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Journal Article

Metaverse Experience and Technology Acceptance (META): A Framework for Decoding Digital Existence in Virtual Worlds

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Abstract:

The metaverse is reshaping interaction, learning, and community-building in immersive virtual environments. While interest in metaverse adoption is growing, most research has focused on technological predictors and has overlooked the experiential dimensions that are central to sustained engagement in these spaces. This gap limits understanding of how users develop and maintain meaningful virtual existence in the metaverse. Therefore, this study develops the Metaverse Experience and Technology Acceptance (META) model by integrating the principles of the Technology Acceptance Model (TAM) and Embodied Social Presence Theory (ESPT). Structural equation modeling (SEM) was used to analyze data collected from 924 students with metaverse experience. The META model demonstrates strong explanatory power in accounting for both technology acceptance and user experience in virtual worlds. Moreover, the findings indicate that adoption of the metaverse as a digital university extends beyond the functional focus of TAM to include the immersive, social, and embodied elements emphasized in ESPT. By bridging technological and experiential determinants, the META model advances theoretical understanding and offers actionable insights for creating metaverse environments that promote conducive digital existence.

Keywords:

Metaverse, Virtual World, Digital University, Technology Acceptance Model, Embodied Social Presence Theory, Structural Equation Modeling

INTRODUCTION

The metaverse is described as a three-dimensional (3D) digital space that is distinct and separate from the physical world (Ritterbusch & Teichmann, 2023). Merging the words 'meta' and 'universe', it forms a parallel world where users interact both socially and economically through their digital avatars. Once a notion confined to science fiction, the metaverse now unfolds as a vivid possibility. Garcia et al. (2023b) attributed the shift from a fictional idea to a plausible reality to the advancements in computer technologies, including holography (He et al., 2023), extended reality (Xi et al., 2023), blockchain (Huynh-The et al., 2023), big data (Siwach et al., 2022), artificial intelligence (Rospigliosi, 2022), internet of things (Asif & Hassan, 2023), digital twins (Sai et al., 2024), and more. With the advent of these emerging technologies, there has been an upsurge in research and development of metaverse ecosystems across different industries. This increasing interest is not just academic, as it reflects a broader realization of the metaverse's potential impact on real-world applications. Various industries, including retail, tourism, entertainment, healthcare, and education, are investigating how these virtual spaces can create more engaging, interactive, and immersive experiences (Adnan et al., 2024; Besson & Gauttier, 2024; Çelik & Ayaz, 2025; Hajian et al., 2024). As institutions continuously adapt to this digital evolution, the metaverse is becoming a critical component in future strategies concerning customer interaction, learning models, community engagement, and more.

While the proliferation of the metaverse has sparked a multitude of studies and practical implementations, significant research gaps remain in understanding user interactions within this parallel world. Prior works have endeavored to fill this gap, yet they often fall short in several key areas. For instance, Al-Adwan et al. (2023) extended the Technology Acceptance Model (TAM) to measure students' intention to use metaverse-powered learning platforms. However, their participants were primarily experienced in digital platforms and interactive technologies (e.g., extended reality) rather than in metaverse technologies specifically. This limitation is quite understandable, given that metaverse applications are not yet widely accessible or fully integrated into mainstream use. Nonetheless, behavioral intention was the end point of their research model rather than actual usage as indicated in the original TAM (Davis et al., 1989). Wu and Yu (2023) confronted the same limitation, though they broadened the scope of TAM by incorporating social and psychological elements into their study. The additional constructs, such as perceived enjoyment, emotional attachment, flow, and social interaction, highlight the significance of experiential aspects in the metaverse context. Nevertheless, their framework could be further enhanced by the Embodied Social Presence Theory (ESPT) principles. According to Mennecke et al. (2011), this theory emphasizes the importance of physical representation and the perception of being in a shared space with others. It suggests that a more immersive experience, where users feel a sense of embodiment within the virtual space, can lead to richer, more meaningful interactions. This ideal outcome is especially significant in collaborative settings like the metaverse, as it fosters a more profound sense of connection and engagement among digital inhabitants and enhances communication, cooperation, and overall user satisfaction.

Consequently, this study aims to develop and empirically validate the Metaverse Experience and Technology Acceptance (META) model by extending TAM using the principles from ESPT. The model seeks to provide a more holistic framework that not only considers technological acceptance but also the experiential dimensions of user interaction within the metaverse. A systematic review of metaverse technology acceptance revealed that research has primarily focused on the technological factors influencing user decisions (Al-kfairy et al., 2024). With this proposal, this study aims to make several significant contributions to the metaverse research literature by addressing the existing gaps. Firstly, it recruits users with prior experience in a metaverse application. This approach enables the inclusion of the actual usage construct, which has been missing in previous metaverse technology acceptance investigations. Secondly, building upon the foundation of the original TAM (Davis et al., 1989), it integrates ESPT by using constructs that have been previously utilized in assessing an educational metaverse application (Garcia et al., 2023a). The inclusion of these constructs enriches the model by exploring how embodiment, copresence, agency, immersion, and social relationships impact users' acceptance and overall experiences within the metaverse. Thirdly, it evaluates the relationships between ESPT and TAM constructs. This assessment unravels the intricate interplay between users' willingness to adopt metaverse technologies and their actual experiences within this virtual realm. The findings of this study may benefit researchers, developers, practitioners, and policymakers in gaining a deeper understanding of metaverse adoption and utilization. Overall, these contributions aim to advance the field of metaverse research and promote its growth as an increasingly significant aspect of contemporary technology and human interaction.

THEORETICAL FOUNDATION

Technology Acceptance Model

Originally proposed by Davis et al. (1989), the TAM is a widely recognized theoretical framework used to predict and understand user behavior towards technology. A recent comprehensive meta-analysis of technology acceptance studies has revealed that TAM, along with its various expanded iterations, ranks as the most frequently used framework in this field (Marikyan et al., 2023). The core premise of this model is to assess how users come to reject or accept a technology based on several key determinants. In the original version of TAM (see Figure 1), these determinants include *Actual System Use* (ASU), *Behavioral Intention to Use* (BITU), *Attitude* (ATT), *Perceived Usefulness* (PU), and *Perceived Ease of Use* (PEOU). The strength of TAM resides in its simplicity and the robustness of its predictive capability, which has been validated across diverse technological contexts and user groups (Al-Nuaimi & Al-Emran, 2021; Al-Qaysi et al., 2020). In the metaverse context, researchers such as Al-Adwan et al. (2023) and Wu and Yu (2023) have used TAM to investigate how users perceive these 3D virtual environments. Both their studies reaffirmed the applicability and relevance of TAM in understanding user acceptance of metaverse technologies by confirming that its established constructs remain significant predictors of behavioral intention even in immersive settings. In other words, users still evaluate metaverse technologies partly through the same functional and usability considerations that drive adoption of more conventional systems.

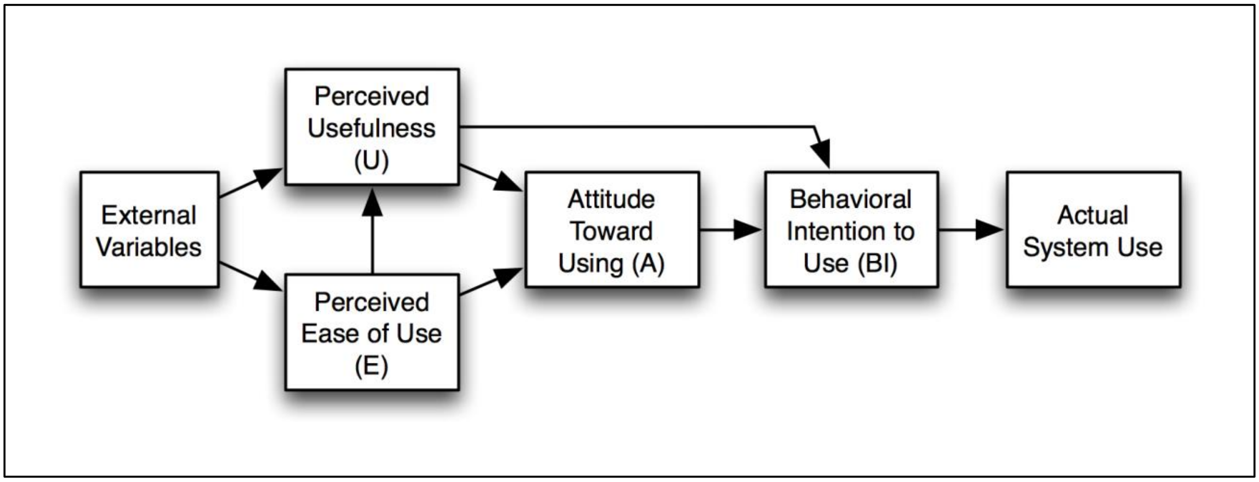

Figure 1. Technology Acceptance Model (Davis et al., 1989)

However, despite the strengths and empirical support of TAM, it has been critiqued for its limitations when applied to highly immersive environments. Scholars argue that the framework's primary emphasis on utilitarian and cognitive appraisals (e.g., PU, PEOU) does not fully capture the affective, sensory, and socially embedded dimensions of engagement in 3D virtual spaces (Garcia et al., 2024b; Makransky & Lilleholt, 2018; Nilashi & Abumalloh, 2025). Evidence from metaverse research suggests that while TAM remains effective for explaining functional and usability-related predictors of adoption (Al-Adwan et al., 2023), it is less suited to accounting for deeply immersive experiences, identity formation through avatars, and the sense of shared presence with others. Furthermore, its relatively static and linear structure overlooks the iterative and evolving nature of user experiences in persistent virtual worlds (Luse et al., 2013), where ongoing interaction and environmental change continually reshape perceptions and intentions. Another limitation is its predominantly individual-level focus, which can underrepresent collective dynamics, such as community belonging (Yasuda, 2025) and social influence (Abdulmuhsin et al., 2025). These gaps, particularly the absence of constructs related to embodiment, copresence, and collaborative engagement, highlight the need for complementary theoretical approaches capable of capturing the unique affordances of the metaverse.

Embodied Social Presence Theory

The metaverse represents a unique fusion of extended realities, social media, and digital economies (Al-Adwan & Al-Debei, 2024; Al-kfairy et al., 2024; Mancuso et al., 2023; Park, 2024). This amalgamation consequently creates a multifaceted platform for interaction, entertainment, and commerce. Such complexity necessitates a theoretical framework that goes beyond traditional models of technology acceptance and usage (e.g., TAM). Understanding user engagement in such a context calls for a framework attuned to the interplay between embodiment

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and social connection rather than one centered primarily on functional appraisal. In this aspect, a theoretical framework like ESPT emerges as particularly relevant (Mennecke et al., 2011). The theory posits that an embodied representation (i.e., imaginal, physical, or virtual form) combined with purposeful and collaborative activities significantly shapes user perceptions. ESPT is deemed particularly suitable because it explicitly links the form of the user's embodiment with the quality of social presence, providing an integrated lens through which to examine how avatar representation, interpersonal interaction, and shared activities co-construct meaning in immersive environments. This alignment makes it especially apt for the metaverse, where experiences are both lived and shared within persistent, avatar-mediated worlds.

Building on this foundation, ESPT's focus on *Embodiment* (EMB) and *Copresence (COP)* directly addresses core experiential qualities of the metaverse that shape how people perceive, interact, and build relationships in virtual spaces. These constructs capture the interplay between the user's sense of "being there" in avatar form and their awareness of "being with others" in a shared environment. These dimensions are central to meaning-making and emotional investment in immersive worlds (Han et al., 2023; Rzeszewski et al., 2024; Sprott et al., 2025). It explains how virtual representations and shared activities foster social connectedness and a sense of presence, which are factors pivotal to understanding user behavior and sustained engagement in the metaverse. Although originally developed to explore embodied virtual representation and social interaction within virtual worlds, ESPT has been increasingly applied in metaverse studies. For instance, Zhang et al. (2022) used the theory to examine embodied presence and embodied copresence, while Garcia et al. (2023a) extended it in an educational metaverse application by incorporating constructs such as *Agency* (AGY), *Social Relationship* (SR), and *Immersion* (IMM). This growing application and adaptation of ESPT in various metaverse contexts, as demonstrated by these studies, highlight its critical role in providing a comprehensive understanding of the intricate user experiences within these expansive digital ecosystems.

HYPOTHESES DEVELOPMENT

TAM Constructs

Decades of research have employed constructs from a diverse array of theoretical frameworks to extend the TAM to accommodate various technologies, contexts, and user groups (Mustafa & Garcia, 2021). Despite these numerous adaptations and extensions, the core constructs (i.e., PU, PEOU, BITU, ATT, and ASU) of TAM have consistently remained central to its application and relevance. These constructs form the foundational pillars of TAM and serve as essential indicators for understanding and predicting users' technology acceptance and usage. In the context of the metaverse, these constructs retain their significance. The original relationships postulated by TAM, such as the influence of PU and PEOU on ATT and BITU, continue to provide valuable insights into user acceptance and behavior. According to Wu and Yu (2023), users proficient in navigating the complexities of the metaverse typically view it as an effective tool for enhancing their efficiency, performance, and productivity. Their perception of the metaverse as both user-friendly and beneficial leads to the development of a positive attitude toward it. This positive attitude often translates into a greater inclination to continue engaging with the metaverse over time. Given the substantial empirical evidence supporting these observations, including evidence specific to the metaverse context, it is reasonable to posit that the original relationships postulated by TAM hold true. However, since ASU has not been extensively tested in the context of the metaverse, its inclusion in the hypotheses of this study is warranted. Therefore, the following hypotheses are proposed for this study:

H_1. Higher PU of the metaverse will positively influence users' ATT towards it.
H_2. Increased PU of the metaverse will lead to a greater BITU the platform.
H_3. PEOU of the metaverse will positively affect users' ATT towards the platform.
H_4. Greater PEOU will enhance the PU of metaverse applications.
H_5. A more favorable ATT towards the metaverse will increase users' BITU the platform.
H_6. Stronger BITU metaverse technologies will lead to higher ASU.

Embodiment

Prior research has indicated that an individual's behavior in digital environments tends to align with their digital self-representation (Pascucci et al., 2024; Taylor et al., 2022). This alignment is particularly evident in the way virtual avatars exemplify specific behaviors. In virtual reality scenarios, this phenomenon of self-representation plays a crucial role in assisting cognitive processes and reducing mental strain during tasks (Jung et al., 2018; Steed et al., 2016). When users adopt a virtual representation, they often encounter a phenomenon where they perceive the avatar's external form as temporarily integrated with their own identity (Rzeszewski et al., 2024; Tsai, 2022). EMB refers to the extent to which users perceive a virtual avatar or body as an extension of themselves within a digital environment, influencing how they interact and engage with the virtual world (Garcia et al., 2023a). For instance, experiencing a strong sense of EMB can increase users' feeling of control within the virtual world. When users feel that the avatar represents them accurately, they may feel more empowered to interact and make decisions within the virtual space (Fribourg et al., 2021). A strong sense of EMB can also lead to deeper and more meaningful social connections. As users identify more with their avatars, their interactions with other avatars might become more personal and emotionally significant (Gall et al., 2021; Jane Patel, 2024). On the same note, when users perceive other avatars as more realistic and engaging, it can foster a stronger sense of being with others in the virtual environment (Mennecke et al., 2011). Leveau and Camus (2023) note that the EMB experienced by users positively impacts their involvement in the virtual world. When users perceive a stronger connection to their virtual representation, it may result in heightened participation in the activities of the virtual environment. Consequently, to examine this within the context of the metaverse, the following hypotheses are proposed for this study:

H_7: Increased EMB will positively influence users' sense of AGY in the metaverse.
H_8: Higher EMB will lead to a stronger sense of COP with other users in the metaverse.
H_9: Greater EMB will enhance the quality of SR formed within the metaverse.

H_{10}: A higher level of EMB will result in deeper IMM in the metaverse environment.
H_{11}: Enhanced EMB will positively affect users' ATT towards the metaverse.

Copresence

In virtual environments, the sense of being together is a pivotal aspect that fundamentally shapes user experiences (Guertin-Lahoud et al., 2023). This virtual sense of togetherness is crucial in creating a rich, immersive environment where interactions and relationships feel as real and meaningful as they do in the physical world. COP refers to the level at which users sense both their own presence and the presence of others within the same virtual space, playing a crucial role in enhancing user experience and acceptance in virtual environments (Garcia et al., 2023a). COP not only establishes a shared sense of space and real-time interaction but also significantly contributes to the users' willingness to engage and participate in the virtual world. In their study, Wu and Yu (2023) discovered that the inclusion of social interaction and social presence elements in the metaverse significantly impacts user acceptance of the platform. With these social features, it can be hypothesized that the metaverse could be conducive to forming meaningful relationships among its users. As an environment rich in social engagement opportunities, the metaverse could pave the way for users to establish and nurture relationships that go beyond superficial interactions. Thus, this study proposes the following hypothesis:

H_{12}. Greater COP in the metaverse will foster deeper SR among users.

Social Relationship

The relationships we build are a crucial element of our human experience. Similarly, in virtual environments, it is common for individuals to forge social connections. The diverse activities present in these environments offer an ideal setting for users to engage with others (van Brakel et al., 2023). While social interaction is a frequently studied aspect in these settings (Wu & Yu, 2023), SR has not been as commonly explored. Through spontaneous conversations or participation in shared activities, users have opportunities to develop and eventually nurture supportive relationships. This tendency mirrors the fundamental human need for interaction and relationship-building in these digital spaces. SR refers to the degree to which users feel that their connections and interactions within a virtual environment are meaningful and valuable (Garcia et al., 2023a), potentially shaping their overall perception and engagement with the digital space. When they perceive these connections as profound, it could enhance the overall appeal and significance of the platform. This scenario implies that users may come to appreciate the platform not only for its technical features but also for the social connections and experiences it facilitates. Such a deeper appreciation for the social aspects of the metaverse could also become a compelling reason for users to utilize the platform. Additionally, the desire to sustain the relationships they have established could drive users to engage with the platform consistently (Freeman et al., 2022). Consequently, this study proposes the following hypotheses:

H_{13}. Stronger SR within the metaverse will positively influence the PU of the platform.
H_{14}. Enhanced SR in the metaverse will lead to a significant increase in ASU.

Agency

The sense of control and influence that users experience in a virtual environment is a critical factor to consider. Felnhofer et al. (2023) noted that, according to the *Threshold Model of Social Influence*, user reactions in these settings are determined by the balance between the realistic behavior of virtual entities and their perceived influence over the environment. Furthermore, a meta-analysis concluded that AGY is an essential factor in examining social influence in mediated interactions (Fox et al., 2015). AGY refers to the extent to which users feel a sense of ownership over their actions within a virtual environment, which can be a key factor in shaping their experience and interaction within the metaverse (Garcia et al., 2023a). Unfortunately, a systematic review of metaverse adoption reveals that this concept has not yet been used in any study (Al-Sharafi et al., 2023). In immersive contexts, this factor not only influences immediate task performance but also affects how users perceive the authenticity and meaningfulness of their interactions. When users perceive a higher degree of AGY, they are likely to feel more connected and involved in their virtual experiences. This heightened engagement, driven by a sense of personal control and influence, suggests that AGY could be an influential factor in determining how absorbed users are while navigating and participating in the metaverse's various activities. Therefore, this study proposes the following hypothesis:

H_{15}. A greater sense of AGY in the metaverse leads to a deeper level of IMM.

Immersion

The metaverse is inherently designed to be immersive (Garcia et al., 2023b; Huynh-The et al., 2023). In some studies, the metaverse is considered a precursor of immersive games, interactive virtual environments, and extended reality (Dwivedi et al., 2022; Shin, 2022). Thus, the immersive quality of metaverse technologies could be crucial in shaping user experiences and engagement. IMM emerges as a key construct in this context, which refers to the level at which users become mentally and emotionally engaged in their experience within a computer-generated world (Garcia et al., 2023a). In immersive contexts, this engagement not only enhances moment-to-moment interaction but also fosters a sustained emotional connection to the platform, which can strengthen long-term adoption behaviors (Jo & Lee, 2024; Zhong & Hamouda, 2024). This deep level of involvement can also be beneficial in enhancing how user-friendly and approachable the platform is perceived to be. As users become more absorbed and invested in their virtual experiences, they may find the interface and interaction within the metaverse more intuitive. In related technological contexts, there is empirical evidence that IMM significantly impacts the willingness of users to engage with immersive technologies such as virtual reality training systems (Xie et al., 2022) and metaverse-based learning (Le, 2025). This influence reflects how deeply users are drawn into the virtual experience, which in turn affects their readiness to regularly interact with and utilize these systems. Thus, this study proposes these hypotheses:

H_{16}. Greater IMM in the metaverse will positively affect the PEOU of the platform.
H_{17}. Increased IMM in the metaverse will enhance users' BITU the platform.

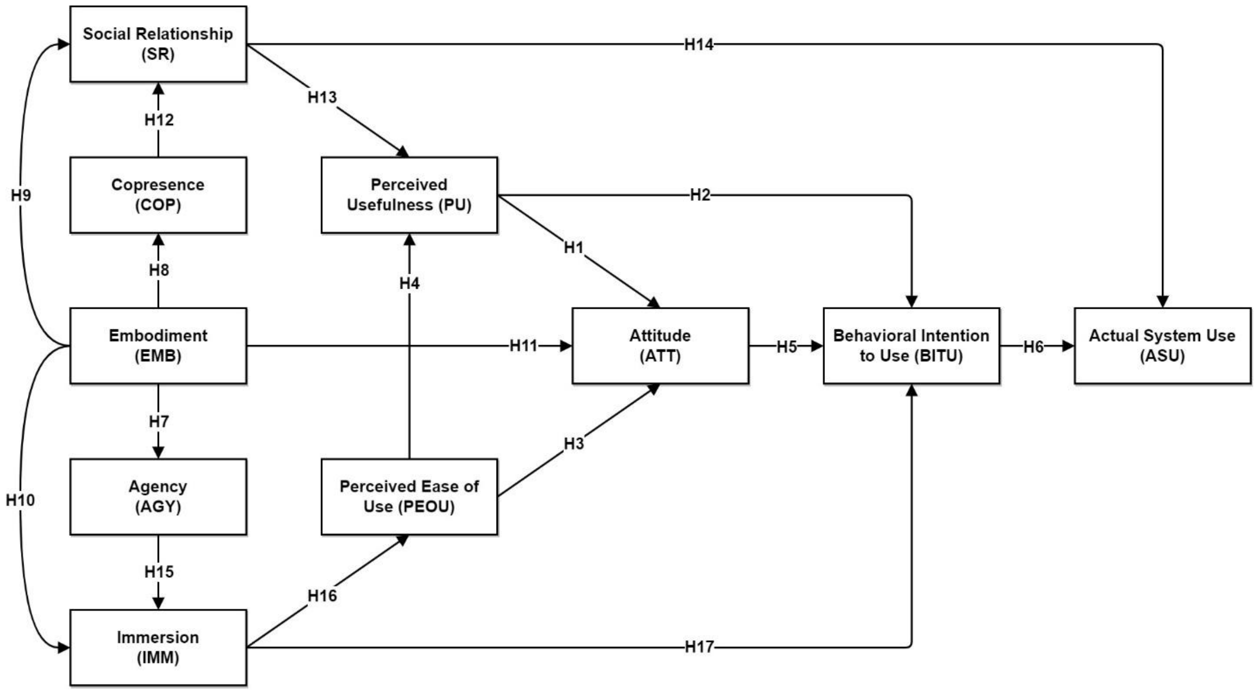

Figure 2. Proposed META Model with Hypothesized Relationships

MATERIALS AND METHODS

Research Design and SEM Procedure

This research is a cross-sectional study that aims to propose the META model by combining the principles of TAM and ESPT. In developing this theoretical framework, the study employs a Structural Equation Modeling (SEM) approach. Covariance-based SEM was selected over variance-based alternatives because the objective was to confirm a theoretically grounded model and rigorously assess both the measurement and structural components simultaneously, rather than primarily predict outcomes. This methodology is a multivariate statistical technique used for testing hypotheses about the relationships among observed and latent variables and is particularly valuable in technology acceptance research for its capacity to handle multiple interrelated dependence relationships, latent constructs, and measurement error. In the field of technology acceptance, researchers (e.g., Garcia, 2023; Xie et al., 2022; Zhang et al., 2022) often utilize SEM as a key tool to analyze and interpret the complex dynamics between different factors and their impact on technology adoption and usage. However, given the cross-sectional nature of the data, the SEM results identify statistical associations rather than definitive causal effects, and a single-time-point collection may introduce temporal bias as user perceptions could change over time. These design constraints are acknowledged and considered when interpreting the findings.

Following the logical sequence of steps outlined by Whittaker and Schumacker (2022), covariance-the SEM process began with model specification, where hypothesized relationships were derived directly from theory and the integration of TAM and ESPT. This initial step ensures that the model was conceptually driven and not the product of post hoc data mining. Next, model identification confirmed that the model could be statistically estimated given the sample size and the number of estimated parameters, satisfying recommended indicator-to-parameter ratios. Model estimation was performed using maximum likelihood estimation, with multivariate normality assumptions assessed through skewness, kurtosis, and Mardia's coefficient. In the model testing phase, fit was evaluated using a suite of indices to provide a multi-criteria assessment of adequacy and avoid overreliance on a single metric. Where modifications were considered, they were guided jointly by modification indices and theoretical justification, avoiding purely statistical adjustments that could compromise construct validity. This iterative refinement process returned to the testing phase after each justified modification, ensuring progressive improvement of model fit without deviating from the original theoretical framework.

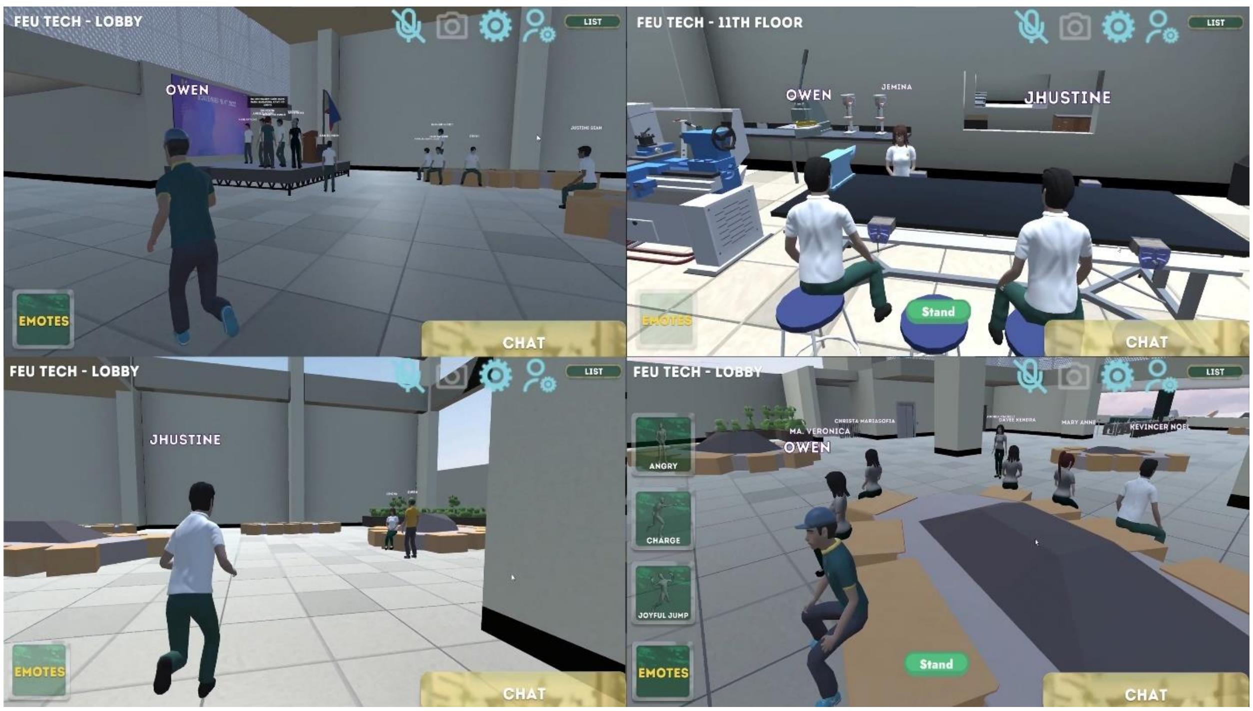

Figure 3. MILES Virtual World: An Educational Metaverse

Study Setting and Metaverse Application

Recently, the Educational Innovation and Technology Hub (https://edith.feutech.edu.ph/) has introduced a metaverse application named 'MILES Virtual World' (Garcia et al., 2023a). This mirror world type of metaverse features exact digital replicas of the physical campuses of three institutions: FEU Alabang, FEU Diliman, and FEU Institute of Technology (i.e., henceforth referred to as FEU Group of Schools). Represented by their digital avatars (Figure 3), students can tour and interact with peers from different campuses, play games together, and purchase digital items to enhance their virtual experience and personalize their avatars. The FEU Group of Schools was selected as the research setting for three main reasons. First, these institutions are among the earliest to implement a fully functional and university-wide metaverse platform (Garcia et al., 2023a). This early adoption ensures that participants have substantial and sustained exposure to immersive educational technology. Second, the group collectively serves a diverse student population across multiple campuses, programs, and socioeconomic backgrounds. This diversity provides a range of perspectives within a single and well-defined educational network. Third, the integration of the MILES Virtual World into both academic and extracurricular activities. Such integration offers a realistic testbed for studying metaverse acceptance in authentic learning contexts. While focusing solely on this research setting may limit direct generalizability, the institutions' early adoption, technological infrastructure, and diverse student body make them a strong proxy for other higher education institutions exploring similar immersive technologies. Consequently, the insights gained are likely to be transferable to comparable academic settings implementing campus-based metaverse applications.

Participants and Sampling

The study population comprised students from the FEU Group of Schools who had prior experience in both utilizing and evaluating the MILES Virtual World (Garcia et al., 2024a). This criterion allowed the inclusion of ASU as a construct, which has been absent in earlier metaverse acceptance studies (e.g., Al-Adwan et al., 2023; Wu & Yu, 2023). A systematic sampling method was employed. The online questionnaire link was embedded within the learning management system (LMS) of each course, and every nth eligible student was invited to participate. Participation was voluntary, and students were informed that their responses would remain anonymous. A total of 924 students participated from various courses and year levels across three campuses. The participants were predominantly male (66%), with a mean age of 19.76 years (SD = 1.24). The measurement model consisted of 10 latent constructs, each measured by four observed indicators, for a total of 40 items. The SEM estimated approximately 152 parameters, including factor loadings, error variances, latent variable variances/covariances, and 17 hypothesized structural paths. Complex SEM models with strong communalities (>0.50) and multiple indicators per construct generally require 200–400 cases for adequate statistical power and stable estimates (Hair et al., 2021). Monte Carlo simulations also show that with high factor loadings (>0.70, as in this study), samples above n = 500 produce robust parameter estimates and model fit indices. With n = 924, the present study far exceeds these thresholds, ensuring sufficient power, convergence, and stability for model estimation.

Instrument Development and Validation

The instrument employed in this study was developed using the TAM (PEOU, PU, ATT, BITU, ASU) and ESPT (SR, COP, EMB, AGY, IMM) constructs adopted from various studies (e.g., Garcia et al., 2023a; Wu & Yu, 2023). These items were specifically tailored to align with the context of metaverse technology. After drafting the initial questionnaire, an expert judgment approach was conducted by two senior researchers and one metaverse technology professional. Their evaluation focused on completeness, relevance, clarity, and alignment. Several modifications were made to the questionnaire based on their feedback. These revisions involved refining item wording for clarity and rephrasing items to reflect the constructs better. Subsequently, the modified questionnaire was pilot tested to assess its reliability. The results confirmed that the questionnaire was reliable, with all constructs showing Cronbach's alpha coefficients well above the acceptable threshold of 0.70. The final version of the questionnaire included a concise demographic section covering age and gender, along with a construct measurement section (See Appendix A) consisting of 40 items designed to assess 10 constructs presented in the proposed research model (Figure 2). All measurement items were structured using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Data Collection and Analysis

The data collection commenced at the beginning of the second trimester of the 2023-2024 academic year, starting on December 15, and concluded at the end of the first week of classes in the following year, on January 6. This timeframe was selected due to the typically lighter schedule of activities in the first week of classes, which provided an optimal opportunity for focused data gathering. Upon completion, the dataset was thoroughly reviewed for completeness, and any responses with significant missing data were excluded from the analysis. Data analyses were performed using IBM SPSS Statistics 22 and IBM SPSS Amos 22. A confirmatory factor analysis was conducted to validate the measurement model. This analysis ensures that the observed variables adequately represent the latent constructs. Subsequently, the study moved to testing the structural model. In this phase, path analysis within SEM was used to examine the hypothesized relationships between constructs. The structural model's goodness-of-fit was evaluated using criteria similar to those employed by Garcia (2023). The final step involved testing the hypotheses that emerged from the structural model analysis using statistical significance levels to evaluate and substantiate each hypothesis.

RESULTS

Bias Assessments

Evaluating potential biases is crucial in ensuring the validity and reliability of research findings, particularly in studies involving complex models like the META. Both common method bias (CMB) and non-response bias were consequently examined before analyzing the measurement and structural model. Kock et al. (2021) noted that failure to address CMB could result in either inflated or deflated correlations between constructs, possibly misrepresenting the true relationships in the model. This study employed Harman's one-factor test to investigate the presence of CMB. The confirmatory principal factor analysis revealed that the main factor explained 48.50% of the total variance, falling below the commonly accepted threshold of 50%. While this result suggests that CMB may not be a significant concern, Harman's test alone is limited in sensitivity. Therefore, a confirmatory factor–based approach was also applied using the unmeasured latent method construct (ULMC) technique. In this approach, all items were allowed to load on both their theoretical constructs and on a latent "method" factor orthogonal to the trait factors. The ULMC model showed fit indices comparable to the trait-only measurement model (ΔCFI = 0.002; ΔRMSEA = 0.001). The average variance explained by the method factor was 4.6%, with substantive loadings and path estimates changing by less than $|\Delta\beta| = 0.015$. These results indicate that CMB is unlikely to have materially biased the study's findings. Similarly, addressing non-response bias is equally essential to ensure the validity of the research findings. To assess this bias, the study analyzed the characteristics and responses of early (December 2023) and late (January 2024) respondents. The *t*-test comparisons between these two groups across various constructs showed no significant differences, with all *p*-values greater than 0.05. This outcome suggests that non-response bias is unlikely to be a significant issue in this study.

Table 1. Measurement Model Results

Constructs	Items	Factor Loading	α	CR	AVE	ASV	MSV
PEOU	PEOU1	0.703	0.781	0.806	0.509	0.461	0.450
	PEOU2	0.701					
	PEOU3	0.709					
	PEOU4	0.740					
PU	PU1	0.740	0.802	0.846	0.579	0.531	0.520
	PU2	0.758					
	PU3	0.777					
	PU4	0.769					
ATT	ATT1	0.788	0.811	0.866	0.618	0.540	0.550
	ATT2	0.809					
	ATT3	0.775					
	ATT4	0.771					
BITU	BITU1	0.756	0.835	0.874	0.634	0.601	0.590
	BITU2	0.787					
	BITU3	0.825					
	BITU4	0.816					
ASU	ASU1	0.866	0.859	0.924	0.753	0.461	0.699
	ASU2	0.874					
	ASU3	0.872					
	ASU4	0.859					
COP	COP1	0.747	0.833	0.867	0.621	0.570	0.560
	COP2	0.807					
	COP3	0.820					
	COP4	0.775					
IMM	IMM1	0.783	0.805	0.851	0.589	0.572	0.540
	IMM2	0.758					
	IMM3	0.736					
	IMM4	0.792					

SR	SR1	0.761	0.802	0.855	0.595	0.551	0.540
	SR2	0.775					
	SR3	0.793					
	SR4	0.757					
AGY	AGY1	0.752	0.802	0.841	0.569	0.503	0.501
	AGY2	0.758					
	AGY3	0.752					
	AGY4	0.756					
EMB	EMB1	0.775	0.811	0.858	0.601	0.504	0.550
	EMB2	0.781					
	EMB3	0.769					
	EMB4	0.777					

Note: PEOU = Perceived Ease of Use; PU = Perceived Usefulness; ATT = Attitude; BITU = Behavioral Intention to Use; ASU = Actual System Use; COP = Copresence; IMM = Immersion; SR = Social Relationship; AGY = Agency; EMB = Embodiment; α = Cronbach's Alpha; CR = Composite Reliability; AVE = Average Variance Extracted; ASV = Average Shared Variance; MSV = Maximum Shared Variance

Measurement Model

As outlined in Table 1, the measurement model assessment was based on three principal criteria: internal consistency reliability, convergent validity, and discriminant validity. Both Cronbach's alpha and Composite Reliability (CR) were utilized to assess internal consistency reliability. Cronbach's alpha values ranged from 0.781 to 0.859, and CR values ranged from 0.806 to 0.924. Since all values exceeded the recommended threshold of 0.7, this result indicates that the questionnaire demonstrates a strong level of internal consistency. These findings suggest that the items within each construct consistently measure the same underlying concept and coherently represent the construct. On the other hand, convergent validity was evaluated using the Average Variance Extracted (AVE). The AVE values for the constructs in this research ranged from 0.509 to 0.753, all of which surpassed the minimum requirement of 0.50. This result indicates that a significant portion of the variance in the observed variables can be attributed to the underlying constructs. Furthermore, the AVE values for each construct were higher than their respective Maximum Shared Variance (MSV) and Average Shared Variance (ASV), confirming the adequacy of convergent validity and suggesting that the constructs are well-defined and effectively capture a substantial portion of the variance in their associated indicators. For discriminant validity, the AVE of each construct was compared with the squared correlations between constructs. As illustrated in Table 2, the squared correlations between pairs of constructs were consistently lower than the square root of the AVE (represented by the diagonal values in bold and italic). This pattern aligns with Fornell and Larcker's (1981) criterion and supports the discriminant validity of the constructs. Following Garcia's approach (2023), the study used the Heterotrait-Monotrait (HTMT) ratio of correlations to detect discriminant validity issues. An HTMT value above 0.90 would indicate a problem with discriminant validity. However, no such issues were identified in this study, as the HTMT values ranged from 0.041 to 0.852, indicating that the constructs are distinct and independent of one another.

Table 2. Inter-Construct Correlations with Square Root of AVE

	PEOU	PU	ATT	BITU	ASU	COP	IMM	SR	AGY	EMB
PEOU	***0.713***									
PU	0.613	***0.761***								
ATT	0.674	0.702	***0.786***							
BITU	0.658	0.750	0.761	***0.796***						
ASU	0.561	0.696	0.601	0.759	***0.868***					
COP	0.664	0.665	0.735	0.733	0.620	***0.788***				
IMM	0.597	0.688	0.634	0.742	0.745	0.746	***0.768***			
SR	0.586	0.687	0.647	0.706	0.681	0.782	0.722	***0.772***		
AGY	0.616	0.632	0.754	0.734	0.690	0.754	0.718	0.734	***0.755***	
EMB	0.646	0.606	0.713	0.770	0.733	0.754	0.766	0.735	0.740	***0.776***

Note: PEOU = Perceived Ease of Use; PU = Perceived Usefulness; ATT = Attitude; BITU = Behavioral Intention to Use; ASU = Actual System Use; COP = Copresence; IMM = Immersion; SR = Social Relationship; AGY = Agency; EMB = Embodiment; Diagonal elements (bold and italic): Square root of AVE.

As shown in the correlation matrix (see Table 2), the values indicate a range of moderate to high correlations between various constructs. While this is a common occurrence in behavioral and social science research, it is essential to ensure these correlations do not affect discriminant validity or lead to multicollinearity. This potential issue is especially important since several inter-construct correlations exceed 0.60. To address potential concerns of multicollinearity, both the Variance Inflation Factor (VIF) and tolerance values for each construct were evaluated. Multicollinearity is generally considered a concern when VIF values exceed 10 or if tolerance values are below 0.10 (Garcia, 2023). In this dataset, VIF values ranged from 3.375 to 6.354, and tolerance values varied between 0.157 and 0.296. These results indicate that multicollinearity is not a significant concern in this study. Despite some relatively high correlations, the constructs remain distinctive, and the model is not compromised by multicollinearity issues. These results are reassuring, as multicollinearity can distort the estimation of regression coefficients.

Structural Model

Following the satisfactory evaluation of the measurement model, the study advanced to path analysis using SEM. Before testing the significance of the hypothesized relationships, it was crucial to assess the overall fit of the research model. Consistent with the approach by Garcia (2023), assessing the overall fit of the research model was a critical preliminary step before examining the significance of the hypothesized relationships. These measures included the Chi-Square statistic/Degree of Freedom (χ^2/df), Non-Normed Fit Index (NNFI), Goodness of Fit Index

(GFI), Normed Fit Index (NFI), Adjusted Goodness-of-Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA), and Comparative Fit Index (CFI). A satisfactory model fit is a prerequisite for the meaningful interpretation of the path coefficients and testing of the hypotheses within the SEM framework. The analysis results indicated a satisfactory fit between the dataset and the measurement model, with $\chi^2/df = 2.31$, GFI = 0.92, AGFI = 0.88, NFI = 0.93, NNFI = 0.97, CFI = 0.96, and RMSEA = 0.04. According to the criteria outlined by Schermelleh-Engel et al. (2003), each fit index suggested an acceptable to a good fit for the structural model.

Table 3. Hypothesis Testing Results

H#	Structural Paths	Path Coefficient	(LLCI, ULCI)	*t*-Value	*p*-Value	Result
H_1	PU → ATT	0.182	(0.062, 0.268)	3.031	0.021	Accepted
H_2	PU → BITU	0.351	(0.239, 0.452)	5.255	0.005	Accepted
H_3	PEOU → ATT	0.148	(0.081, 0.208)	2.245	0.039	Accepted
H_4	PEOU → PU	0.171	(0.093, 0.276)	2.914	0.022	Accepted
H_5	ATT → BITU	0.382	(0.229, 0.502)	4.321	0.006	Accepted
H_6	BITU → ASU	0.349	(0.239, 0.461)	5.127	0.011	Accepted
H_7	EMB → AGY	0.061	(0.020, 0.102)	2.136	0.067	Rejected
H_8	EMB → COP	0.299	(0.216, 0.399)	5.501	0.011	Accepted
H_9	EMB → SR	0.257	(0.169, 0.386)	4.001	0.015	Accepted
H_{10}	EMB → IMM	0.525	(0.453, 0.609)	6.978	0.003	Accepted
H_{11}	EMB → ATT	0.557	(0.434, 0.652)	7.375	0.003	Accepted
H_{12}	COP → SR	0.636	(0.546, 0.718)	8.666	< 0.001	Accepted
H_{13}	SR → PU	0.693	(0.625, 0.757)	9.595	< 0.001	Accepted
H_{14}	SR → ASU	0.616	(0.442, 0.725)	8.217	< 0.001	Accepted
H_{15}	AGY → IMM	0.124	(0.062, 0.199)	2.138	0.040	Accepted
H_{16}	IMM → PEOU	0.268	(0.175, 0.391)	4.312	0.015	Accepted
H_{17}	IMM → BITU	0.167	(0.095, 0.253)	2.951	0.035	Accepted

Note: PEOU = Perceived Ease of Use; PU = Perceived Usefulness; ATT = Attitude; BITU = Behavioral Intention to Use; ASU = Actual System Use; COP = Copresence; IMM = Immersion; SR = Social Relationship; AGY = Agency; EMB = Embodiment; LLCI = lower limit confidence interval; ULCI: upper limit confidence interval.

Having established a satisfactory fit for the structural model, the study then moved to evaluate the significance of the path coefficients (β). This assessment involved examining the magnitude and significance of the relationships between the constructs as hypothesized in the model. According to the path coefficient analysis, as presented in Table 3 and Figure 4, all hypotheses are statistically significant except H_7. This finding signifies that most of the theorized relationships in the META framework have empirical support. It is worth noting that H_{12}, H_{13}, and H_{14} exhibited the strongest path coefficients, suggesting particularly robust relationships in these areas of the model. Following the evaluation of path coefficients, the study focused on analyzing the coefficient of determination (R^2) values for the endogenous constructs, which served as an indicator of the model's explanatory power (Hair et al., 2019). The R^2 values in this study indicated strong explanatory power for ATT (62.28%), BITU (68.16%), and ASU (77.17%), while the explanatory power for the remaining endogenous constructs was moderate. This distinction in explanatory power highlights areas where the model is particularly effective, as well as areas where further research might uncover additional contributing factors. The predictive capability of the proposed model was assessed through Stone-Geisser's Q^2 values, which are derived from cross-validated redundancy measures. Hair et al. (2019) noted that Q^2 values exceeding zero for a specific endogenous construct are indicative of the structural model's predictive accuracy for that construct. In this study, Q^2 values ranged between 0.13 and 0.45, denoting that the model exhibits a small to medium predictive relevance. This result reinforces the ability of the META model to not only explain but also predict the endogenous constructs effectively.

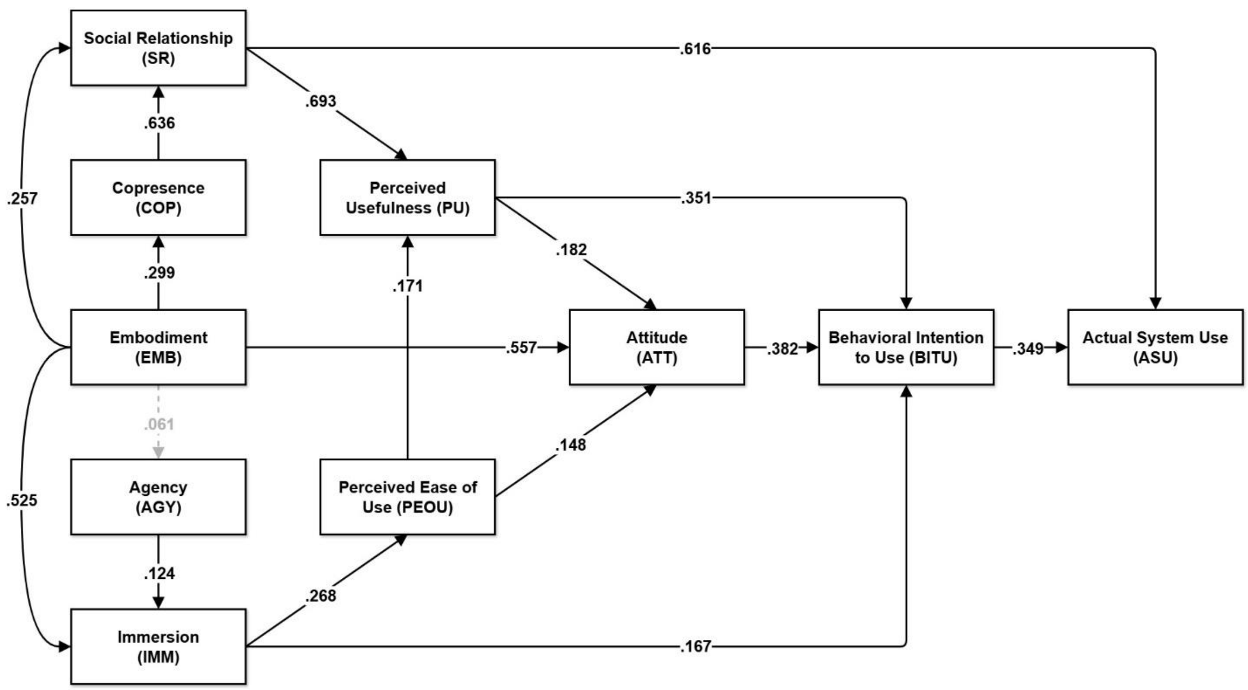

Figure 4. Standardized Path Coefficients for the META Model

DISCUSSION

Validation of Core TAM Relationships in the Metaverse Context

Expectedly, the research hypotheses related to the original constructs of the TAM and their interrelationships demonstrated statistical significance. This outcome highlights the enduring relevance and robustness of the TAM framework in explaining technology acceptance behaviors (Mustafa & Garcia, 2021). As hypothesized in H_1 and H_2, there is a significant relationship between PU and ATT (β = 0.182, p = 0.021) and PU and BITU (β = 0.351, p = 0.005).

These findings indicate that the practical benefits identified in technologies play a pivotal role in shaping a user's favorable outlook towards its usage, as well as in influencing their preparedness to engage with it (Garcia, 2023). Prior research on metaverse technology acceptance also observed similar significant relationships, although PU has a stronger influence on ATT than BITU (Wu & Yu, 2023). In terms of H_3 and H_4, it was found that PEOU positively influences ATT ($\beta = 0.148$, $p = 0.039$) and PU ($\beta = 0.171$, $p = 0.022$). These findings suggest that user-friendly technologies are more likely to be perceived positively and considered useful by users (Oh et al., 2025). The pattern in which PEOU has a greater influence on PU than on ATT is similar to that observed by Wu and Yu (2023). The positive impact of ATT on BITU, as indicated in H_5 ($\beta = 0.382$, $p = 0.006$), reinforces the notion that a user's positive disposition towards a technology significantly drives their intent to use it. This finding aligns with the core principles of TAM, which posit ATT as a key intermediary linking PEOU and PU with BITU. The importance of this relationship is echoed in research across various technology acceptance contexts, including the metaverse (e.g., Wu & Yu, 2023) and other technological contexts (e.g., Buabeng-Andoh, 2018).

Actual System Use as a Missing but Critical Dimension in Metaverse Acceptance

Despite ASU being a crucial construct in the TAM framework, it has not been included in previous metaverse studies (e.g., Al-Adwan et al., 2023; Wu & Yu, 2023). This omission is significant because ASU represents the observable behavioral manifestation of adoption, which captures not just a user’s stated willingness to engage but their actual engagement patterns with the technology over time. In immersive and persistent environments such as the metaverse, ASU becomes particularly crucial for understanding the full spectrum of adoption and continued use. Without this construct, technology adoption studies risk overstating the impact of intention while overlooking potential barriers that emerge in the transition from intention to actual behavior. Addressing this gap, the present study explicitly incorporated ASU into the META framework and examined its determinants. In line with H_6, the study posited that BITU would be a strong predictor of ASU. The results supported this hypothesis ($\beta = 0.349$, $p = 0.011$), which reaffirms TAM’s original causal pathway and validating its relevance within immersive 3D virtual contexts. Importantly, empirically confirming this relationship in the metaverse setting strengthens the argument that intention–behavior consistency remains a robust mechanism even when mediated by experiential factors. This finding strengthens the argument that while immersive experiences may influence adoption (Al-Sharafi et al., 2023; Park, 2024), the underlying decision-making mechanism from intention to use remains grounded in established behavioral theory.

Relational Influences on Continued Metaverse Usage Behavior

In addition to BITU, this study proposed that SR also has a significant connection to ASU (H_{14}). The results confirmed this relationship ($\beta = 0.616$, $p < 0.001$), which indicates that strong social ties within the metaverse exert a substantial influence on whether users continue to actively engage with the platform. This finding aligns closely with the tenets of ESPT, which emphasize that users’ perceptions, behaviors, and sustained participation are shaped by the quality of their embodied social interactions. In highly immersive environments, engagement is not solely a function of PEOU or PU but also deeply dependent on the richness, stability, and value of social connections cultivated over time. Furthermore, the significant relationship between SR and PU (H_{13}; $\beta = 0.693$, $p = 0.011$) reinforces the premise that social factors directly enhance the perceived functional value of the technology itself. When users derive meaningful relationships and a sense of belonging from the platform, they are more likely to view it as beneficial, relevant, and worth continued investment of time and effort. This dual effect (SR influences both ASU and PU) suggests that social connectedness operates both as a direct behavioral driver and as a value amplifier. Importantly, these findings reframe social interaction from being a "nice-to-have" feature to a core adoption mechanism in metaverse environments. The ability of a platform to support enduring and rewarding social relationships becomes a determinant of long-term viability and not merely an engagement strategy. This resonates with Garcia et al. (2023a), who highlight that relational affordances in immersive spaces can anchor users even in the face of competing platforms or fluctuating novelty. This concept is strengthened by the idea that the motivation to sustain established relationships within these environments can lead users to consistently engage with a platform (Freeman et al., 2022).

Embodiment and Copresence as Foundations for Social Relationship Formation

Another strength of this study is incorporating ESPT principles into the TAM in building the META framework. Characterized by its immersive environments, understanding metaverse adoption demands an approach to technology acceptance that extends beyond the traditional focus on functionality and cognition. In such settings, user perceptions and interactions are profoundly influenced by their sense of physical presence and social connectivity (Dwivedi et al., 2022; Garcia et al., 2023b; Zhang et al., 2022). Consequently, central to the META framework is the influence of EMB on TAM constructs alongside other key elements of the ESPT. Considering the substantial impact of SR on both PU (H_{13}) and ASU (H_{14}), the role of EMB becomes particularly critical as it significantly influences SR (H_9; $\beta = 0.257$, $p = 0.015$). This relationship elucidates the integral role of EMB in shaping the dynamics of social interaction within the metaverse. By enhancing the user's sense of presence and engagement in a virtual environment, EMB contributes to the formation and deepening of social relationships. As noted by Gall et al. (2021), users who develop a stronger identification with their virtual avatars tend to have more personal and emotionally significant interactions with other users. This relationship is further exemplified in H_{12}, which explores the influence of COP on SR. The significance of this association ($\beta = 0.636$, $p < 0.001$) not only reinforces the interplay between the sense of being together and the formation of social connections but also emphasizes the multifaceted nature of social dynamics in virtual environments (Campos-Castillo, 2012). It also consolidates the role of EMB within this framework as it also significantly influences COP (H_8; $\beta = 0.299$, $p = 0.011$).

Immersion as a Mediator Between Embodiment and Technology Acceptance

In addition to the social aspects, the immersive quality of the metaverse plays a crucial role in user engagement and acceptance (Dwivedi et al., 2022; Huynh-The et al., 2023; Shin, 2022). As hypothesized in H_{16} and H_{17}, IMM has a significant effect on PEOU (β = 0.268, p = 0.015) and BITU (β = 0.167, p = 0.035). The influence of IMM on PEOU indicates that the depth of immersion in a virtual environment can enhance users' perception of the technology as user-friendly and intuitive. A more immersive experience tends to simplify their interaction with the technology, making it appear more accessible and straightforward. Interestingly, this relationship can be bidirectional, as evidenced in other studies. For instance, research by Xie et al. (2022) indicates that PEOU also influences IMM. This finding means that when users find technology easy to use, they may consequently feel more immersed in it. On the other hand, the effect of IMM on BITU underscores the role of immersive experiences in fostering a user's willingness to engage with the technology. This relationship suggests that the more users feel absorbed and involved in the virtual environment, the more likely they are to intend to use the technology. Given the critical role of IMM, the significance of EMB is further amplified as it influences IMM (H_{10}; β = 0.525, p = 0.003). In addition to EMB, AGY also has an impact on IMM (H_{15}). This relationship (β = 0.124, p = 0.040) highlights the role of user control and autonomy within the virtual environment in contributing to the immersive experience (Felnhofer et al., 2023).

The Limits of Embodiment in Shaping User Agency in the Metaverse

Interestingly, EMB does not influence AGY (H_7; β = 0.061, p = 0.067). While EMB enhances immersion, it does not necessarily translate into a sense of agency. This finding simply indicates that the factors contributing to a user's sense of control and influence in the virtual environment are distinct from those that contribute to their sense of physical presence. In contrasts to earlier studies indicating that a stronger sense of embodiment typically enhances perceived control of users over their virtual environment (Fribourg et al., 2021; Leveau & Camus, 2023), the present results points to a more nuanced relationship. One possible explanation is that while users may feel physically "present" in the metaverse through their avatars, this sense of presence does not automatically translate into a heightened sense of autonomy or influence over the environment. Agency in immersive settings is shaped not only by self-identification with an avatar but also by the actual functional affordances, interactivity mechanisms, and user interface design that enable control (Felnhofer et al., 2023). If the platform limits a user's capacity to alter the environment, make impactful decisions, or perform complex interactions, then embodiment alone may be insufficient to produce a strong sense of agency. Another factor could be habituation: as users become accustomed to their virtual representation, the novelty of embodiment may fade, diminishing its effect on perceived control. This finding suggests that in metaverse environments, enhancing agency likely requires deliberate design interventions (e.g., expanding interactive features, granting meaningful decision-making power, and supporting customizable avatar actions) rather than relying solely on strengthening embodiment.

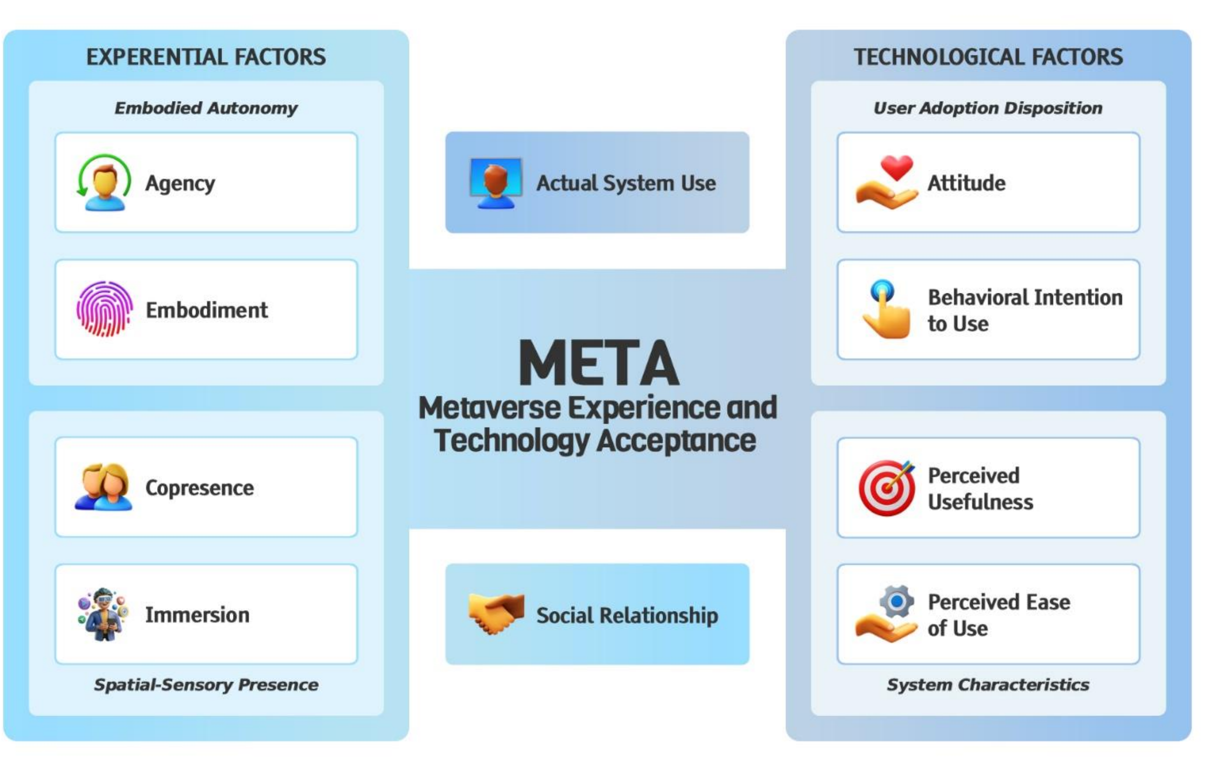

Figure 5. Metaverse Experience and Technology Acceptance Model

IMPLICATIONS AND FUTURE DIRECTIONS

Theoretical Implications

This research enriches the TAM with ESPT to create the META model (Figure 5). While TAM has been widely applied in metaverse research, ESPT has not yet been operationalized as the central theoretical basis for an acceptance study in this domain. Prior work has examined these models independently or incorporated presence-related constructs in a limited, supplementary capacity. The META framework fills this gap by offering a holistic, theory-driven, and statistically validated hybrid in which social and experiential constructs (SR, COP, EMB, AGY, IMM) are not peripheral add-ons but core, interacting drivers of acceptance. This integration addresses a long-standing limitation in TAM-based studies of immersive environments, which is the absence of constructs that capture embodied experiences and socially embedded interactions as direct determinants of acceptance behaviors. By embedding ESPT's constructs within TAM's causal structure, the META framework provides new explanatory power for understanding how socially mediated embodiment influences functional appraisals (e.g., PU, PEOU) and usage behaviors (ATT, BITU, ASU). This theoretical advancement responds directly to calls for models that can account for the affective, relational, and experiential dimensions of persistent 3D spaces and positions the META framework as a foundation for future metaverse adoption research.

Practical Implications

From a practical standpoint, the findings provide actionable guidance for adopters, developers, designers, and stakeholders in metaverse technologies. The META framework highlights that successful adoption strategies cannot rely solely on enhancing functional and usability factors. Instead, equal emphasis must be placed on fostering social connectivity (e.g., community-building features, opportunities for meaningful interaction) and immersive experiences (e.g., high-fidelity avatars, responsive environments) to sustain engagement (Garcia, 2025). For developers, the results underscore the need to design user-centric platforms that integrate embodiment and copresence-enhancing features with robust usability. These features ensure that users not only find the system easy to use but also feel deeply present and socially connected (Valera et al., 2025). For platform managers and marketers, the study provides evidence that social relationship-building tools (e.g., persistent friend networks, collaborative activities, and events) are central to retaining users and increasing their actual system use. For adopters, understanding the multi-layered benefits of immersive environments can inform investment decisions and help match platform capabilities to user needs.

Social and Educational Implications

In terms of social implications, this research highlights the significance of social connections (Bujić et al., 2021) and embodied experiences (Shin, 2018) in shaping engagement within virtual environments. The META framework demonstrates that these factors are not peripheral but central adoption drivers, which has implications for designing more inclusive, engaging, and socially beneficial virtual spaces. These findings suggest that metaverse platforms that prioritize social bonding, shared presence, and personalization can enhance well-being, reduce isolation, and foster meaningful online communities. The insights also extend to educational settings, particularly online learning environments that utilize extended realities (Meccawy, 2023) and the metaverse (Onu et al., 2023). Understanding how immersion and social presence impact learning outcomes can inform the development of educational platforms that increase student engagement, collaboration, and retention of information. For instance, incorporating avatar-mediated group activities or immersive simulations can leverage embodiment and copresence to deepen conceptual understanding and skill acquisition.

Policy and Governance Implications

Lastly, this study offers important implications for policymakers and governance bodies seeking to understand and regulate the metaverse. By evidencing the interconnected roles of technological and experiential aspects in driving adoption, the META framework helps policymakers anticipate how users will interact with and depend on these environments. Such insights are essential for crafting guidelines and regulatory frameworks that ensure user safety, privacy, accessibility, and equity in virtual spaces. When considered alongside broader discourse in the field, an important consideration is the role of equitable design and inclusive access in ensuring that metaverse experiences are available and beneficial to users regardless of socioeconomic status, physical ability, or technological literacy (Abd El-Sattar, 2025; Pal et al., 2025; Raman et al., 2025). Moreover, the findings can inform governance strategies that encourage responsible design practices (e.g., ensuring fair moderation systems, supporting cross-platform identity management, and safeguarding vulnerable users from harmful interactions). Understanding that social connectivity is a primary adoption driver means that policies must balance the encouragement of social interaction with protections against harassment, misinformation, and exclusionary behavior. By providing a research-backed perspective on these dynamics, this study equips policymakers with the theoretical and empirical grounding needed to guide the sustainable and ethical growth of metaverse ecosystems.

Limitations and Future Research Directions

While the study offers valuable insights into technology acceptance in the metaverse, it also presents opportunities for further exploration and refinement. Firstly, given the metaverse's relatively nascent stage, the findings of this study are limited to its current technological state. As metaverse technologies continually evolve, it is imperative for future research to revisit and re-evaluate these findings to maintain their relevance and accuracy. Replicating this study in the context of future iterations of the metaverse will be crucial in understanding the changing dynamics of technology acceptance. Secondly, the inherently subjective nature of experiences within the metaverse also represents a limitation. User interactions with and within these virtual environments are highly individualized, often shaped by personal preferences and perceptions (Dwivedi et al., 2022). This subjectivity underscores the complexity of researching technology acceptance in such diverse and personalized spaces. Future research should consider these individual differences and potentially explore more personalized or segmented approaches to understand user behavior in the metaverse better. Finally, the study could be enriched by considering additional constructs that play a role in technology acceptance. These include external influences (e.g., media coverage, peer opinions, or cultural trends), demographic variability (e.g., age, gender, and cultural background), and technological advancements (e.g., improved VR hardware or more immersive software). Incorporating these and other relevant factors into future research could provide a more comprehensive understanding of the complexities surrounding technology acceptance in the rapidly evolving metaverse.

CONCLUSION

Despite the growing body of research on metaverse technology acceptance, prior studies have paid insufficient attention to the experiential dimensions of user interaction within virtual worlds. Addressing this oversight is critical, as experiential factors are not peripheral but central drivers of how users perceive, adopt, and sustain engagement with metaverse environments. This study directly responds to that gap by theoretically developing and empirically validating the META framework, which is an integrated model that unites the functional rigor of the TAM with the socially and experientially grounded principles of ESPT. By applying a SEM approach, this research demonstrates the compatibility and complementarity of these two theories in explaining digital existence in the metaverse. The findings show that metaverse adoption extends well beyond utilitarian considerations, as captured by TAM, to encompass the profound influence of embodied presence, social connectivity, and immersive engagement, consistent with ESPT's core propositions. This study advances metaverse acceptance research by reintroducing the often-overlooked TAM construct of ASU and revealing that it is shaped by both usage intentions and the depth of social connectedness within the platform. Overall, the META framework advances theoretical understanding by systematically bridging technological acceptance and experiential interaction in persistent virtual worlds. As metaverse technologies continue to evolve, the META framework stands as a foundational reference point for future scholarship and development that guides the construction of inclusive, engaging, and socially beneficial digital spaces.

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Appendix A. Survey Questionnaire

Technology Acceptance Model

Perceived Usefulness (PU)

PU1: Using metaverse technologies enhances my productivity.
PU2: I find metaverse technologies useful in my daily activities.
PU3: Metaverse technologies improve the quality of tasks I perform.
PU4: Overall, I find metaverse technologies beneficial.

Perceived Ease of Use (PEU)

PEU1: Learning to operate metaverse technologies is easy for me.
PEU2: I find it easy to get metaverse technologies to do what I want.
PEU3: Interacting with metaverse technologies is clear and understandable.
PEU4: I find metaverse technologies to be flexible to interact with.

Attitude (ATT)

ATT1: I feel positive about using metaverse technologies.
ATT2: Using metaverse technologies is a pleasant experience.
ATT3: I think using metaverse technologies is a good idea.
ATT4: I am enthusiastic about the potential of metaverse technologies.

Behavioral Intention (BI)

BI1: I plan to use metaverse technologies in the future.
BI2: I intend to increase my use of metaverse technologies.
BI3: I will recommend metaverse technologies to others.
BI4: I am committed to using metaverse technologies regularly.

Actual Usage (AU)

AU1: I frequently use metaverse technologies.
AU2: Using metaverse technologies is part of my routine.
AU3: I spend a significant amount of time using metaverse technologies.
AU4: I rely on metaverse technologies for various activities.

Embodied Social Presence Theory

Embodiment (EMB)

EMB1: I feel physically present in the metaverse environment.
EMB2: My virtual representation in the metaverse feels like an extension of myself.
EMB3: I feel that my movements are naturally mirrored in the metaverse.
EMB4: I experience a sense of physical presence when interacting in the metaverse.

Copresence (COP)

COP1: I feel the presence of others when I am in the metaverse.
COP2: Interacting with others in the metaverse feels like they are physically near me.
COP3: I feel connected with others when I am in the metaverse.
COP4: The presence of other users enhances my metaverse experience.

Agency (AGY)

AGY1: I feel in control of my actions within the metaverse.
AGY2: I can influence events in the metaverse environment.
AGY3: My decisions have a noticeable impact on the metaverse.
AGY4: I feel autonomous in my interactions within the metaverse.

Immersion (IMM)

IMM1: I feel completely absorbed in the metaverse environment.
IMM2: The metaverse experience feels realistic to me.
IMM3: I lose track of time when I'm in the metaverse.
IMM4: I feel emotionally connected to the metaverse experience.

Social Relationship (SR)

SR1: I have formed meaningful relationships in the metaverse.
SR2: Interactions in the metaverse have improved my social connections.
SR3: I feel a sense of community with other users in the metaverse.
SR4: The metaverse provides valuable opportunities for social interaction.

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Garcia, M. B., Quejado, C. K., Maranan, C. R. B., Ualat, O. N., Adao, R. T., Happonen, A., Yilmaz, R., & Bozkurt, A. (2024). *TENCON 2024 - 2024 IEEE Region 10 Conference (TENCON)*, 1533-1536. https://manuelgarcia.info/publication/social-relationship-development-metaverse

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LET'S COLLABORATE!

If you are looking for research collaborators, please do not hesitate to contact me at mbgarcia@feutech.edu.ph.

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