 items)	BI1	0.943	0.965	0.965	0.973	0.877
	BI2	0.937				
	BI3	0.933				
	BI4	0.934				
	BI5	0.935				
Control (CON) (4 items)	CON1	0.943	0.953	0.954	0.966	0.877
	CON2	0.936				
	CON3	0.935				
	CON4	0.933				
Curiosity (CUR) (4 items)	CUR1	0.939	0.958	0.958	0.969	0.887
	CUR2	0.945				
	CUR3	0.937				
	CUR4	0.946				
Immersion (IM) (4 items)	IM1	0.957	0.962	0.963	0.973	0.899
	IM2	0.945				
	IM3	0.949				
	IM4	0.940				
Information Quality (IQ) (5 items)	IQ1	0.933	0.961	0.961	0.970	0.865
	IQ2	0.934				
	IQ3	0.932				
	IQ4	0.920				
	IQ5	0.932				
Joy (JOY) (6 items)	JOY1	0.945	0.975	0.975	0.979	0.887
	JOY2	0.944				
	JOY3	0.944				
	JOY4	0.926				
	JOY5	0.948				
	JOY6	0.945				

Table 6. Cont.

Variables	Items	Factor Loading	CA	Rho(A)	CR	AVE
Perceived Ease of Use (PEOU) (6 items)	PEOU1	0.942	0.968	0.969	0.974	0.863
	PEOU2	0.925				
	PEOU3	0.923				
	PEOU4	0.935				
	PEOU5	0.928				
	PEOU6	0.923				
Perceived Usefulness (PU) (6 items)	PU1	0.936	0.968	0.968	0.974	0.862
	PU2	0.929				
	PU3	0.930				
	PU4	0.930				
	PU5	0.925				
	PU6	0.919				
System Quality (SQ) (4 items)	SQ1	0.943	0.958	0.958	0.969	0.888
	SQ2	0.941				
	SQ3	0.941				
	SQ4	0.945				

In order to assess discriminant validity, we performed a test based on the Fornell-Larcker criterion, where we determined that the square root of the AVE for each structure in Table 7 is greater than the value of the correlation coefficient that precedes each value. Second, all Heterotrait-Monotrait ratios of correlations (HTMT) are below 0.85 (Table 8). In Table 9, the loadings of each indicator in cross-loadings are higher than the loadings of their corresponding variable indicators. Therefore, by combining the analysis of these three indicators, we conclude that the model in this study has a good discriminant validity [90].

Table 7. Discriminant validity (Fornell-Larcker criterion).

	BI	CON	CUR	IM	IQ	JOY	PEOU	PU	SQ
BI	0.936								
CON	0.703	0.937							
CUR	0.703	0.627	0.942						
IM	0.699	0.565	0.533	0.948					
IQ	0.696	0.607	0.547	0.556	0.930				
JOY	0.702	0.558	0.626	0.566	0.547	0.942			
PEOU	0.683	0.600	0.577	0.517	0.575	0.560	0.929		
PU	0.717	0.635	0.600	0.567	0.643	0.593	0.576	0.928	
SQ	0.693	0.602	0.515	0.581	0.593	0.651	0.557	0.587	0.942

Table 8. Discriminant validity (HTMT values).

	BI	CON	CUR	IM	IQ	JOY	PEOU	PU	SQ
BI	-								
CON	0.732	-							
CUR	0.730	0.656	-						
IM	0.726	0.590	0.555	-					
IQ	0.723	0.634	0.570	0.578	-				
JOY	0.724	0.579	0.648	0.585	0.565	-			
PEOU	0.706	0.624	0.599	0.536	0.596	0.576	-		
PU	0.741	0.661	0.623	0.587	0.666	0.611	0.594	-	
SQ	0.720	0.629	0.537	0.605	0.618	0.673	0.577	0.609	-

Table 9. Discriminant validity (cross-loadings.).

	BI	CON	CUR	IM	IQ	JOY	PEOU	PU	SQ
BI1	0.943	0.677	0.685	0.653	0.642	0.681	0.652	0.691	0.674
BI2	0.937	0.650	0.658	0.666	0.665	0.656	0.644	0.655	0.642
BI3	0.933	0.667	0.644	0.649	0.652	0.625	0.609	0.685	0.650
BI4	0.934	0.657	0.665	0.647	0.650	0.664	0.660	0.669	0.642
BI5	0.935	0.638	0.637	0.660	0.648	0.661	0.630	0.655	0.633
CON1	0.652	0.943	0.606	0.549	0.565	0.515	0.574	0.595	0.569
CON2	0.668	0.936	0.596	0.530	0.553	0.538	0.549	0.588	0.558
CON3	0.668	0.935	0.561	0.539	0.591	0.513	0.575	0.595	0.559
CON4	0.644	0.933	0.586	0.498	0.566	0.525	0.549	0.601	0.568
CUR1	0.686	0.608	0.939	0.519	0.517	0.603	0.563	0.586	0.516
CUR2	0.663	0.583	0.945	0.512	0.533	0.593	0.544	0.561	0.471
CUR3	0.625	0.559	0.937	0.462	0.500	0.569	0.528	0.541	0.462
CUR4	0.671	0.610	0.946	0.514	0.510	0.593	0.538	0.570	0.489
IM1	0.669	0.547	0.516	0.957	0.534	0.530	0.492	0.549	0.546
IM2	0.645	0.532	0.488	0.945	0.507	0.549	0.488	0.501	0.544
IM3	0.677	0.542	0.513	0.949	0.553	0.542	0.476	0.560	0.577
IM4	0.660	0.522	0.504	0.940	0.514	0.527	0.506	0.539	0.537
IQ1	0.662	0.567	0.529	0.525	0.933	0.512	0.561	0.616	0.550
IQ2	0.654	0.564	0.494	0.514	0.934	0.498	0.528	0.592	0.551
IQ3	0.666	0.564	0.505	0.535	0.932	0.499	0.535	0.587	0.558
IQ4	0.619	0.564	0.521	0.497	0.920	0.526	0.517	0.609	0.546
IQ5	0.634	0.566	0.493	0.517	0.932	0.508	0.534	0.583	0.552
JOY1	0.643	0.515	0.593	0.536	0.515	0.945	0.544	0.565	0.620
JOY2	0.660	0.521	0.581	0.537	0.505	0.944	0.514	0.543	0.592
JOY3	0.664	0.511	0.592	0.539	0.519	0.944	0.518	0.545	0.606
JOY4	0.654	0.527	0.578	0.520	0.500	0.926	0.543	0.559	0.591
JOY5	0.679	0.540	0.619	0.540	0.540	0.948	0.535	0.573	0.629
JOY6	0.668	0.540	0.576	0.530	0.513	0.945	0.513	0.569	0.637
PEOU1	0.634	0.577	0.558	0.488	0.545	0.530	0.942	0.543	0.519
PEOU2	0.638	0.555	0.549	0.485	0.544	0.524	0.925	0.549	0.534
PEOU3	0.613	0.531	0.515	0.461	0.507	0.481	0.923	0.495	0.483
PEOU4	0.638	0.574	0.538	0.490	0.548	0.538	0.935	0.548	0.547
PEOU5	0.622	0.556	0.517	0.466	0.513	0.497	0.928	0.541	0.489
PEOU6	0.661	0.548	0.540	0.492	0.547	0.551	0.923	0.533	0.527
PU1	0.672	0.596	0.601	0.506	0.580	0.552	0.561	0.936	0.538
PU2	0.654	0.558	0.520	0.522	0.610	0.543	0.521	0.929	0.519
PU3	0.668	0.593	0.570	0.529	0.577	0.550	0.540	0.930	0.540
PU4	0.665	0.592	0.540	0.531	0.599	0.548	0.522	0.930	0.550
PU5	0.661	0.603	0.553	0.522	0.615	0.557	0.549	0.925	0.551
PU6	0.670	0.594	0.556	0.548	0.596	0.554	0.514	0.919	0.569
SQ1	0.650	0.576	0.493	0.541	0.557	0.609	0.540	0.556	0.943
SQ2	0.651	0.559	0.476	0.539	0.554	0.600	0.526	0.543	0.941
SQ3	0.648	0.566	0.483	0.570	0.565	0.625	0.493	0.549	0.941
SQ4	0.661	0.566	0.491	0.541	0.558	0.618	0.539	0.564	0.945

4.4. R-Square and Q-Square

After measuring the model, we further evaluated its validity using the coefficient of determination (R^2) and predictive relevance (Q^2), encompassing its predictive and explanatory power. R^2 reflects the magnitude of the variance of the endogenous variable as influenced by the corresponding exogenous variable, with a range from zero to one where higher values indicate greater explanatory power. Based on the values of 0.75, 0.50, and 0.25, it is considered strong, moderate, and weak predictive power, respectively [91]. In contrast, Q^2 combines out-of-sample prediction and in-sample explanatory power. Higher values indicate higher prediction accuracy, and 0, 0.25, and 0.5 are commonly used to describe the correlation between small, medium, and large predictions of the model. Among the nine variables in this study, six of them are endogenous (PU, CUR, JOY, CON, BI, and IM)

and three are exogenous (PEOU, IQ, and SQ). As shown in Table 10, the adjusted R^2 values ranged from 0.417 to 0.705, where PU, CUR, JOY, and CON predicted 70.5% of the variance in BI, and IQ, PEOU, and SQ predicted the variance in PU (51%) and CON (50%), which suggests that they have strong predictive power in forecasting. In addition, Q^2 values range from 0.410 to 0.647, suggesting that the correlation paths are good predictors of each of the endogenous variables. It is particularly noteworthy that BI has the largest predictive correlation (64.7%).

Table 10. Values of R^2 and Q^2 .

Construct	R^2	R^2 Adjusted	Q^2
BI	0.708	0.705	0.647
CON	0.507	0.503	0.494
CUR	0.422	0.417	0.410
IM	0.445	0.439	0.413
JOY	0.495	0.491	0.484
PU	0.510	0.506	0.499

4.5. Evaluating the Structural Model

As shown in Table 11 and Figure 3, the path coefficients, t-values, and p-values of all items were combined. In this study, bootstrapping method was used, and 5000 random resamples were simulated to test the path coefficients. The results show that CUR ($\beta = 0.113$, $p = 0.116$) has no effect on IM, and therefore H5b is not supported. The other 19 remaining path hypotheses were significant. IQ had a positive and significant effect on PU ($\beta = 0.367$, $p < 0.001$), CUR ($\beta = 0.246$, $p = 0.001$), and JOY ($\beta = 0.162$, $p = 0.009$), and CON ($\beta = 0.279$, $p < 0.001$) had a positive and significant effect, thus confirming H1a, H1b, H1c, and H1d. Meanwhile SQ positively and significantly affected PU ($\beta = 0.241$, $p < 0.001$), CUR ($\beta = 0.184$, $p = 0.003$), and JOY ($\beta = 0.427$, $p < 0.001$), and CON ($\beta = 0.278$, $p < 0.001$) produced positive and significant effects, thus confirming H2a, H2b, H2c, and H2d. PEOU had a positive and significant effect on PU ($\beta = 0.230$, $p = 0.001$), CUR ($\beta = 0.334$, $p < 0.001$), and JOY ($\beta = 0.230$, $p < 0.001$), and CON ($\beta = 0.285$, $p < 0.001$) produced positive and significant effects, thus H3a, H3b, H3c, and H3d were validated. Also, PU ($\beta = 0.271$, $p < 0.001$), CUR ($\beta = 0.220$, $p < 0.001$), JOY ($\beta = 0.268$, $p < 0.001$), and CON ($\beta = 0.243$, $p < 0.001$) had a positive and significant effect on BI, thus supporting H4a, H4b, H4c, and H4d. Finally, PU ($\beta = 0.213$, $p = 0.002$), JOY ($\beta = 0.246$, $p < 0.001$), and CON ($\beta = 0.222$, $p = 0.001$) positively and significantly influence IM, therefore H5a, H5c, and H5d are positively and significantly supported.

Table 11. Summary of hypotheses tests.

	H	Relationship	β	t-Value	p	2.50%CI	97.50CI	Supported
H1	H1a	IQ $\rightarrow$ PU	0.367	6.144	0.000	0.255	0.488	Yes
	H1b	IQ $\rightarrow$ CUR	0.246	3.447	0.001	0.105	0.386	Yes
	H1c	IQ $\rightarrow$ JOY	0.162	2.618	0.009	0.045	0.287	Yes
	H1d	IQ $\rightarrow$ CON	0.279	4.369	0.000	0.154	0.407	Yes
H2	H2a	SQ $\rightarrow$ PU	0.241	3.806	0.000	0.118	0.366	Yes
	H2b	SQ $\rightarrow$ CUR	0.184	2.943	0.003	0.056	0.304	Yes
	H2c	SQ $\rightarrow$ JOY	0.427	6.651	0.000	0.303	0.558	Yes
	H2d	SQ $\rightarrow$ CON	0.278	4.068	0.000	0.141	0.410	Yes
H3	H3a	PEOU $\rightarrow$ PU	0.230	3.354	0.001	0.098	0.365	Yes
	H3b	PEOU $\rightarrow$ CUR	0.334	4.584	0.000	0.193	0.474	Yes
	H3c	PEOU $\rightarrow$ JOY	0.230	3.786	0.000	0.116	0.355	Yes
	H3d	PEOU $\rightarrow$ CON	0.285	4.243	0.000	0.148	0.415	Yes

Table 11. Cont.

	H	Relationship	β	t-Value	p	2.50%CI	97.50CI	Supported
H4	H4a	PU $\rightarrow$ BI	0.271	6.159	0.000	0.187	0.361	Yes
	H4b	CUR $\rightarrow$ BI	0.220	4.144	0.000	0.112	0.324	Yes
	H4c	JOY $\rightarrow$ BI	0.268	5.776	0.000	0.176	0.357	Yes
	H4d	CON $\rightarrow$ BI	0.243	5.186	0.000	0.154	0.338	Yes
H5	H5a	PU $\rightarrow$ IM	0.213	3.170	0.002	0.080	0.342	Yes
	H5b	CUR $\rightarrow$ IM	0.113	1.573	0.116	−0.034	0.249	No
	H5c	JOY $\rightarrow$ IM	0.246	3.696	0.000	0.114	0.374	Yes
	H5d	CON $\rightarrow$ IM	0.222	3.180	0.001	0.081	0.352	Yes

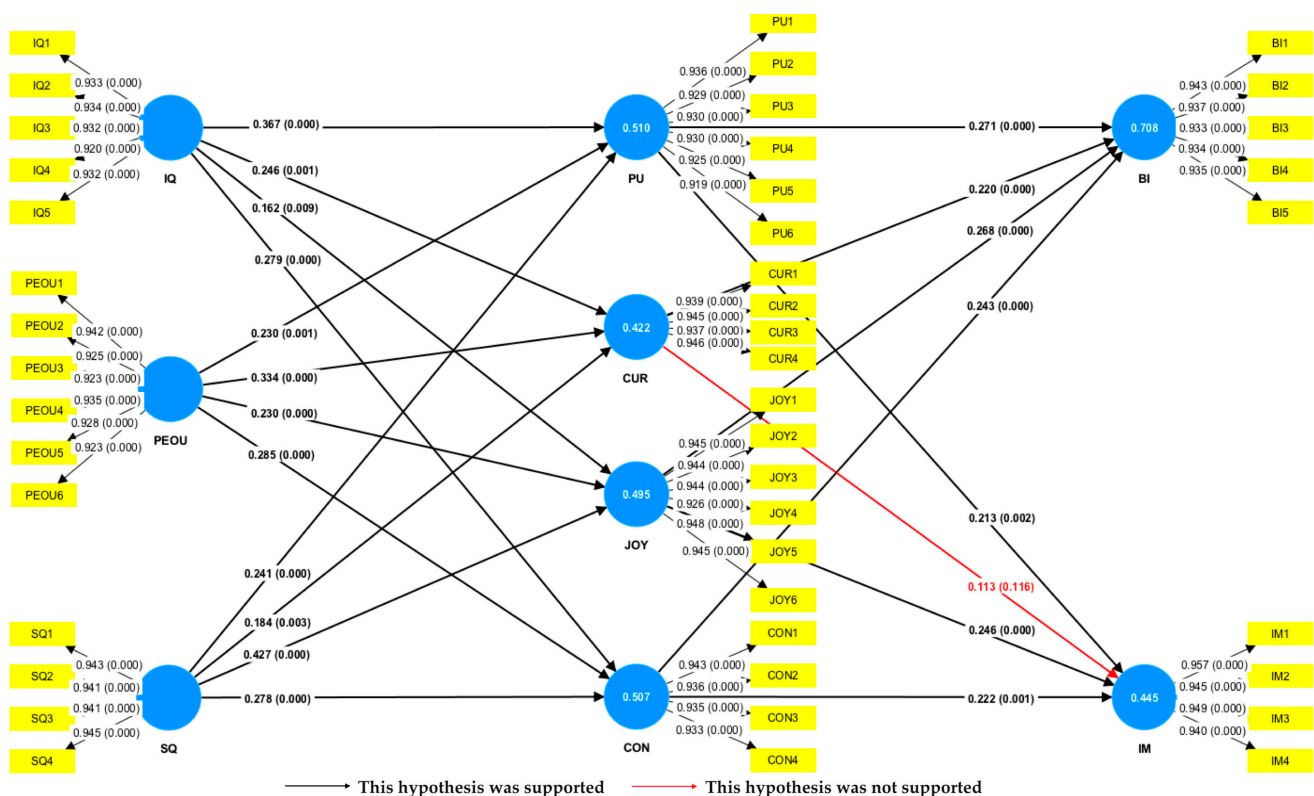


Figure 3. Results of structural model test.

4.6. Mediation Analysis

This study provides an in-depth analysis of the mediation effect of the model. According to previous literature, the mediation effect is considered significant if the 95% confidence interval of bootstrap does not include zero [92]. We found that all four variables (JOY, PU, CUR, and CON) have significant mediation effects, as none of the 95% confidence intervals for IQ, SQ, and PEOU with BI include zero (Table 12). To make the relationship between the strength of the mediating effect clearer, we use the variance accounting factor (VAF) indicator in PLS-SEM. This indicator assesses the magnitude of the mediating effect by calculating the ratio of the indirect effect to the direct effect. A partial mediation effect is indicated when $20\% < \text{VAF} < 80\%$, while a $\text{VAF} > 80\%$ indicates a full mediation effect. Based on the results presented, we find that IQ not only directly affects BI ($\beta = 0.265$, $t = 6.532$, $p < 0.001$), but also has a partially mediating effect through PU, CUR, and CON, which explain 37.7%, 20.4%, and 25.7% of the variance.

Table 12. Direct and indirect impact analysis.

	Relationship	β	SE	t-Value	<i>p</i>	2.50%CI	97.50CI	Supported	VAF
Direct effect	IQ → BI	0.265	0.041	6.532	0.000	0.188	0.344	Yes	-
	SQ → BI	0.288	0.044	6.482	0.000	0.197	0.374	Yes	-
	PEOU → BI	0.267	0.047	5.714	0.000	0.175	0.357	Yes	-
	IQ → IM	0.208	0.036	5.717	0.000	0.139	0.281	Yes	-
	SQ → IM	0.239	0.040	5.908	0.000	0.159	0.318	Yes	-
	PEOU → IM	0.206	0.039	5.285	0.000	0.134	0.286	Yes	-
Indirect effect	IQ → JOY → BI	0.043	0.019	2.282	0.023	0.012	0.088	Yes	0.162
	IQ → PU → BI	0.100	0.023	4.312	0.000	0.060	0.154	Yes	0.377
	IQ → CUR → BI	0.054	0.021	2.555	0.011	0.020	0.105	Yes	0.204
	IQ → CON → BI	0.068	0.021	3.304	0.001	0.034	0.118	Yes	0.257
	SQ → JOY → BI	0.114	0.027	4.197	0.000	0.068	0.175	Yes	0.396
	SQ → PU → BI	0.065	0.021	3.121	0.002	0.031	0.113	Yes	0.226
	SQ → CUR → BI	0.040	0.017	2.388	0.017	0.014	0.081	Yes	0.139
	SQ → CON → BI	0.067	0.022	3.111	0.002	0.033	0.120	Yes	0.233
	PEOU → JOY → BI	0.061	0.020	3.071	0.002	0.028	0.107	Yes	0.228
	PEOU → PU → BI	0.063	0.022	2.840	0.005	0.025	0.114	Yes	0.236
	PEOU → CUR → BI	0.073	0.027	2.702	0.007	0.030	0.137	Yes	0.273
	PEOU → CON → BI	0.069	0.022	3.173	0.002	0.034	0.123	Yes	0.258
	IQ → JOY → IM	0.040	0.020	2.039	0.041	0.010	0.089	Yes	0.192
	IQ → PU → IM	0.078	0.030	2.634	0.008	0.028	0.146	Yes	0.375
	IQ → CUR → IM	0.028	0.021	1.342	0.180	−0.004	0.081	No	-
	IQ → CON → IM	0.062	0.023	2.706	0.007	0.025	0.116	Yes	0.298
	SQ → JOY → IM	0.105	0.031	3.359	0.001	0.051	0.173	Yes	0.439
	SQ → PU → IM	0.051	0.021	2.384	0.017	0.018	0.107	Yes	0.213
	SQ → CUR → IM	0.021	0.016	1.322	0.186	−0.002	0.061	No	-
	SQ → CON → IM	0.062	0.026	2.390	0.017	0.020	0.125	Yes	0.259
	PEOU → JOY → IM	0.056	0.023	2.483	0.013	0.022	0.111	Yes	0.272
	PEOU → PU → IM	0.049	0.020	2.420	0.016	0.018	0.099	Yes	0.238
	PEOU → CUR → IM	0.038	0.026	1.460	0.144	−0.007	0.099	No	-
	PEOU → CON → IM	0.063	0.025	2.496	0.013	0.023	0.127	Yes	0.306

Moreover, the three variables (JOY, PU, and CON) do not include zero in the 95% confidence intervals of IQ, SQ, and PEOU with IM, and also have significant mediation effects. On the contrary, CUR includes zero in the 95% confidence intervals of IQ, SQ, and PEOU with IM, and therefore does not have a mediating effect. IQ can directly affect IM ($\beta = 0.208$, $t = 5.717$, $p < 0.001$) and has a partial mediating effect through PU and CON, explaining 37.5% and 29.8% of the variance. SQ could significantly affect IM ($\beta = 0.239$, $t = 5.908$, $p < 0.001$) through JOY, PU, and CON, explaining 43.9%, 21.3%, and 25.9% of the variance. Meanwhile, PEOU can significantly affect IM ($\beta = 0.206$, $t = 5.285$, $p < 0.001$), which is also partially mediated through JOY, PU, and CON, explaining 27.2%, 23.8%, and 30.6% of the variance.

5. Discussion

In our study, which focuses on the factors that influence users' intention to engage and immerse themselves in the metaverse art exhibition platform (MeAEP) combining the concepts of ISSM and HMSAM, we obtain some key findings through the results analyzed in the empirical study.

First, H1a, H1b, H1c, and H1d are validated, demonstrating that IQ positively affects PU, CUR, JOY, and CON. Users are more likely to understand and perceive the connotations of artwork when art exhibitions in MeAEP present high-quality information that is more detailed and accessible. This clear communication of information is more likely to make users feel that MeAEP is useful, therefore they will be more inclined to use it [51]. Meanwhile,

the significant relationship between IQ and PU is also in line with previous findings [20]. MeAEP serves as a virtual social platform where users can customize their avatars to not only personalize their experience of art exhibitions, but also share and exchange ideas, resulting in their curiosity increasing [54]. Compared to physical exhibitions, some artworks are displayed in glass showcases because they are more precious, and viewers can only see a part of the artwork. However, in MeAEP it is possible to look at the artwork from any angle, see tiny details or brushstrokes, get more information about the artwork, and the same art exhibition can be more diversified and interesting to visit. This diversified visiting experience satisfies the user's needs, and they will feel happy because of it [47]. Through high-quality information, MeAEP makes it easier for users to understand and control art exhibition messages, and they can independently select art exhibitions of interest and interact with other users or enjoy them alone, thus increasing users' self-confidence and sense of control [19]. In the current results, we observed that IQ was able to directly influence BI and IM, especially with respect to PU, which was the strongest predictor of IQ. For BI and IM, the indirect effects through $IQ \rightarrow PU \rightarrow BI$ and $IQ \rightarrow PU \rightarrow IM$ are more significant, suggesting that PU has a stronger mediating role between the two. Users utilize the information provided by MeAEP to access the content of art exhibitions, and since MeAEP has no spatial or economic limitations, it not only provides richer information, but also makes it easy to change and update exhibition information. In addition, the level of IQ directly affects their knowledge and understanding of art exhibitions, and a high level of IQ will significantly improve PU. Therefore, MeAEP developers need to update the database in a timely manner to ensure the comprehensiveness of the information on art exhibitions so that artists can display more personalized works of art and ordinary users can enjoy diversified art exhibitions at any time.

Secondly, H2a, H2b, H2c, and H2d are established, indicating that SQ has a significant effect on PU, CUR, JOY, and CON. MeAEP's technology breaks through physical space, time, and location constraints for access, has a cleverly designed platform layout and navigation, and offers varied visit formats and interactive socialization activities [19,21]. Meanwhile, MeAEP utilizes Web3D digital technology to achieve multi-platform and multi-terminal interconnectivity, helping artists and audiences understand cloud display and cloud experience. For users, they will find such a platform more useful [20]. In addition, SQ positively affects PU in line with the results of previous researchers. The continuous upgrading of the MeAEP system ensures that the process of users' interactions with the platform is smoother and more interesting, meaning they are more likely to find their interactions with MeAEP enjoyable [19]. This will effectively increase the quality and frequency of users' visits. The good performance of SQ not only provides users with diverse interactive experiences, but also provides artists with more opportunities to display artwork, thus enriching the exhibition experience for users. Such innovative browsing will stimulate their curiosity [59]. In this, SQ directly influences BI and IM, and JOY is the factor where SQ has the most significant impact ($SQ \rightarrow JOY \rightarrow BI$ and $SQ \rightarrow JOY \rightarrow IM$), emphasizing the critical importance of the need for enjoyment and pleasure in influencing usage behaviors and immersion in MeAEP. The efficient response time of MeAEP's quality assurance platform ensures that users are able to interact and socialize, thus contributing to the user's sense of control and satisfaction. Therefore, MeAEP developers should choose appropriate ways to present artwork and design relevant system content in a way that minimizes unnecessarily cumbersome data and interfaces, thereby reducing load times and enhancing user enjoyment. In addition, MeAEP can introduce new features of social interaction in the system such as user messages, likes, and presents. On the other hand, these features ensure that artists receive direct audience feedback and understand their needs and expectations, so that they can continuously improve and optimize their artwork.

H3a, H3b, H3c, and H3d show that PEOU positively affects PU, CUR, JOY, and CON. The positive effect of PEOU on PU has also been confirmed several times in the previous literature examining new platforms [23,48]. The intuitive interface and easy-to-use operation provided by MeAEP help users to access information about the art exhibitions

quicker, which in turn enhances their PU. Through a simple and pleasurable operational experience, users are more likely to establish an emotional connection, which increases their curiosity and pleasure in MeAEP [68]. The results of the research further suggest that PEOU directly influences BI and IM. CUR is the most significant factor influencing PEOU and the mediator (PEOU $\rightarrow$ CUR $\rightarrow$ BI), which is likewise the most significant factor influencing BI. This shows that CUR is the biggest motivator for users to actively explore MeAEP, pushing them to actively try out the features and experiences of the platform. For IM, CON served as the most significant mediator (PEOU $\rightarrow$ CON $\rightarrow$ IM), indicating that when users were able to easily perform various operations without much effort, they were more focused on the exhibition content, further enhancing immersion. Prior research has also shown that PEOU positively affects user happiness [70]. Meanwhile, PEOU allows artists to plan and design virtual art exhibitions more freely without having to learn too much about complex technical details. This inspires artists to spend more time and energy on art exhibitions, as they can update and adjust the exhibition at any time without having to face tedious operational steps, increasing the artist's sense of control over the exhibition creation process. Therefore, MeAEP developers could add more vivid and interesting art exhibition templates to give artists more options when creating their personal exhibitions. Developers should also regularly maintain the platform's data and interface to ensure it is stable and smooth to prevent crashes and lag, ensuring that users can easily use and maneuver the platform.

Moreover, H4a, H4b, H4c, and H4d were valid, stating that PU, CUR, JOY, and CON were significant factors influencing MeAEP usage intention. PU positively affects users' BI, which is consistent with previous studies [62,67,68], suggesting that when users obtain more useful information about exhibitions and gain insights into related artworks through MeAEP, they continue to stimulate pleasure and imagination and perceive the platform as having tangible value [19]. This in turn promotes their long-term use. In addition, scholars have confirmed that CUR and JOY are positively related to BI [64]. Users are more inclined to learn about and use the platform when they are curious about art exhibitions in MeAEP. Considering that most of the respondents were young, they were more inclined to experiment with new technologies and platforms, understanding interface commands and manipulating digital interfaces more easily [67]. Among the path coefficients, PU has the highest direct coefficient, indicating that MeAEP users' PU has a greater effect on BI than CUR, JOY, and CON. Users pay more attention to the smoothness of using the platforms, the friendliness of the interface design, the convenience of the interaction, and the practicality of providing the art exhibition content to satisfy their practical needs. Users prioritize the use of the platforms that provide useful information about the art exhibitions. Therefore, MeAEP's developers can consider introducing real-time online question-and-answer robots to guide new users through specific operations and provide operational guidance so that new users can master the platform's functions easier. Providing instant help and answers to older users will help the platform collect user feedback and concerns, which will in turn allow for developers to continuously optimize the question database, further enhancing and updating the platform's functions, and more accurately meeting users' needs and improving user satisfaction.

Finally, H5a, H5c, and H5d hold true, meaning that PU, JOY, and CON have positive and significant effects on IM. Among them, JOY has the most significant direct effect, followed by CON and PU. These findings show that MeAEP is perceived as useful for users to fulfill the needs of art appreciation and information acquisition, and that users are more willing to invest their time and attention in order to feel immersed using the platform. Users are able to ignore other distractions [78] and become fully immersed while browsing art exhibitions on MeAEP. In addition, MeAEP provides easy access to art exhibitions, and users stimulate interest and imagination and have an enjoyable experience by learning information about the artwork and participating in the artist's creative process [21]. The significant impacts of JOY and CON with IM have similar results to previous studies [18]. MeAEP has enjoyable experiences and diverse interactions that can enhance

users' emotional resonance and improve pleasure, resulting in enhanced immersion [81]. This same sense of control over the platform could prompt a deeper immersive experience for the user if MeAEP provided more personalized settings where the artist could adjust the presentation of the art exhibition according to their own preferences and needs [60]. Some scholars have confirmed that users are more inclined to use more immersive systems [79], however, H5b does not validate that CUR does not have a significant effect on IM. This result is contrary to previous research [80], likely because, as an emerging art exhibition platform, users will initially enter MeAEPs out of curiosity, but due to the lack of in-depth interactive mechanisms on the platform, they will be lost when they get the information about a specific art exhibition and will only explore superficially, not being able to experience the richness of MeAEP, thus failing to develop a deeper immersion and experience. MeAEP developers should integrate more advanced technologies to enhance users' sensory experiences such as visual, auditory, and tactile senses, and design more in-depth interactive elements including (but not limited to) touch, gesture, voice, and other interaction methods so that users can be immersed in MeAEP and improve the sense of immersion.

6. Implications, Limitations, and Conclusions

6.1. Implications

This study integrates two theories—the information system success model (ISSM) and the hedonic motivation system adoption model (HMSAM)—to factor analyze the usage and immersion behaviors of users of the metaverse art exhibition platform (MeAEP), which includes IQ, SQ, PEOU, PU, CUR, JOY, CON, BI, and IM. First, our research is one of few current projects that integrate these two models, providing a more comprehensive and multilevel theoretical framework for MeAEP research which facilitates a comprehensive examination of all aspects affecting user experience and immersion behavior. Meanwhile, the intersection of information systems and hedonic motivation provides researchers with more in-depth thinking and exploration space. The empirical analysis of the model by using PLS-SEM method provides concrete data support for the practical application of ISSM and HMSAM, which helps to better explore the intrinsic mechanisms of user experience and behavior in MeAEP and provide new perspectives and theoretical contributions to research in fields related to the metaverse. In the future, relevant researchers can similarly adopt this approach to integrate relevant theories and explore the factors that influence users in other domains of the metaverse in depth.

Next, as an emerging way to promote the dissemination of information and innovation in art and culture, MeAEP adopts the Internet as its medium. It provides an innovative and digitized exhibition platform that enables artists to display forward-looking and experimental artworks in virtual form, which is conducive to expanding the boundaries of artistic innovation and promoting the continuous development of the art field. In addition, MeAEP expands the scope of global dissemination of art works, enabling artists to get rid of the geographical limitations of traditional art exhibitions and present their works in virtual form to a global audience, prompting the dissemination of art works to a wider audience and realizing the sharing of global art.

Meanwhile, the government can encourage institutions and professionals in the fields of culture, science, technology, and education to participate in MeAEP through incentives (financial support and special funds, etc.) to promote cross-border cooperation and innovation, and to promote continuous innovation and the diversified development of technological content, which is conducive to promoting the digitalization of the entire cultural industry. In addition, a more friendly legal and regulatory environment is established to support the continuous development of MeAEP, which includes requiring platforms to clarify their policies on the collection and use of user data as well as strengthening the protection of user privacy. These measures will not only help improve users' trust in the platforms and increase their intention to use them, but also promote healthy competition among MeAEPs and the continuous upgrading of their technologies and services.

Finally, PU and JOY are important factors that influence MeAEP users' intention and immersion behavior. In order to attract more users, MeAEP developers should regularly organize events that enhance user engagement and immersion. Examples include virtual art festivals, virtual themed exhibitions, lectures by renowned artists, and interactive workshops that are fun and artistic. In addition, the MeAEP platform can introduce games and reward mechanisms such as virtual medals, points, honorary titles, and digital artwork giveaways to stimulate users' interest and sense of joy and increase their retention. At the same time, enhancing the personalization of users' virtual images to include more diverse and low-limit elements confers a stronger social aspect to the virtual art exhibition platform. By providing more diverse virtual image elements, MeAEP can become a space for users to create personalized virtual identities and promote interaction and communication between users. More avatar hairstyles, costumes, makeup, and decorations can also be added within the platform to create a more interesting, interactive, and rich virtual community environment. This will provide users with a more personalized and immersive experience that better meets their desires, thus enhancing the attractiveness and sustainability of MeAEP.

6.2. Limitations and Future Research Directions

This research has some limitations. Firstly, the majority of the subjects of the questionnaire for this research came from online sources, with only a small number coming from offline sources. Although online questionnaires can quickly collect a large number of samples in a short period of time, if all of them can be collected through offline face-to-face methods, it will help the respondents to understand the questions more fully and provide more accurate answers, thus reducing errors caused by understanding bias and further improving the reliability of the questionnaire data and the recovery rate. Second, due to the rapid growth of MeAEP and the short survey period, the majority of respondents used it only once a week or once a month. Since user experience changes over time, a long-term survey of users regularly attending metaverse art exhibitions could be conducted in the future to obtain more detailed and accurate results. Third, the data in this research came only from users in China, which may not be fully representative of the global user community. In the future, consideration can be given to expanding the geographic scope of the sample and investigating users' perceptions of MeAEP globally in order to obtain a more comprehensive evaluation and make the conclusions more widely applicable.

Notably, the different intention and immersion behaviors of MeAEPs such as The Sandbox, Cryptovoxels, and Somnium Space can be explored in future research. The attitudes of artist and non-artist users towards MeAEP can also be compared to understand the differences in platform experience, demand expectations, and feedback between these two groups of users, which can be beneficial for the personalization of the platform's functional design in order to provide an experience that meets the expectations of different user groups. In addition, since our research focuses on constructing and validating a theoretical model, a prototype of MeAEP will be developed in the future, using the theoretical model, applied to a company project for practice, and then optimized again through evaluation and feedback by a panel of experts. Finally, we can also consider combining more research methods such as in-depth interviews and field experiments to make up for the limitations of the questionnaire method, obtain more comprehensive and in-depth data, and better understand the immersive usage behavior and feedback of MeAEP users. Despite the above limitations, this research has made significant progress in constructing and validating the theoretical model and is committed to exploring the factors that influence users' usage behavior and immersion in MeAEP in greater depth.

6.3. Conclusions

In this research, we integrate ISSM and HMSAM for assessing users' behavioral intention and immersion with MeAEP. Nine factors (IQ, SQ, PEOU, PU, CUR, JOY, CON, BI, and IM) of these two models were validated by PLS-SEM. Online and offline questionnaires were used to collect data from a total of 370 respondents, and then SPSS 27 and Smartpls

4 were used to test the validity and model fit. Out of the 20 hypotheses, 19 hypotheses were empirically supported, validating the integration relationship between the theoretical models. PU has the greatest influence on users' behavioral intention to use MeAEP, followed by JOY, CON, and CUR. In addition, JOY has the greatest influence on users' immersion behaviors, followed in descending order by CON and PU. Similarly, IQ, SQ, and PEOU can be mediated by these three mediators to indirectly influence IM. The current CUR does not have a positive effect on IM. Thus, different factors have different effects in influencing MeAEP users' intentions to use it in the long term as well as their immersive behaviors while experiencing it. This study makes theoretical and practical implications for academia and the arts and culture. On the one hand, the theoretical model of this study is not only limited to MeAEP, but also generalizable enough to be used in all metaverse virtual environments, providing new perspectives on the study of users' intention to use MeAEP and their immersion behaviors at the level of information systems and hedonic motivation. On the other hand, PU and JOY have become key factors influencing MeAEP users' BI and IM, and the introduction of metaverse virtual technology into art exhibitions as a new platform helps to promote deeper user participation and usage, thus expanding the forms of expression in art exhibitions. Therefore, in the design of MeAEP, developers can promote the value of art exhibitions by enriching the information and knowledge of art exhibition works, as well as developing more exhibition themes of different art styles. In addition, the platform system can also plan the interface content and set up interesting interactions to increase the participation experience of virtual images and enhance entertainment and immersion.

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Abbreviations

The following abbreviations are used in this manuscript:

MeAEP	Metaverse art exhibition platform
ISSM	Information system success model
HMSAM	Hedonic motivation system adoption model
TAM	Technology acceptance model
CA	Cognitive absorption
PLS-SEM	Partial least squares structural equation modeling
PEOU	Perceived ease of use
PU	Perceived usefulness
IQ	Information quality
SQ	System quality
CUR	Curiosity
JOY	Joy
CON	Control
BI	Behavioral intentions
IM	Immersion
HTMT	Heterotrait-Monotrait ratio of correlations

Appendix A

Table A1. Questionnaire for variable items and reference (n = 44).

Variables	Items	Issue	Reference
Information Quality (IQ) (5 items)	IQ1	MeAEP finds content that meets my needs.	(Y.-M. Cheng, 2014) [47], (Aeni Hidayah et al., 2020) [48], (Lee et al., 2020) [93], (Wu et al., 2021) [19], (A. Cheng et al., 2023) [50]
	IQ2	MeAEP has enough resources to meet my needs.	
	IQ3	The output information from MeAEP is clear.	
	IQ4	The information on exhibits from MeAEP is concise.	
	IQ5	MeAEP presents the information of exhibits in an appropriate way.	
Perceived Ease of Use (PEOU) (6 items)	PEOU1	I found MeAEP easy to use.	(Davis, 1989) [16], (Venkatesh, n.d.) [94], (Lowry et al., 2013) [18], (Deng and Yu, 2023) [66], (Perez et al., 2023) [67]
	PEOU2	Interaction with MeAEP is clear and understandable.	
	PEOU3	Interacting with MeAEP did not require a lot of my mental effort.	
	PEOU4	It was be easy for me to become skillful at using MeAEP.	
	PEOU5	I found MeAEP to be trouble free.	
	PEOU6	I found it easy to get MeAEP to do what I want it to do.	
System Quality (SQ) (4 items)	SQ1	The MeAEP system interface is friendly to me.	(Lee et al., 2020) [93], (Gim et al., 2022) [20], (Wu et al., 2022) [19], (Zhang and Abd Rahman, 2022) [49], (A. Cheng et al., 2023) [50]
	SQ2	MeAEP not only attracts the user's attention, but also enhances the understanding of the exhibits.	
	SQ3	MeAEP provides easy access to the content the user needs.	
	SQ4	I have ready access to the resources in the MeAEP system.	
Perceived Usefulness (PU) (6 items)	PU1	MeAEP reduces my stress.	(Davis, 1989) [16], (Oluwajana et al., 2019) [61], (Wu et al., 2021) [95], (Xu et al., 2023) [96]
	PU2	MeAEP can improve my artistic ability.	
	PU3	MeAEP can get the content of the exhibition I want.	
	PU4	MeAEP makes it easy for me to understand the exhibits.	
	PU5	MeAEP improves my efficiency in accessing exhibit resources.	
	PU6	I find MeAEP useful for my studies.	
Curiosity (CUR) (4 items)	CUR1	Using MeAEP inspires my curiosity.	(Lowry et al., 2013) [18], (Chen et al., 2021) [63], (Perez et al., 2023) [67]
	CUR2	MeAEP makes me curiously.	
	CUR3	MeAEP inspires my imagination.	
	CUR4	MeAEP favors the intention to explore uncharted territories of art.	

Table A1. Cont.

Variables	Items	Issue	Reference
Joy (JOY) (6 items)	JOY1	Interacting with MeAEP is enjoyable.	(Lowry et al., 2013) [18], (Palos-Sanchez et al., 2022) [65], (Deng and Yu, 2023) [66], (Perez et al., 2023) [67]
	JOY2	I find MeAEP very interesting.	
	JOY3	Using MeAEP makes me feel satisfied.	
	JOY4	MeAEP never bores me.	
	JOY5	I really enjoy using MeAEP.	
	JOY6	I had fun using the MeAEP.	
Control (CON) (4 items)	CON1	I have a lot of control in MeAEP.	(Lowry et al., 2013) [18], (Palos-Sanchez et al., 2022) [65], (Deng and Yu, 2023) [66], (Perez et al., 2023) [67]
	CON2	I have control of interactions with the MeAEP.	
	CON3	I have the ability to take control of MeAEP.	
	CON4	I have easy and convenient access to information about MeAEP features.	
Immersion (IM) (4 items)	IM1	I can block most other distractions in MeAEP.	(Sidek et al., 2020) [62], (Deng and Yu, 2023) [66], (He et al., 2023) [77], (Perez et al., 2023) [67]
	IM2	I was absorbed in what I was doing.	
	IM3	It's easy for me to get immersed in MeAEP.	
	IM4	My attention was not diverted very easily.	
Behavioral Intentions (BI) (5 items)	BI1	I intend to use more MeAEP in the future.	(Oluwajana et al., 2019) [61], (Chen et al., 2021) [63], (Perez et al., 2023) [67]
	BI2	I like the exhibition way of MeAEP.	
	BI3	MeAEP makes art more interesting	
	BI4	I intend to continue to use MeAEP.	
	BI5	I would highly recommend MeAEP to others.	

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