Journal of Computer Science

Research Article

The Impact of Design and Security on Generation Z's Continuance Intention in the AI-Enhanced Metaverse

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Article history
Received: 05-06-2026
Revised: 04-07-2026
Accepted: 12-08-2026

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Abstract: Artificial Intelligence (AI) and the Metaverse are the source of quick and extensive changes in the virtual world. Unfortunately, such a point is rarely discussed in the academic community and the reasons why users may be able to accept an AI-enhanced Metaverse environment are not well explored. The purpose of this study is to further reconnoiter the relationship between AI and the Metaverse and how AI can help improve and spread the Metaverse. To develop the research model, the TAM was combined with the Expectancy Confirmation Model (ECM). Data were collected online through an online survey. For the Metaverse, 541 people participated, with an 89% response rate. Data was analyzed with Smart-PLS 4. The results showed that the level of security in the Metaverse is not directly related to perceived usefulness or ease of use but it affects the ability users have to use the Metaverse. The findings provide valuable insights for the metaverse designers to understand the metaverse design features and its security elements and how to promote its acceptance.

Keywords: Metaverse, Perceived Usefulness, Perceived Ease of Use, Artificial Intelligence, Satisfaction

Introduction

The Metaverse was first conceptualized in Neal Stephenson's Speculative Book Snow Crash (1993) as a shared reality with millions of people involved. The Metaverse is the combined digital world in which the internet connects the internet and VR and allows users to interact with one another as well as virtual entities (Mozumder et al., 2023). In this online world, people can create and build their own digital identity and story and keep up with others (Tukur et al., 2024). Artificial intelligence is in a unique position in this virtual world because these two worlds interact in a reciprocal way to enhance the capabilities of each of them (Zohuri et al., 2023). AI can analyze massive amounts of data and make sense of it and learn from it, so that users and creators can have a tool to enhance their experience in the virtual world (Khang et al., 2023). The AI's message interpretation capabilities allow the process of communicating over language barriers without the need for language barriers and has all regions to work together to work in a global field. As the virtual world is likely to create jobs like the internet, new businesses and jobs will be created in the virtual world and job roles and job descriptions needed to manage and control the virtual ecosystem (Fui-Hoon et al., 2023).

Artificial intelligence is capable of performing tasks, adapting to changing environments and learning things autonomously (Dubova, 2022). AI can be a powerful resource that enhances user interactions and collaboration, improving the overall experience in the Metaverse (Huynh-The et al., 2023). AI has been added to the Metaverse and has been developing and improving the user experience in the Metaverse with AI agents, personalization and natural language processing (Bibri and Jagatheesaperumal, 2023). AI and the Metaverse are being used in many fields such as gaming, education and healthcare. In order to do so, we must be able to see the convergence of products in all industries that we are working in. According to the report, video game players are the pioneers in virtual reality activities today. And there are more than 3.2 billion players all around the world and it is growing every day. Such developments are expected to develop a large user base and sustain the Metaverse and increase the popularity of the Metaverse beyond the current popularity. Young people and new users are very good at adapting to new websites and platforms on their own. The virtual world is synchronizing with the real world and becoming more intelligent and autonomous with AI (Yang et al., 2023). The Metaverse can create VR, AR, and mixed reality experiences in virtual reality by integrating supported technologies in real life with artificial intelligence, blockchain, the Internet of Things (IoT) and 5G (Jagatheesaperumal et al., 2024).

Theoretical Background

Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) has been widely applied in the field of acceptance of new electronic technologies (Davis, 1989; Venkatesh and Davis, 1996) and related digital services. In line with the Theory of Reasoned Action (TRA) of Ajzen and Fishbein (1970), TAM is considered one of the best contributions in the field. Experiments have shown that users' perceptions of a technology in terms of the utility of the technology, usability of its work, attitude to it, and desire to use it depend on two key dimensions: Perceived usefulness and perceived ease of use. Perceived usefulness indicates that users believe using a system would improve their work performance while perceived ease of use means that users wish to be as simple as possible to use a system. It was proven that perceived usefulness is a significant predictor of users' attitudes towards the Metaverse and its role in accessing it in different places, eLearning and professional services (Wu and Yu, 2024; Alhalaybeh and Althunibat, 2023; Leo et al., 2023). On the other hand, perceived ease of use is not significant enough to influence intention, meaning users might be more interested in the advantages than the ease of use (Ali et al., 2025; Alshammari and Alshammari, 2024).

Al-Adwan et al. (2018) studied the factors that affect students who intend to use Metaverse technology in higher education. They suggest the development of a more comprehensive TAM that does this. The research shows the importance of perceived usefulness, personal innovation, and perceived enjoyment in students' motivation to use Metaverse technologies. Toraman and Geçit (2023) used TAM to study Metaverse technologies and non-fungible tokens (NFTs) and found that perceived compatibility, enjoyment, and trust have a positive impact on perceived usefulness. Misirlis et al. (2023) used TAM to examine the relationship between students' intentions to use the Metaverse in education and TAM-based constructs such as attitude (ATT), Perceived Usefulness (PU), perceived ease of use (PE), perceived Self-Efficacy (SE) about Metaverse technologies in education, and Subjective Norm (SN).

Expectation Confirmation Model (ECM)

The Expectation Confirmation Model (ECM) seeks to explain the long-term use of technology beyond its initial acceptance (Bhattacherjee, 2001). It has four main aspects: Usefulness, confirmation, satisfaction, and desire to use the system. Satisfaction is the user's emotional response to the service provider. Moreover, this emotion enters when you consume the technology. Confirmation is when the user feels that their expectations about the technology have been met (Bhattacherjee, 2001). Confirmation is the user's initial belief in the technology's effectiveness, based on the user's expectations. Moreover, confirmation emphasizes the user's initial acceptance of the technology, since changes will occur in future usage (Bhattacherjee, 2001). So, usefulness is the user's attitude toward starting to use a new technology. Users' perceived usefulness and confirmations from the first interaction are crucial for user adoption and satisfaction with the technology. Users who understand how to use their product and are satisfied with interacting with it will be more likely to continue using it. The Expectation-Confirmation Model (ECM) is essential for measuring user satisfaction and the desire to stay on platforms in digital spaces. User engagement depends on expectations about the future and the experience that follows (Lai et al., 2016). In the Metaverse, the ECM is also shaped by emotional attachments, perceived enjoyment, and social interaction that affect users' perceptions and behavior (Wu and Yu, 2024).

Natale et al. (2024) developed the Extended Expectation-Confirmation Model (EECM) as a theoretical tool to investigate the factors behind students' acceptance (and their intention to continue using integrated learning environments) in educational settings. Since the EECM aims to bridge the gap between pre-adoption expectations and the current experience of technology adoption, it can be viewed as a holistic approach to understanding technology adoption in schools. As the authors found, performance expectancy and effort expectancy had little impact on expectancy confirmation. However, when students' initial expectations matched the experience, their perception of the technology's value and their intention to adopt it in their schools were stronger, so the technology was implemented in their schools.

Literature Review

Role of AI in Metaverse

When there are differences among users in the virtual world, one of the key functions of artificial intelligence is "decision-making." For instance, in virtual reality gaming, there may be challenges (Cossich et al., 2023). In the end, we have to decide who wins and who loses, and that will be reflected in the end product. Another possibility of artificial intelligence modules is "simulation." In agriculture or animal husbandry, there should be a mechanism to simulate the growth or development of flora and fauna over time (Huynh-The et al., 2023).

Artificial intelligence modules would also need to be able to make decisions according to the designs and rules set out by the designer (e.g., when some events occur and some rules are applied to them) and hence to determine the outcome (Hwang et al., 2023). This technology allows caregivers to engage in self-directed learning and build experience and confidence to do things remotely and safely for them to do away with patients. ChatGPT can create realistic patient interactions and scenarios if they can be simulated in the real world, and the Metaverse can provide virtual reality experiences and situations where caregivers can practice and learn in real-time and a safe and controlled environment (Sharma and Sharma, 2023). Digital assets are also like AI-driven NPCs in video games where people can react to the actions in the virtual reality mode rather than a real person (Johri et al., 2024). All digital assets in the virtual space were created in a very advanced technological way and are essential for the functioning of the ecosystem (Ersoy and Gürfidan, 2023).

Several companies such as Soul Machines have invested in this field because there are many potential applications; non-playable characters in video games, and the ability to get people to be involved in a virtual professional setting (Vero, 2023). Artificial intelligence can be used to create realistic virtual beings by using computer vision to support real-life virtual users, using natural language processing to generate the voice of virtual characters, and virtual reality to create a realistic virtual environment (Massaro et al., 2025). A company might create a virtual office in the Metaverse so that it can simulate its manufacturing facility in the Metaverse and create a virtual version of its own, but users are also experts in building virtual environments and simulations in these environments, and also in developing other robotics tools like speech and autonomous robots. NVIDIA technology is an example of artificial intelligence and Metaverse in the field where virtual environments are created to be social in the context of AI (Guo et al., 2022; Bibri and Jagatheesaperumal, 2023). Generation Z is very tech-oriented and believes in individual identity, exhibits depressive behavior, and has a great interest in a wide range of products and services (Slepian et al., 2024). This generation has been formed at a time of rapid technological advancement with widespread access to the internet. Unlike millennials (people born 1981 to 1996), Generation Z started using the internet and virtual technologies from a young age and has been digitally interacting with a 'connected' world (Wilson, 2021; Buhalis et al., 2023).

AI-Driven Design

AI-driven design in the form of generative agents has been quantified and understood by users in various contexts. AI-based prototypes for mobile application UI (User Interface) and UX (User Experience) design were compared to human-made prototypes based on A/B testing and the System Usability Scale (SUS). Through qualitative interviews, we pieced together the user experience and were able to get a sense of how they felt. AI designs were frequently praised for creativity and efficiency but not yet able to consider the nuance that human-centered design requires (Kamnerddee et al., 2024). At the avatar design level, designers perceived AI as a co-creative agent and could not change the AI outputs and get inspiration. Thus, the research shows the difficulty designers face in integrating AI input into design while also considering the interests of the stakeholders and iterative development (He et al., 2023). Users had dynamic agency with AI in complex creative tasks such as image generation and writing and used strategies to take action when AI was not certain to execute. It focuses on intelligent AI that could be used to provide multiple levels of control and creativity for the user (Rafner et al., 2025).

To evaluate the quality of AI-generated designs, it’s always going to be about how they impact the user experience and the nature of AI-human interaction. Users’ opinions are affected by creativity, ease of use, and the trade-off between aesthetics and applicability. In branding the retail space, people felt AI-generated designs would better represent brand identity and brand image than existing designs. AI is also a strategic approach to better consumer experience and brand consistency (Lee et al., 2025). AI is often seen as a tool and not a partner, so it needs robust systems to work with humans and AI capabilities to improve the user experience. AI can be used in UI/UX design in differentiating ways as well as a source of efficiency and creativity. Designers recognized the role of AI in designing alternative design ideas and research, which in turn drives design process innovation (Cheng, 2025).

Research Model

The research model is developed by integrating the Technology Acceptance Model (TAM) and the Expectation-Confirmation Model (ECM). The model includes variables from both theoretical models, such as perceived usefulness, perceived ease of use, confirmation, satisfaction, and continued intention to use metaverse. Security and design are the additional constructs included in the model (Fig. 1).

Hypothesis Development

Davis (1987) argued that a system's design features affect its perceived utility. Such a technological or product design may increase the perceived utility of a system by drawing an individual's belief that it will enhance their tasks or responsibilities. Koch et al. (2011) stated that a system's design characteristics affect its perceived usefulness and user-friendliness. Balakrishnan et al. (2024) argued that the vibrancy and color palette of Metaverse design improve the overall experiential quality and utility.

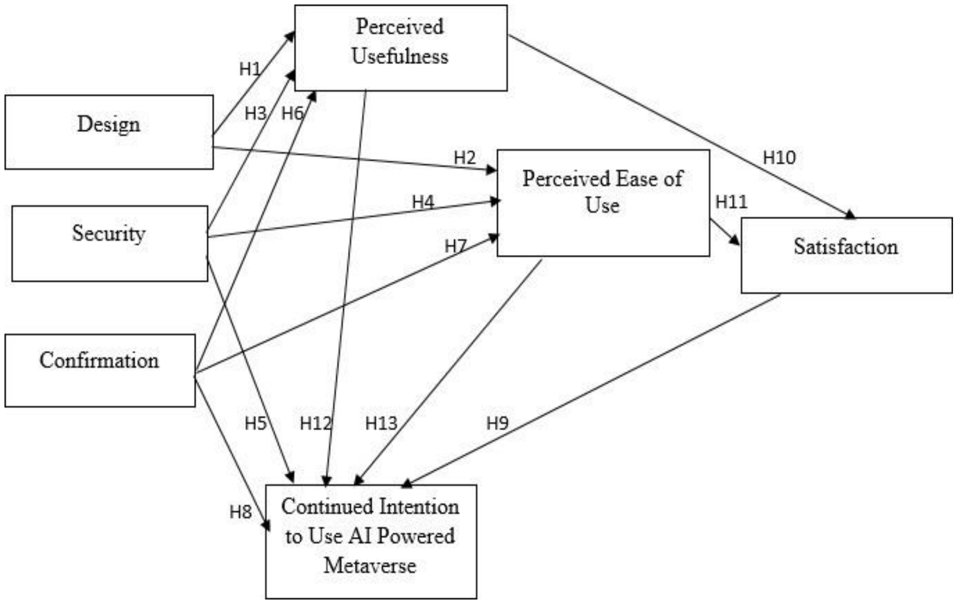

Fig. 1: Research Model

The information embedded in the Metaverse can help its users to achieve their objectives while reducing effort (Balakrishnan et al., 2024). Kim and Lee (2023); Ibili et al. (2023) realized that the Metaverse's characteristics, telepresence, interoperability, and concurrence, affect the users' sense of usefulness. These technologies are what have raised users' awareness of the utility of the Metaverse. Moreover, it has been shown that perceived usefulness is positively correlated with perceived value, suggesting that a well-thought-out Metaverse design can influence user behavior and acceptance. The design of the Metaverse itself is likely to influence users' perceptions of its utility. Based on the arguments above, we propose the following hypothesis:

H_1 : Metaverse design positively influence perceived usefulness
H_2 : Metaverse design positively influence perceived ease of use

Nikou (2019) conducted a simple empirical study to understand the effects of security, privacy, and other factors on people's perceptions of smart home technologies. Security risk is the potential loss of control over personal information and can lead to many negative consequences. They found that security risks negatively affected users' perceptions of usability and utility. In this research, security risk is important in how people think of smart home security. It was important to consider data use and security as fundamental parts of the risk perception for smart home applications for safety. The same theoretical framework applies to the Metaverse (Al-kfairy et al., 2024), which is currently an emerging marketplace with a large user base yet largely unaware of security and privacy issues. This lack of awareness reduces users' perceived utility, ease of use, and overall sense of security (Al-Adaileh et al., 2024). For this reason, security risks in the Metaverse will affect users' perceived usefulness and perceived ease of use. Based on the arguments above, we propose the following hypothesis:

H_3 : Security risks in Metaverse negatively influence perceived usefulness
H_4 : Security risks in Metaverse negatively influence perceived ease of use

In the Metaverse, security is a major concern due to potential cyber threats, including identity theft, fraud, and data breaches. The Metaverse is a fast-evolving and interconnected digital world in which people can interact, transact, and create value without the necessary security precautions. These threats are imminent and have a significant impact on many users and virtual assets (Zhao et al., 2022; Hwang et al., 2023). The Metaverse is the picture of digital technology evolution in its current form. The Metaverse has huge growth potential but is also prone to similar cyber threats across intelligent computing, cloud-network integration, terminal access, and digital assets (Li et al., 2024). Oleksy et al. (2023) noted that Metaverse integration could be damaging for privacy and the potential for interaction with the physical world. Therefore, security vulnerabilities in the Metaverse might deter people from using it too much:

H_5 : Security risks in Metaverse negatively influence Continued Intention to Use Metaverse

Confirmation refers to the extent to which an individual's expectations align with the user experience of a product or service. Confirmation is key to user satisfaction with a product or service and to the likelihood of continued use (Bhattacherjee, 2001). If users feel that the experiences align with their expectations, perceived usefulness, perceived ease of use, and their intention to continue using the system are greatly improved (Natale et al., 2024). Confirmation will therefore have a substantial impact on perceived usefulness, perceived ease of use, and the likelihood of continued use of the Metaverse. Based on the arguments above, we propose the following hypothesis:

H_6 : Confirmation positively influence Perceived Usefulness
H_7 : Confirmation positively influence Perceived Ease of Use
H_8 : Confirmation positively influence Continued Intention to Use Metaverse

User satisfaction refers to positive emotional responses to technology that align with users' expectations or typical usage behavior. Teng et al. (2022) studied the factors for the acceptance of an educational Metaverse using an augmented UTAUT model. Their findings showed that user satisfaction was strongly correlated with the likelihood of continued use of the system. Almarzouqi et al. (2022) argued that user satisfaction is important for users' readiness to use the Metaverse in medical education. Natale et al. (2024) commented that the technology's usefulness, satisfaction with usage (as a result of use), and self-efficacy are important factors for users to use the technology repeatedly. If satisfaction is such an important aspect of users' desire to use the service, then it is likely the reason they use it:

H9 : Satisfaction positively influence Continued Intention to Use Metaverse

According to Lestari et al. (2024), consumers' perceptions of utility can lead to higher satisfaction with a service. Maghaydah et al. (2024); Lestari et al. (2024) found that perceived ease of use can increase user satisfaction with online services, including those in the Metaverse. Mandal et al. (2024) found that both perceived utility and perceived ease of use in the Metaverse have a significant impact on people in Generation Z's engagement and satisfaction. As such, perceived utility and perceived ease of use positively affect satisfaction. Based on the arguments above, we propose the following hypothesis:

H_{10} : Perceived Usefulness positively influence Satisfaction
H_{11} : Perceived Ease of Use positively influence Satisfaction

As people use technology to make sense of day-to-day life, their decision to use it is determined by its practical application (Venkatesh et al., 2012). Users' attachment to technology and their ability to retain it as they use it will be affected by positive experiences, ease of use, and the technology's ability to meet users' increasing needs. The usability, convenience, and perceived value will also matter when users engage with the Metaverse (Chakraborty et al., 2024). In light of these factors, users' willingness to continue using the Metaverse (perceived usefulness and perceived ease of use) will be affected:

H_{12} : Perceived Usefulness positively influence Continued Intention to Use Metaverse
H_{13} : Perceived Ease of Use positively influence Continued Intention to Use Metaverse

Research Methodology

Instrument Development

The survey-based questionnaire is used to collect data. The survey was first tested with qualified experts (faculty members) prior to the main research study. The faculty was asked to review the linguistic precision, the relevance, and the organization of the survey. After a few minor adjustments, the questionnaire was considered complete for the main study. The questions are analyzed using a five-point Likert scale. For this study, a five-point Likert scale is used because it is easy to elicit responses from participants. The first part of the survey is designed to collect demographic information from the participants. The second part covers questions of seven constructs: Perceived Usefulness (PU), perceived ease of use (PEOU), design (DES), security (SEC), confirmation (CON), satisfaction (SAT), and the intention to continue using the Metaverse (CUI).

The questionnaire consists of 22 items. Four items of the ‘design’ construct derived from Zallio et al. (2023) are incorporated into the Metaverse framework. Three items associated with the construct of ‘Continued Usage Intention’ (CUI) and three items about the construct of ‘satisfaction’ (SAT) are extracted from the scales developed by Teng et al. (2022); Dwivedi et al. (2025). Four items of the ‘security’ (SEC) construct are adapted from the measurement scale developed by Zibarzani et al. (2024). Three items concerning ‘Perceived Usefulness’ (PU) and three items of ‘perceived ease of use’ (PEOU) are sourced from the scale formulated by Yu et al. (2024). Additionally, three items related to ‘confirmation’ (CON) are adopted from the scale devised by Thong et al. (2006).

Data Collection

The Generation Z demographic is of particular interest due to the high social appeal of the Metaverse and the high likelihood of engaging with it. Generation Z is defined as adolescents born 1997-2012 who are currently in their mid-twenties to younger ages (Slepian et al., 2024). In this sense, Gen Z university students are a very appropriate sample for Metaverse research. Gen Z digital natives (ages 1997-2012) are more fluent in digital learning and early adopters of AI-enabled experiences (Bagdi et al., 2023; Routray et al., 2024), and therefore seem ecologically suitable for Metaverse studies. Educational institutions are also adopting Metaverse applications, and this group is indeed a good fit (Nagadeepa et al., 2023). A survey-based questionnaire is applied for the data collection. Students in higher education, aged 15 to 25, are selected. We use convenience sampling to select participants, and the sample is a mix of available participants. A total of 541 responses were received from the survey, with an impressive 89% response rate.

Sample Description

The sample consisted of 56% male and 43.9% female participants, and 77.81% were aged 20 to 24 years. The majority of the respondents were aged 20 to 24 years. 49% of respondents reported using the Metaverse for 1-2 hours daily. Minecraft (42.88%) and Fortnite (23.66%) were the most commonly used platforms in the Metaverse (Table 1).

Data Analysis

Assessing Data Validity

Data analysis began by assessing the normality of the variance, which showed that skewness and kurtosis were within reasonable limits (Tabanchnick and Fidell, 2007). One of the most serious issues is the common source variance (CSV).

Overall, the study showed that Common Method Variance (CMV) was mostly handled as described by Podsakoff et al. (2003), and the CMV was most often controlled. To assess the risks of CMV, Kock (2015) collinearity analysis was conducted, and the internal Variance Inflation Factor (VIF) did not exceed 3.3. The results of the collinearity analysis showed that all internal VIFs were below the predetermined value. This result means that the model is not affected by multicollinearity.

Confirmatory Factor Analysis

Two consecutive and interconnected methodologies were employed during the data analysis phase. Initially, the unidimensionality, reliability, and validity of each measurement scale were meticulously examined. Subsequently, the thirteen hypotheses (H1 to H13) were systematically assessed. The results of the confirmatory factor analysis are delineated in Table 2.

As shown in Table 2, all primary order factors have strong, statistically significant factor loadings exceeding the expected threshold (Hair et al., 2006). Because of the very small loadings (less than 0.70) in the analysis model, one component of security, specifically SEC4, was not included. To assess the composite reliability and convergent validity of the model, we measured Cronbach's alpha, rho_a, composite reliability, and average variance for all factors (Table 2). We find that the composite reliability and Cronbach's alpha for the factors exceed the recommended levels of 0.70 and 0.80, which is satisfactory for the measurement model. As the average variance extracted for each item exceeded the 50% threshold, convergent validity was confirmed (Hair et al., 2006). Table 3 shows the discriminant validity of each construct, where the square root of the average variance extracted (AVE) is higher than the correlations with other components (Fornell and Larcker, 1981). For HTMT (heterotrait-monotrait ratio), we also test it (see Table 4), as suggested by Henseler et al. (2015). For each HTMT, we assess discriminant validity if all HTMT values are below 0.85.

The HTMT values of all items were less than 0.85. The R square values for continuance intention, satisfaction, perceived usefulness, and perceived ease of use in this study are 0.60, 0.30, 0.45, and 0.48 ($p<0.01$), all greater than 0.10 (Falk and Miller, 1992) and thus explain the sufficient variance of endogenous variables with respect to exogenous variables security, design, and confirmation (SEC, DES, and CON). The Q-square values of continuance intention, perceived ease of use, perceived usefulness, and satisfaction are 0.38, 0.47, 0.44, and 0.37. Q values greater than zero indicate the model's predictive power, as proposed by Hair et al. (2017). When an exogenous variable is removed from the model, the effect size (f-squared) reflects the change in R-squared (Chin, 2010; Cohen, 1988). The range of values is 0.02 for a weak effect, 0.05 for a moderate effect, and 0.35 for a large effect. As shown in Table 3, confirmation (0.21), design (0.19), perceived ease of use (0.11), perceived usefulness (0.07), and security (0.02) in this study have moderate effect sizes, and satisfaction has a large effect size (0.47). In contrast, all other components have small effect sizes.

Table 1: Sample Demographics

Age	Total	Count %
15 to 19 years	42	7.763
20 to 24 years	421	77.81
25 to 30 years	78	14.41
Metaverse Platform	Total	Count %
Minecraft	232	42.88
Fortnite	128	23.66
Roblox	56	10.35
Zepeto	35	6.47
Second Life	30	5.55
Sandbox	28	5.18
Others	32	5.91
Frequency of Usage	Total	Count %
1 to 2 hours	266	49.17
2 to 3 hours	149	27.54
3 to 4 hours	65	12.01
4 to 5 hours	34	6.28
More than 5 hours	27	4.99
Gender	Total	Count %
Male	303	56
Female	238	43.9

Table 2: PLS algorithm Results

Constructs (Items)	Loadings (λ)	Mean/SD	Cronbach's Alpha (α)	Composite Reliability (rho_a)	Average variance extracted (AVE)	VIF
PU1	0.88	3.37/0.93	0.88	0.88	0.81	2.18
PU2	0.92	3.46/0.85				2.98
PU3	0.89	3.48/0.84				2.58
PEOU1	0.88	3.57/0.82	0.87	0.87	0.79	2.12
PEOU2	0.88	3.50/0.83				2.29
PEOU3	0.90	3.61/0.84				2.38
DES1	0.75	3.26/0.87	0.82	0.84	0.66	1.65
DES2	0.83	3.72/0.93				1.76
DES3	0.86	3.29/0.91				1.87
DES4	0.77	3.21/0.98				1.72
SEC1	0.83	3.62/0.89	0.77	0.79	0.64	2.27
SEC2	0.87	3.37/0.99				2.32
SEC3	0.72	3.53/0.98				1.25
CON1	0.82	3.39/0.90	0.81	0.81	0.69	1.58
CON2	0.86	3.68/0.90				1.89
CON3	0.87	3.79/0.92				1.90
SAT	0.89	3.63/0.97	0.87	0.87	0.79	2.35
SAT2	0.88	3.78/0.95				2.06
SAT3	0.90	3.84/0.96				2.33
CUI1	0.88	3.49/0.99	0.80	0.81	0.72	1.93
CUI2	0.80	3.31/1.02				1.56
CUI3	0.86	3.29/0.97				1.79

Table 3: Discriminant validity

	CON	CUI	DES	PEOU	PU	SAT	SEC	R-Square	Q-Square	F-Square (Effect Size)
Confirmation (CON)	0.85									0.21
Continued Usage Intention' (CUI)	0.58	0.85						0.60	0.38	
Design (DES)	0.65	0.56	0.80							0.19
Perceived Ease of Use (PEOU)	0.60	0.46	0.64	0.89				0.48	0.47	0.11
Perceived Usefulness (PU)	0.65	0.52	0.55	0.59	0.89			0.45	0.44	0.07
Satisfaction (SAT)	0.61	0.74	0.57	0.50	0.47	0.89		0.30	0.37	0.47
Security (SEC)	0.49	0.45	0.41	0.37	0.39	0.42	0.83			0.02

Table 4: HTMT Matrix

	CON	CUI	DES	PEOU	PU	SAT
CUI	0.72					
DES	0.78	0.68				
PEOU	0.72	0.55	0.75			
PU	0.77	0.62	0.62	0.67		
SAT	0.73	0.89	0.66	0.58	0.54	
SEC	0.59	0.57	0.51	0.46	0.48	0.51

Note n = 540; Square root values of AVE for all the constructs are located on the diagonal; inter- construct correlations are found at lower diagonal values

Hypotheses Results

Test of Hypotheses (H1-H13)

In this study, we employed SmartPLS 4.0 and used a partial least squares-based structural equation modeling (PLS-SEM) to analyze the research hypothesis (Fig. 2). The study style, complexity and sample parameters are suitable for the PLS-SEM method (Hair et al., 2021). Within this approach, the exogenous variables are design (DES), security (SEC) and confirmation (CON), and the endogenous variables are perceived usefulness (PU), perceived ease of use

(PEOU), continuance usage intention (CUI) and satisfaction (SAT). PU, PEOU and SAT are both exogenous and endogenous variables. All hypotheses except H3, H4, H8 and H13 have significant coefficients (p<0.01). The empirical results showed that Metaverse design has a positive effect on perceived usefulness and perceived ease of ease. It was observed that security has a negative effect on the continuance usage intention of the Metaverse but does not significantly influence perceived usefulness or perceived ease of use. Confirmation also helps to improve the perceived usefulness and perceived ease of use. The study also found that perceived usefulness and perceived ease of use are positively related to satisfaction. Satisfaction was positively related to the continuance usage intention of the Metaverse. However, both confirmation and perceived ease of use are not very much related to the continuance usage intention. Results of the hypotheses with p-values and 95% confidence interval are presented in Table 5. The standardized root mean square residual (SRMR) is an indicator of the model's agreement with the data (Hair et al., 2021). In this study, the SRMR was 0.05 and below the 0.08 proposed by Hu and Bentler (1999) and Hair et al. (2021).

Specific Indirect Effects

To start the mediation analysis, we assess the indirect effects using bootstrapping. Indirect effects describe the influences that are there when the relation between two variables is moderated by one or more of them. A more specific way to understand this is that one variable influences the other, but the other is indirectly affected by the other variables. As shown in Table 6, the indirect effects of design on continuous intention, through perceived usefulness and satisfaction, and through perceived ease of use and satisfaction, are statistically significant. The indirect effects of confirmation on CUI via PU and SAT, and via PEOU and SAT, are also statistically significant. These indirect effects indicate that the relationships between design and continuous intention as well as between confirmation) and continuous intention were entirely mediated by PU (perceived usefulness) and satisfaction) in combination with perceived ease of use) and satisfaction, respectively. The indirect effects of security on CUI through PU and SAT and through PEOU and SAT were not significant.

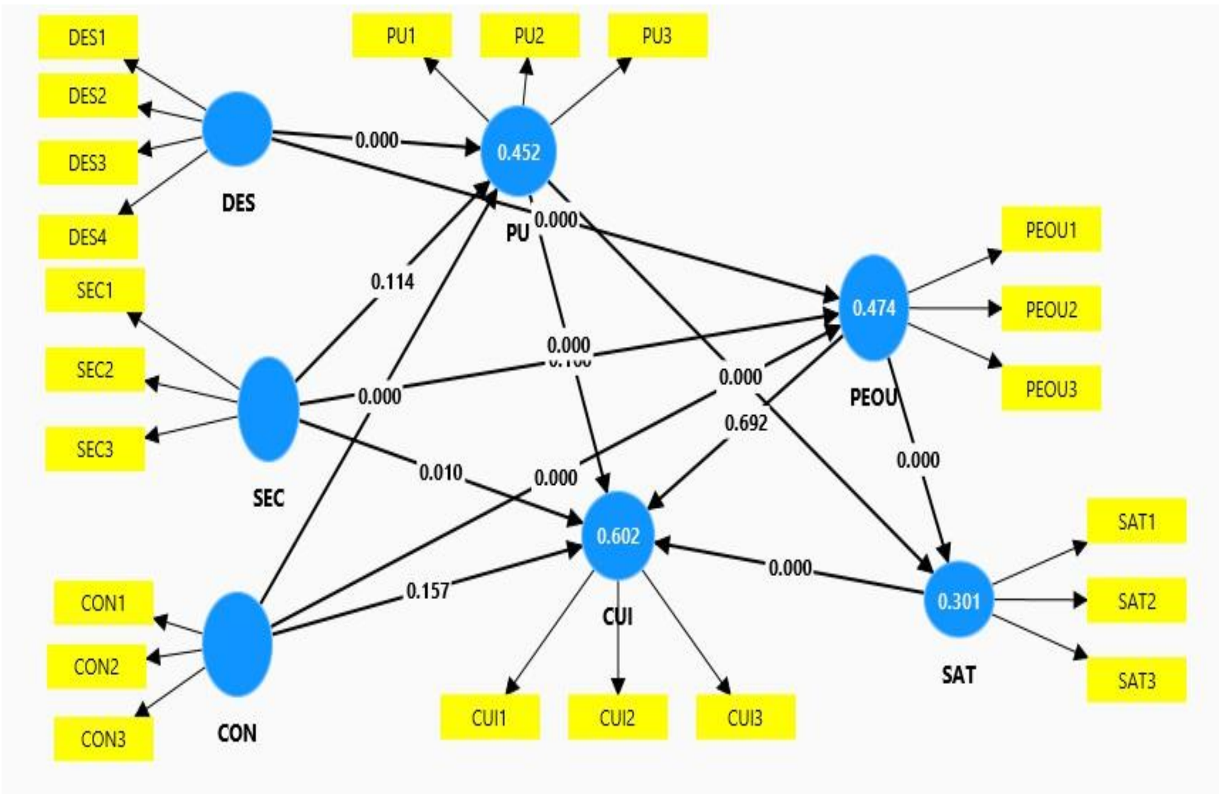

Fig. 2: PLS Structural Model

Table 5: Hypotheses Result

Hypotheses	Paths	Path Coefficients	T Statistics	P values	2.5% CI	97.5% CI
H_1	Design -> Perceived Usefulness	0.21	3.6	0.00	0.09	0.32
H_2	Design -> Perceived Ease of Use	0.42	8.6	0.00	0.33	0.52
H_3	Security-> Perceived usefulness	-0.08	1.6	0.11	-0.02	0.19
H_4	Security -> Perceived Ease of Use	-0.05	1.4	0.16	-0.02	0.13
H_5	Security -> Continued Usage Intention’	-0.11	2.6	0.01	0.03	0.19
H_6	continued usage intention’ -> Perceived Ease of Use	0.47	10.0	0.00	0.38	0.56
H_7	Perceived Ease of Use -> Perceived Ease of Use	0.30	5.4	0.00	0.19	0.41
H_8	Confirmation -> Continued Usage Intention’	0.08	1.4	0.16	-0.03	0.20
H_9	Satisfaction -> Continued Usage Intention’	0.58	11.5	0.00	0.47	0.67
H_{10}	Perceived usefulness -> Satisfaction	0.28	4.5	0.00	0.15	0.39
H_{11}	Perceived Ease of Use -> Satisfaction	0.34	5.1	0.00	0.20	0.47
H_{12}	Perceived Usefulness -> Continued Usage Intention’	0.16	3.7	0.00	0.07	0.25
H_{13}	Perceived Ease of Use-> Continued Usage Intention’	-0.02	0.4	0.69	-0.09	0.06

Table 6: Specific Indirect Effects

Path	Path Coefficients	T Statistics	P values
Confirmation -> Perceived Usefulness -> Satisfaction	0.13	4.09	0.00
Confirmation -> Perceived Ease of Use -> Satisfaction	0.10	3.46	0.00
Design -> Perceived Usefulness -> Satisfaction	0.06	2.42	0.01
Security -> Perceived Usefulness -> Continued Usage Intention’	0.01	1.34	0.18
Design -> Perceived Ease of Use -> Satisfaction	0.14	4.29	0.00
Security-> Perceived Ease of Use -> Continued Usage Intention’	-0.00	0.32	0.74
Security-> Perceived Usefulness -> Satisfaction	0.02	1.54	0.12
Security-> Perceived Ease of Use -> Satisfaction	0.02	1.28	0.20
Security-> Perceived Ease of Use -> Satisfaction -> Continued Usage Intention’	0.01	1.30	0.19
Security-> Perceived Usefulness-> Satisfaction -> Continued Usage Intention’	0.01	1.56	0.12
Confirmation -> Perceived Ease of Use -> Satisfaction -> Continued Usage Intention’	0.06	3.37	0.00
Confirmation -> Perceived Usefulness -> Satisfaction -> Continued Usage Intention’	0.08	3.71	0.00
Design -> Perceived Usefulness -> Satisfaction -> Continued Usage Intention’	0.03	2.30	0.02
Design -> Perceived Ease of Use -> Satisfaction -> Continued Usage Intention’	0.09	4.19	0.00
Confirmation -> Perceived Usefulness -> Continued Usage Intention’	0.08	3.58	0.00
Confirmation -> Perceived Ease of Use -> Continued Usage Intention’	-0.01	0.38	0.71
Design-> Perceived Usefulness -> Continued Usage Intention’	0.03	2.56	0.01
Perceived Ease of Use -> Satisfaction -> Continued Usage Intention’	0.19	4.96	0.00
Design -> Perceived Ease of Use -> Continued Usage Intention’	-0.01	0.39	0.69
Perceived Usefulness -> Satisfaction -> Continued Usage Intention’	0.16	4.05	0.00

Discussion

The study found that the architectural features of the Metaverse are positively associated with perceived utility and user-friendliness. These results are in line with Davis (1987); Koch et al. (2011); Ibili et al. (2023). In the Metaverse, they found that system design characteristics can improve users' perceived usefulness and ease of use (and, indeed, the accuracy of the task) by creating a false sense that a specific technology will help them. Additionally, Balakrishnan et al. (2024) found that information about the Metaverse can enhance navigation efficiency in virtual worlds, reducing the work required to achieve user goals. The study found that users are more likely to continue to use the Metaverse if they perceive it as useful to them and to meet their educational and personal interests, and the need to engage with it is well known in prior studies (Teng et al., 2022; Lee et al., 2025; Alshammari et al., 2024). However, according to the study, the authors found that perceived ease of use (e.g., Alshammari et al. (2024)) does not affect the users' perception of the Metaverse's ease of use, and users tend to stay using the Metaverse, as long as they feel that it is useful. In this regard, as digital natives, they do not experience any difficulty using the Metaverse in their daily lives. The users are not particularly hard tools to deal with at all (for example, Generation Z, or 'digital natives', have a deep interest in technology from a very young age. One reason is that there is already knowledge of digital environments within the generation, and they do not consider ease of use a primary driver of intention when using digital platforms. They take into account other factors like experience, functionality, and trust.

Functional aspects, such as usefulness, are important to Gen Z. They are more likely to use technology that offers tangible benefits in time savings and productivity (Syamillah et al., 2025). In digital payment systems, experience is also significant in decision-making due to perceived enjoyment and ease of use. As Gen Z is more likely to use digital services and is more influenced byinfluenced by ease of use in their decision-making, the perception of enjoyment is a key factor for Gen Z in decision-makingdecision-making. So platforms that are enjoyable or entertaining are attractive to this group (Wijerathne and Peter, 2023). Furthermore, the security issues associated with the Metaverse affect the desire to continue using the platform and this is in line with Oleksy et al. (2023) who stated that if we adopt the Metaverse, we would have lower privacy and uncertainty of people being removed from physical environments which would limit the use of the Metaverse for a longer time in the future. It also showed that confirmation has a beneficial impact on the perceived usefulness and perceived ease of use of the Metaverse. These results are in line with Natale et al. (2014), who say that when users' initial expectations of the Metaverse align with the user experience, their perceptions of the Metaverse are enhanced, as are satisfaction and confidence in using it.

The study also found that confirmation does not affect users' intention to continue using the Metaverse, which is in line with Natale et al. (2024), who found that users' intention to use the Metaverse is influenced by perceived usefulness, ease of use, and overall satisfaction. Therefore, confirmation does not affect users' intention to engage with the Metaverse. In fact, the users' satisfaction in the Metaverse is positively influenced by perceived utility and simplicity of use as Maghaydah et al. (2024); Mandal et al. (2024); Lestari et al. (2024) showed that perceived simplicity of use has a positive impact on user satisfaction to digital service such as Metaverse, and that the perceived utility of the Metaverse is important in Generation Z users' engagement and satisfaction level with this digital environment. The result of this study regarding the correlation between user satisfaction and continued intention to use the Metaverse is in line with the findings of Natale et al. (2024), who concluded that the extent of satisfaction with engaging in the Metaverse is a significant driver of continued use. Security affects the user's intention to use the Metaverse, but not the perceived ease of use or perceived usefulness. The results agree with Pragha et al. (2025) that users' intention to adopt the Metaverse is strongly associated with security, so adoption is key to trust and alleviating concerns. The study also found that the adoption is highly dependent on security measures, while traditional ease of use and usefulness are relatively less important in this context. In contrast to the conventional technology acceptance model, perceived ease of use does not affect users' intention to continue using the Metaverse. This is indeed the case in several studies, which suggest that ease of use may be less significant for immersive technologies like the Metaverse (Ali et al., 2025; Alshammarı & Alshammari, 2024; Al-Adwan et al., 2018).

Similarly, perceived usefulness, a key factor in technology adoption for years, does not influence users' intention to continue using the Metaverse in education. This could be due to the nature of the Metaverse, where engagement and security are more important (Yusof et al., 2025; Al-Adwan et al., 2018). DES and CON have indirect effects on continuous intention (CUI), measured by Perceived Usefulness (PU), perceived ease of use (PEOU), and satisfaction (SAT); therefore, these mediators are significant for continued intention to use the Metaverse. The two results show that DES and CON had significant indirect effects on CUI and are believed to be fully mediated by these mediators, indicating that user perception and satisfaction are key to maintaining use of the Metaverse. Security (SEC) does not have a significant indirect effect on CUI, and other factors are more important in this case. This study highlights that design, confirmation, and user intentions interact in complex ways through perceived usefulness, ease of use, and satisfaction. Knowing these dynamics will help developers and policymakers decide which design and user experience improvements to prioritize to encourage long-term use of the Metaverse.

Practical and Policy Implications

Designers and security architects of the Metaverse will have many opportunities and challenges as AI is integrated. AI-supported Metaverse environments require robust security measures to protect data and ensure privacy. Designers and security architects will have to cover many different and not-so-massive points to make the systems safe and easy to understand. It must identify the security issues in the Metaverse ecosystem and implement AI-backed solutions to meet them. It offers AI tools to strengthen security with real-time behavioral analytics to detect anomalies and threats. This could involve machine learning models that dynamically adjust security policies and anticipate threats before breaches occur all while preserving usability. Designers are responsible for ensuring usability is not sacrificed in this case. Such authentication systems should meet organizational and user requirements.

Security architects need to be aware of the compliance and regulatory requirements for the security architecture and the security measures, and ensure compliance with the laws and regulations they implement, including data protection laws and industry standards. So, implementing security-by-design features in the Metaverse is a holistic problem that needs to be handled. Moreover, if we are to be honest with ourselves, a digital ecosystem like the Metaverse is always vulnerable to threats such as avatar impersonation, biometric data compromise, and smart contract violations, as well as known threats like phishing and identity theft. Developers need to implement security measures from the start of development to protect user privacy while still delivering an immersive experience. Design platforms for secure social interaction that still protect user privacy without compromising it. This includes the design of privacy-preserving systems for communication and interaction in the Metaverse. Construct accountability frameworks for responses to misinformation and privacy violations. Such frameworks must also incorporate mechanisms for reporting and addressing privacy breaches that allow users to pursue remedies when their privacy is violated. Implement end-to-end encryption to protect data and maintain confidentiality. Anonymization also improves privacy by masking user identities during data processing. Use multi-factor authentication to improve authentication and make it harder for unauthorized users to access a user account. This is vital to preventing identity theft and unauthorized access.

Limitations and Contribution

The limitations of the study warrant future research. The research is mainly based in India; hence, there is scope to study other countries as well to obtain more comprehensive data for the present study. The current research also considered the use of Metaverse technology from user satisfaction, user comfort level, usability, design, and security points, and future work might also consider technology costs, technology knowledge, and self-efficacy. It is impossible to cover the whole study in this paper. This study focuses on the use of Metaverse technology in the education sector, but future research will also examine its applications in manufacturing, healthcare, tourism, retail, and beyond. The main limitation of this study is the focus on Generation Z participants.

As a result, future studies will also consider millennials in their analyses. As a convenience sample of students aged 15-25 who use the Metaverse, the study is targeted at this generation, and its findings may not be transferable or generalizable to other groups of Gen Z, such as working professionals or non-students of the same generation. This is especially relevant in this article, as students' behavior and preferences might not be representative of other Gen Z groups, such as young professionals or students not enrolled in formal education.

Those results are also useful to developers and practitioners working on the design/security of the Metaverse, helping encourage its widespread adoption. This research contributes to the limited body of knowledge on Metaverse technology in education and its acceptance in this field. Our findings will be of great interest to policymakers, developers, and researchers and will contribute significantly to the Metaverse adoption in our society. The Metaverse integration discussed in this research will be valuable to system designers in creating an inclusive, less damaging virtual world.

Declaration of Conflict of Interest

This manuscript is devoid of any conflicts of interest pertaining to its publication.

Acknowledgment

Thank you to the publisher for their support in the publication of this research article. We are grateful for the resources and platform provided by the publisher, which have enabled us to share our findings with a wider audience. We appreciate the efforts of the editorial team in reviewing and editing our work, and we are thankful for the opportunity to contribute to the field of research through this publication.

Funding Information

The authors have not received any financial support or funding to report.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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