The Role of Embodiment, Experience, and Self-Image Expression in Creating Continuance Intention in the Metaverse

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Abstract

Despite the growth of the metaverse, users' perception of their self-image based on the embodied elements remains unexplored. This research explores the metaverse world's relationship between embodiment, experience, expression, and continuance intention. This research deploys an exploratory sequential mixed-method research design to operationalise the study objective. Study 1 performs a qualitative investigation to develop a hypothetical model, and Study 2 employs a 3x3 factorial experimental design with 356 participants to investigate the proposed hypotheses. The results indicate that embodied presence and co-presence can lead to positive continuance intentions. Also, it is crucial to develop self-image expressions in the metaverse space. This research offers multiple insights and advances the theoretical knowledge

of cognitive embodiment, flow, cognitive bias, and expectancy confirmation theories. The results can also aid metaverse practitioners in designing an interactive metaverse domain.

Keywords: embodied presence; cognitive experience; self-expression; self-concept; continuance intention; metaverse explorations; physical experience

1. Introduction

The rapid progress of immersive technologies and metaverse environments and platforms has created opportunities for various human life processes. The metaverse refers to a virtual space where users can interact with a computer-generated environment and other users in real-time (Tan et al., 2023). The metaverse generally denotes a shared virtual environment where users can participate in digital activities (Dwivedi et al., 2023a). Examples of platforms are video games such as Roblox and Fortnite, virtual sports training environments such as Zwift and RGT cycling, and virtual meeting spaces such as Meta Horizon Workrooms and Raum. The metaverse has expanded user interaction with virtual environments through augmented reality, leading to a qualitative change in the user's embodiment. There is a close connection between embodiment and the metaverse. Through their embodied avatars, people traverse and interact with the digital environment in the metaverse. The boundaries between the real and virtual worlds are becoming increasingly thinner due to technological advancements, which open new possibilities for embodiment and immersive metaverse experiences. Research forums use virtual worlds and the metaverse as interchangeable terms, but their functionalities may differ. While "metaverse" refers to a more general notion that includes a collective and interconnected virtual realm that transcends individual virtual worlds, virtual worlds are distinct, immersive settings where users can interact (Dwivedi et al., 2023a). Many consider the metaverse the next generation of the Internet, offering a more linked and immersive online experience. Researchers have asserted that businesses can leverage the metaverse to develop a lucrative ecosystem to interact with customers (Dwivedi et al., 2022a; Dwivedi et al., 2023b). Papagiannidis et al. (2008) state that the metaverse can potentially replace website-based electronic commerce business. For the metaverse to progress as a parallel world to human reality, users should develop more long-term engagement intentions. Some of the conceptual explorations in the metaverse have supported the idea that user experience is the key to creating the metaverse (Mogaji et al., 2023). Various intentions can structure the metaverse behaviour, such as behavioural intentions (Pillai et al., 2023), recommendation intentions (Mladenović et al., 2023), and continuation intentions (Jo, 2023). One primary driver to generate these

intentions is user experience (Wongkitrungrueng & Suprawan, 2023). The metaverse also allows customers to have the opportunity to express themselves in unique and innovative ways with avatar customisations, wearing accessories, designing digital art, and through social interactions (Barrera & Shah, 2022). The features characterising metaverse platforms are becoming increasingly dynamic, leading to a more significant user experience (Dwivedi et al., 2023). However, given the evolution of technology and the web domain, users have developed various intentions and expressions associated with virtual space. There is a need to understand the intentions and expressions underlying experience that drive the metaverse.

Previous research that has worked in the metaverse domain has explained the role of creating avatars, and its significance is widely investigated, but how it relates to perceiving the embodiment elements is yet to be explored (Cosentino & Giannakos, 2023). Embodiment in the context of the metaverse describes how people or entities are portrayed in the metaverse's virtual environment (Kim et al., 2023). It entails making digital representations or avatars that users may manipulate and use to communicate with other users and the virtual environment (Hennig-Thurau et al., 2023). This idea is essential to give people a feeling of identity and presence in the metaverse. In the context of virtual reality and the metaverse, embodiment pertains to the way that an individual or group represents themselves in a digital setting. In order to provide users a sense of presence and immersion in virtual environments and make them feel as though they are really "in" the virtual world, embodiment is essential. The embodied presence can develop positive intentions and allow users to express themselves differently or similarly in a way consistent with the real world. However, such a relation is indirectly driven by the experience that users perceive in the metaverse space (Kim et al., 2023).

Though experience as a concept is derived through the tenets of flow theory (Csikszentmihalyi, 1990), researchers have introduced various experiential annotations explaining that experience is more contextual and can differ based on the technology and people (Balakrishnan & Dwivedi, 2021). So, it is essential to understand which experiences play a significant role in the metaverse. From a holistic view, the same should be conceptualised as a precursor of various intentions and expressions. In terms of stimuli, different peripheral and cognitive stimuli can exist around the metaverse (Shin et al., 2022). Research in the metaverse has suggested that users perceiving and feeling their avatar embodied with the metaverse is a new experience (Dincelli & Yayla, 2022). After various evolutionary advancements, interaction on the Internet is slowly replacing a part of reality (Koohang et al., 2023). The metaverse offers a physical structure where users can create their own or imaginary avatars to represent

themselves in the virtual world (Dwivedi et al., 2022). Little research has questioned whether users feel their physical touch in the virtual world, which may be essential to feeling various intentions (Dwivedi et al., 2022). Thus, the experience can indirectly influence the relationship of embodiment with user intentions and expressions in the metaverse. So, based on the following gaps, this research investigates the relationship between embodiment and experience, leading to various intentions in the metaverse. The same is formulated as research questions (RQs) as given below:

RQ1: What is the role of embodiment in creating metaverse intentions and expressions?

RQ2: What is the indirect role of experience in the relationship mentioned in RQ1?

This research uses embodiment cognitive theory (Wilson, 2002) as an overarching theory to develop a comprehensive conceptual and theoretical model. Besides, the study also uses cognitive, self-concept, and flow theories to support and shape the ideas of the conceptual model. This research adds to existing knowledge of these theories regarding the metaverse exploration. Previous research using embodiment theories has tried to explore it through the lens of virtual space and games, but few studies have tried to understand the scope of these theories from the metaverse angle. Further, this research also adds meaningful contributions to industry practitioners as well.

The research questions mentioned above envelope a broad conceptual dilemma explaining the relationships among embodiment, experience, intentions, and expressions in the context of the metaverse. This research follows an exploratory sequential mixed-method research design. This mixed method design operates as two studies. Study 1 examines the proposed research objective using a structured, in-depth interview. Study 1 precisely explores the conceptual idea proposed in the research question to discover the underlying variables in the metaverse concept. Subsequently, based on the insights of the Study 1, a hypothetical model is proposed. The proposed hypothetical model will be tested empirically using a 3x3 factorial design in a simulated retailing metaverse environment in Study 2. Both studies' discussion and theoretical contributions are highlighted following the results section of Study 2.

2. Literature and Theoretical Background

2.1. The Metaverse

The advent of the metaverse as a digital platform for user interaction, creation, and commerce has generated great interest among marketers looking for novel approaches to communicating

with customers (Yoo et al., 2023). The metaverse is a collection of linked virtual worlds with immersive settings for users to explore, engage with, and produce content (Hennig-Thurau et al., 2023). Science fiction gave rise to the metaverse, a real-world digital environment that includes online gaming platforms, augmented reality, and virtual reality. Businesses have started creating branded virtual locations, events, and experiences in the metaverse to engage with customers more deeply (Zabel et al., 2023). With the metaverse, marketers have never-before-seen chances to engage customers in fully immersive virtual worlds. This marks a fundamental leap in digital engagement. Shopping experiences are being reimagined as the metaverse develops into a dynamic digital ecosystem that offers customers novel ways to find, interact with, and buy goods and services (Leong et al., 2023). Apart from the technical functionalities, the metaverse allows customers to personalise and customise their shopping experiences by using avatars, which are digital representations of themselves that can be used to try on virtual clothes and accessories (Arya et al., 2024). The metaverse can also allow customers to frequently interact with friends, influencers, and virtual assistants to get advice, comments, and suggestions in the virtual space (Oh et al., 2023).

Most of the research has supported the idea that experience can be an important driver in the metaverse to attain a positive result (Capatina et al., 2024). Users can interact with digital content, explore virtual environments, and engage in ways that imitate or improve real-life experiences. These fully immersive experiences give users a sensation of embodiment and presence in the virtual world by obfuscating the lines between the actual and virtual worlds (Balakrishnan et al., 2024). Experience, embodiment, and the metaverse are intricately and profoundly entwined as the metaverse redefines how people interact with digital spaces and understand their presence inside them. Users usually construct avatars to represent themselves in the metaverse. Avatar creation frequently includes customization choices for appearance, clothing, and accessories, allowing users to express their identity and preferences. Users have agency and control over their avatars, enabling them to navigate the virtual world, participate in activities, and create metaverse experiences (Kim et al., 2023). The anonymity and flexibility of avatars in the metaverse frequently motivate users to investigate various elements of their identity, experiment with self-expression, and engage in social interactions that differ from their offline personas (Ribeiro et al., 2024).

Shopping in the metaverse is more than just purchasing goods and services; it is also a method of self-expression and carrying out long-term goals (Ahn et al., 2024). Many metaverse

platforms let users personalize their avatars with virtual clothing, accessories, haircuts, and other items. These avatar customizations allow users to show their style, personality, and individuality. Shopping in the metaverse can be a social experience, with individuals browsing virtual stores together, sharing recommendations, and discussing purchases (Koohang et al., 2023). Purchase objectives may include buying products to improve social relationships or participate in virtual events and activities. Thus, the metaverse allows users to have an embodied connection through various creations such as avatars. These creations will help users self-express themselves while simultaneously creating more experience in the virtual space. Overall, this metaverse process allows users to decide on long-term or short-term planning related to their commercial activities within the metaverse.

Prior literature has highlighted diverse benefits associated with the adoption of metaverse technologies and platforms. We present a comprehensive overview of Appendix A.

2.2. Embodied Cognition Theory and the Metaverse

Embodied cognition theory is a branch of cognitive science which explains the intertwined role of the physical body and cognitive senses as connected with an environment (Wilson, 2002). Research investigating humans' cognitive and information processing has given little focus on the embodied cognitive actions of humans (Foglia & Wilson, 2013). Embodied cognition stresses how our bodies, sensory experiences, and sensory-motor activities shape our thoughts, perceptions, and understanding of the world. The principles of embodied cognition are based upon the internal processes of embodied simulation, grounding in-sensory motor experience, situation cognition, perceptual symbol symptoms, and extended mind (Lara et al., 2018). These processes explain how a body interaction can open the neural pathways, sensory understanding, meanings, and problem-solving with the support of cognitive aspects. Numerous disciplines, including psychology (Gjelsvik et al., 2018), neurology (Meteyard et al., 2012), linguistics (Chatterjee, 2010), and philosophy (Shapiro, 2007), have investigated different variables associated with embodied cognition. It casts doubt on the notion of a mind that is only symbolic and abstract and contends that our physical experiences and interactions with the outside world fundamentally influence our thinking and comprehension.

The way we see and engage with the metaverse can be significantly impacted by embodied cognition. People can connect, socialise, work, play, and engage in various other activities using avatars or digital representations of themselves in the metaverse, a virtual universe or a digital realm (Zallio & Clarkson, 2022). The connection between embodiment and the

metaverse can relate to various concepts such as avatar embodiment, gesture and interactions, spatial cognition, contextual understanding, extended embodiment, and cultural and social embodiment. In the metaverse, the creation of captivating and immersive experiences is the aim of embodiment. When interacting with individuals and the environment in a virtual realm, users should experience a sense of presence that replicates or improves interactions in the real world. The metaverse offers novel and distinctive marketing options, enabling companies to interact creatively with consumers (Barrera & Shah, 2023) to induce more user purchase behaviour (Jafar et al., 2023). More than the tools connected in the metaverse space, the journey in the metaverse essentially augments the immersive experience present in the metaverse. Marketers enable users to create avatars to develop new brand experiences (Wongkitrungrueng & Suprawan, 2023). Research in marketing has found that the avatar or any visual representation in the virtual world is more connected with the consumers' identity and self-expression, resulting in how they connect with the avatar (Park et al., 2023). So, individual and social identities exist in how users or consumers connect with the physical being in the metaverse. Unlike the traditional marketing context, the metaverse augments users' movement and interactions, which can bring the virtual place to reality (Tan et al., 2023). However, the outcome of such physical movements and interactions for the benefit of academics and practitioners needs contextual examination.

By providing a strong embodied presence, the journey in the metaverse can be augmented to a real-time feel in the metaverse. Research in information systems has explained that providing more physical embodiment will enrich the experience associated with the technology (Watson et al., 2010). The metaverse experience can improve when users see their avatars as extensions of themselves and can engage with the virtual world and other users as if they were physically present. Users have a greater sense of agency within the metaverse when they undergo cognitive embodiment experiences (Shin, 2022). They feel more in control and empowered because they think their choices and actions have genuine consequences in the digital realm. Metaverse can offer different experiences to its users, such as social, creative, emotional, cognitive, and entertainment experiences (Golf-Papez et al., 2022; Chan et al., 2023). However, these experiences can differ based on the metaverse's context. Visits to the metaverse may last longer and occur more frequently if the cognitive embodiment is enhanced. Users are more likely to return when a virtual world offers a strong sense of presence and meaningful experiences. Thus, the connection between the embodiment in the metaverse and experience can be strong.

Besides the experience that the metaverse can offer, during the experience, the users can gather intentions that hail present or future behaviour. Various kinds of intentions were discussed previously in the literature on marketing and information systems, such as behavioural intentions (Pappas & Woodside, 2021), revisit intentions (Shin et al., 2023), continuance intentions (Yan et al., 2021), and recommendation intentions (Jiménez-Castillo et al., 2019). However, it is too early to corner down a specific intention in the context of the metaverse. The metaverse is a growing medium, and there is a need for in-depth exploration to determine the particular intentions underlying the metaverse growth. Thus, based on the discussion above, a conceptual model is proposed in Figure 1, which will be expanded using Study 1.

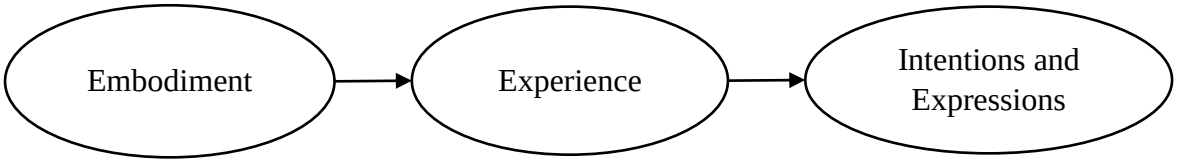

Figure 1: The proposed conceptual model

3. Study 1

3.1. Study Design

3.1.1. Sampling and Operationalisation

Study 1 is operationalised using a qualitative design following an in-depth interview approach. Thirty metaverse users participated in a qualitative interview. The metaverse users were identified through game and technology forums, and based on the knowledge and participation they shared in the forums, they were invited to participate in the qualitative study. Demographic and participation information of interviewees is provided in Appendix B. The interview participants were asked to navigate in a metaverse-simulated setup created by the authors using Roblox with the help of a third-party virtual developer. The metaverse consisted of 5 fictional retail stores, allowing the users to navigate a free tour in the digital world. The exploration of the metaverse, on average, took 30 minutes, after which the participants were interviewed about their experience in a structured manner. The interview lasted up to 70 minutes, with participants explaining their background and limitations with the metaverse. However, the discussion is structured and routed to uncover the inherent dimensions present within the conceptual model given in Figure 1. The indicative questions used during the interview process are given in Appendix C

4.1.2. Data Analysis

We followed a five-step process to evaluate the data verbatim provided by the participants (Braun & Clarke, 2019; Dwivedi et al., 2023b; McCrudden & McTigue, 2019). As a first step, the interview participants' data were thoroughly examined to check whether it falls under the study's conceptualisation. In the second step, the data was screened to identify the closed phrases in the transcript. The closed phrases were identified without deviating from the conceptualisation or scope of the study. For example: "I wish to be physically present in the metaverse to gain better experience" (P11), "The way I can process my experience mentally, I can express myself in the metaverse" (P6), "I am happy to see other avatars walking in the metaverse, I am excited to interact with them, it is a kind of new experience to me" (P21), and "I will be happy to continue shopping with the metaverse if given more chance" (P26). In step three, the open codes extracted from the phrases were coded further into labels to underlying concepts within the phrases. For example, P6's statement above was coded as "mental processing" and "self-perception". In the fourth step, the identified codes were grouped into broad categories to determine thematic congruence and relationships identified in the context of the conceptual model. For example, the labels "mental processing" and "cognitive explorations" were grouped under "Cognitive experience". Finally, the interconnection and thematic relationships among the labels were identified in the fifth step to understand the connection between the variables. NVIVO and GEPHI 0.10 were used to understand the codes and to visualise the relationship pattern. Appendix D shows the thematic network diagram exhibiting the relationships among the investigated variables.

3.2. Results of Study 1

The study results are explained based on the conceptualisation provided in Figure 1. The concepts are further expanded and explained to aid in developing a comprehensive hypothetical model.

Table 1: The categories and codes for the Study 1 (N =30)

Embodiment	**N**	**Experience**	**N**	**Intentions and Expressions**	**N**
Embodied Presence		***Cognitive Experience***		***Intentions***	
Physical presence (+)	15	Mental processing (+)	16	Continuance Intention (+)	20
My movements (+)	11	Thinking (+)	14	Re-use intention (+)	11
Ownership (+)	10	Cognitive explorations (+)	12	Recommendations to others (+)	7
Free movements (+)	5	Remembrance (+)	8	Addiction (+)	3
Spatial content (+)	4	Cognitive involvement (+)	7		
Objects (+)	4	Rational processing (+)	4		
My Avatar (+)	4				
Embodied Co-presence		***Physical Experience***		***Expressions***	
Social presence – Avatar (+)	17	Physical sensation (+)	17	Self-Image (+)	18

Interaction (+)	16	Bodily awareness (+)	12	Self-Perception (+)	17
Social actor (+)	11	Auditory perception (+)	8	Satisfaction (+)	12
Movements (+)	8	Tactile sensitivity (+)	8	Happiness (+)	8
Design (+)	8	Sensory perception (+)	7	Self-disclosure	5
Social distance (-)	5	Touch and Feel (+)	4	Habit formation (+)	4
Co-shopping (+)	4				

3.2.1. Embodied Presence

Based on the discussion with the participants, it is clear that the labels in the embodiment can mainly be categorised as two significant variables: embodied presence and embodied co-presence. These two variables denote how the users feel about their physical and social presence in the metaverse. A total of 21 labels arose from the phrases concerned with the embodied presence, of which 14 labels were identified to have high weights to be considered for the thematic classification. The 14 labels based on the content of the discussion were classified into two major variables: embodied presence and embodied co-presence. The label and classification is given in Table 1.

It can be seen that embodied presence is comprised of seven labels denoting the physical and agency expectations of the participants. "Physical presence", "My movements", and "Ownership" are found to have higher weights compared to the other four labels in embodied presence. On the other hand, "social presence – avatar", "interaction", and "social actor" were found to have higher weights in embodied co-presence compared to the other four labels. Some indicative phrases provided by participants are mentioned below:

> *P2: "The metaverse is a new experience to me. Unlike other virtual domains, I can feel my physical presence here."*
>
> *P17: "I can realise my ownership while seeing other avatars and interacting with them."*
>
> *P19: "When I see the avatars of others in the metaverse, it makes me feel physically present in the metaverse."*

Thus, embodiment is categorised as embodied presence and co-presence based on the labels generated in the phrases. Also, the labels will be further used to design the experimental conditions in Study 2.

3.2.2. Experience

The term "Experience" is explored further to understand the kind of experience that the metaverse users expect. Eighteen labels were identified during the process of analysing the phrases which are relevant to the term "Experience". Of the 18 labels, 12 labels were found to have relatively higher weights. The 12 labels are dissected into two major categories: "cognitive experience" and "physical experience". Though enough literature has spoken about cognitive experience, physical experience is not explored enough in technology-based research. Moreover, the thematic analysis of the embodiment should have higher weights for these two experiences. Some indicative phrases provided by participants are mentioned below, which are concerned with experience:

> *P8: "I term this metaverse experience more of a physical sensation, and my sensory perceptions support such physical realism."*
>
> *P18: "Apart from the sensations, I can process my experience mentally, and I believe it will help me remember this for a long time."*
>
> *P23: "Though I cannot feel the touch and other physical deep sensations, the metaverse provides me bodily awareness because of my avatar and other avatars around me."*

Thus, experience is categorised as a physical experience and cognitive experience based on the labels generated in the phrases. These experiences will be identified in literature leading to support the hypothetical model.

3.2.3. Intentions and Expressions

The participants of the metaverse expressed four intentions, as mentioned in Table 1. Of which, continuance intention with the metaverse is found to have high weights. Moreover, the continuance intention is thematically connected with the labels representing the experience and embodiment. Thus confirming the hypothetical and triangulated relationship that can exist among the variables. On the other hand, eight expressions were identified among the participants, of which self-image and self-perception are weighed high. The thematic analyses showed that self-image expression is highly connected with the labels associated with embodiment and experience. Also, two-directional weights were related from self-image expression to continuance intention. So, based on the analysis and results, continuance intention and self-image expressions are identified under intentions and expressions.

P19: "I will be happy to continue using the metaverse again, given that I can imagine myself within it."

P10: "While walking in the metaverse, I felt like walking in the physical world, and I can express myself with great freedom."

P14: "There are many elements to express my happiness in the metaverse. I would be happy to revisit this."

Thus, the continuance intention and self-image expression are endogenous variables based on the intentions and expressions explored. Also, based on the thematic relationships discovered (Appendix D), we propose the hypothetical model given in Figure 2. Figure 2 is expanded based on the conceptual idea given in Figure 1.

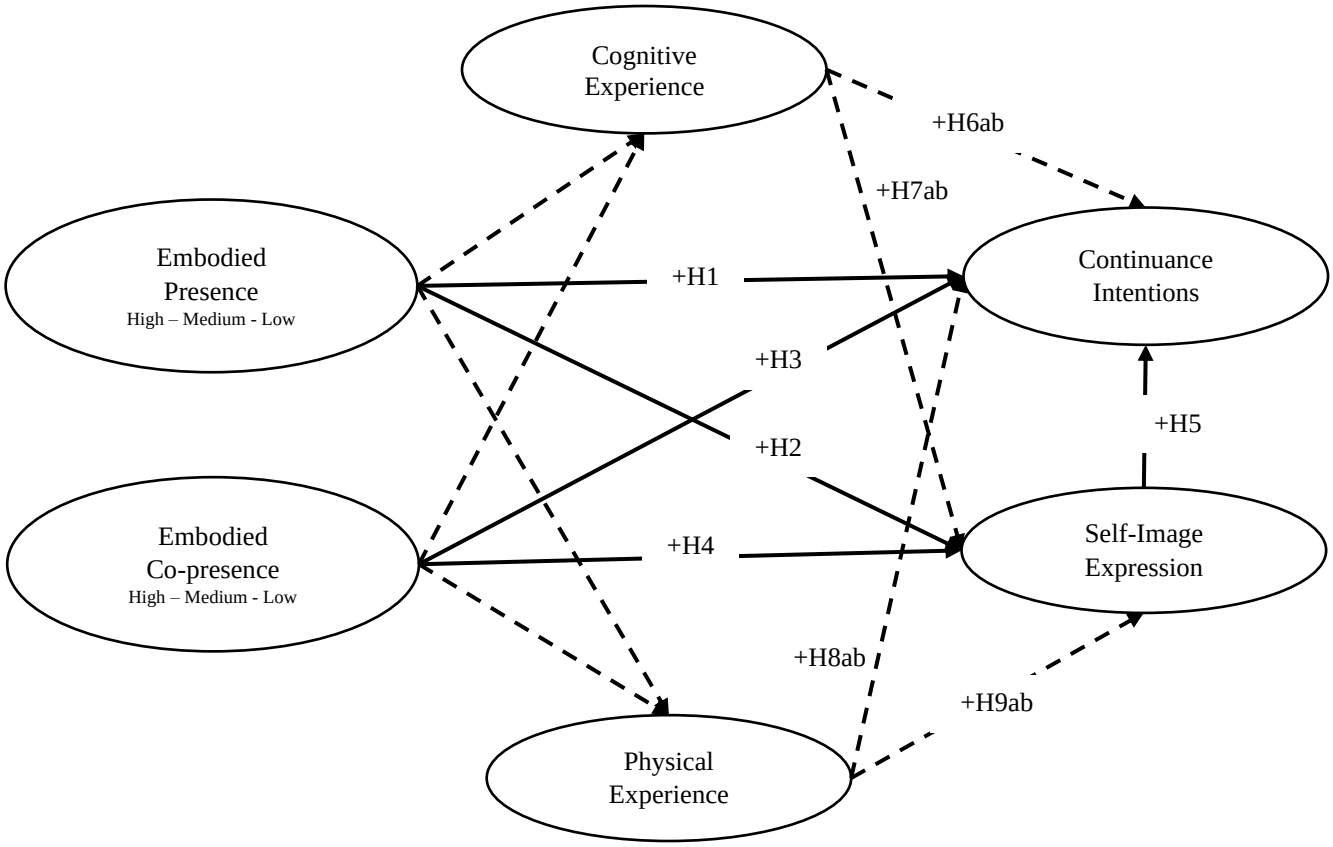

Figure 2: The proposed conceptual model

4. Study 2

4.1. Model and Hypothesis Development

4.1.1. Embodied presence

The degree to which a person feels involved or linked with a virtual or digital environment—often via technology—is called embodied presence (Wilson, 2002; Foglia & Wilson, 2013). It entails experiencing the virtual environment as if it were real by being "present" or "immersed" in it. Although virtual reality (VR) experiences are frequently linked to this idea, the emergence of the metaverse provides more meaning to this concept (Tan et al., 2023). According to the Perceptual Control Theory (PCT; Powers et al., 1960; Powers, 1973), people work hard to maintain and control their perceptions to conform to their desired outcomes (Marken & Mansell, 2013). PCT can be used to explain how people modify their activities and behaviours in virtual settings to preserve a sense of presence and congruence with their objectives (Vancouver & Putka, 2000). Also, according to the Extended Mind Theory, the mind goes beyond the boundaries of the brain and includes tools and technology (Clark & Chalmers, 1998; Slaby & Gallagher, 2015). This idea can be used to comprehend how technology, such as VR interfaces, extends the user's mind and body in embodied presence (Parker et al., 2020). So, the interconnection between the metaverse and the perception of embodied presence is essential for forming a fruitful outcome. According to the Expectation Confirmation Theory (ECT), pre- and post-usage impressions impact their satisfaction with technology (Oliver, 1980; Bölen, 2020). Users are more inclined to stick with technology if it meets or exceeds their expectations (Bölen, 2020). Thus, the perception of a strong embodied presence in the metaverse can build a positive continuance intention with the metaverse. Based on the above discussion, the following hypotheses are proposed.

> *Hypothesis 1: The embodied presence is significantly related to a continuance intention.*

Users frequently build avatars or digital representations of themselves in virtual reality (VR) and similar digital settings. Users may feel like their avatars are an extension of themselves when they have an intense sensation of embodied presence (Schultze, 2010). This behaviour may impact how people customise their avatars regarding dress, appearance, and behaviour (Barreda-Ángeles & Hartmann, 2022). A strong sense of embodied presence can increase psychological engagement in a virtual world. Deeply involved users may convey their self-image more passionately and truthfully, which helps create a more vivid digital identity.

Symbolic interactionism emphasises how symbols, language, and social interactions influence one's self-concept and self-expression (Piacentini & Mailer, 2004). It implies that social engagement and communication help people form positive opinions. Self-expression is viewed as a method of communicating one's identity to others symbolically (Calvert et al., 2003; Piacentini & Mailer, 2004). Thus, users create self-portrayal images and avatars in the metaverse to develop their ownership and agency in the virtual world. However, it remains unknown whether such actions of embodied presence can result in a positive self-image expression. Based on the above discussion, the following hypothesis is proposed.

Hypothesis 2: The embodied presence is significantly related to self-image expression.

4.1.2. Embodied co-presence

Embodied co-presence is the feeling of being physically present while interacting with others in a shared space, which is frequently made possible by technology (Zhang et al., 2022). In its most basic form, it refers to the experience of feeling "together" with others in a digital or virtual environment as if they were physically there (Aroles & Küpers, 2022). The experience of being socially connected with others in a digital environment is called social presence, which is improved via embodied co-presence. Social Presence Theory focuses on how users feel about being with others in a mediated communication context (Gunawardena, 1995), such as online social interactions (Cui et al., 2013). It explores how technology can facilitate or hinder social presence, affecting the quality of interpersonal communication and relationships. Embodied co-presence can foster a sense of dedication and allegiance to the metaverse, and higher engagement and connection are more likely to want to stick around because they see the platform as essential to their social lives. Previous research suggests that an enjoyable and fulfilling experience of embodied co-presence can benefit users' psychological well-being (Lee et al., 2020). Users are more inclined to use the technology if they have positive emotional and psychological effects. The same principle applies to the metaverse in which users who perceive embodied co-presence will develop positive continuance intentions. Based on the above discussion, the following hypothesis is proposed.

Hypothesis 3: The embodied co-presence is significantly related to a continuance intention.

Previous research has found that individuals tend to develop their self-image and expressions based on social communications and expressions (Kim et al., 2011). Self-disclosure theory (Cozby, 1973), which has roots in interpersonal psychology and communication studies,

suggests that people participate in self-disclosure, divulging private information about themselves to others (Schlosser, 2020). Some research has confirmed such propositions from the technology point of view (Schlosser, 2020). Depending on the connection and situation, self-disclosure can vary in depth and breadth, which can affect how one expresses their self-image. Also, the idea behind self-presentation theory, commonly called impression management theory, is that people deliberately and unconsciously control the perceptions they give to others (Leary & Kowalski, 1990). This theory examines how people utilise verbal and nonverbal cues to influence how others see them, which can impact how they express their self-image. Users in the metaverse can discover that embodied co-presence gives them the confidence to articulate certain parts of their self-image through various social elements present within. The appearance of anonymity and disassociation from the physical world might increase self-assurance in self-expression in the metaverse. Thus, the embodied co-presence in the metaverse can positively impact the self-image expression in the metaverse.

Hypothesis 4: The embodied co-presence is significantly related to self-image expression

4.1.3. Self-Image Expression to Continuance Intention

Self-image expression is the process through which people express their self-concept, identity, values, beliefs, and feelings to others (Gecas, 1982; Chen & Chen, 2020). This process is frequently done through various actions, behaviours, nonverbal cues, and verbal and nonverbal communication. People are more likely to have a good self-image when expressing it consistent with their identity and beliefs in the metaverse. This sense of fulfilment through self-expression may help to increase the intention to continue in the metaverse. Previous research has supported the idea that perceived self-image in the technology medium can increase the likelihood of visiting again (Zhou et al., 2019). Certain users may use metaverse to discover and shape their self-identity. They could have a long-term interest in utilising the metaverse world as they develop and experiment with their self-image. Self-perception theories suggest that individuals infer their attitudes based on their perceptions, resulting in a sustainable outcome (Yan et al., 2021). Thus, metaverse users may develop positive continuation intentions based on their perceived self-image. Based on the above discussion, the following hypothesis is proposed.

Hypothesis 5: Self-image expression is significantly related to continuance intention.

4.1.4. Cognitive and physical experience

Cognitive experience refers to the flow of mental processes arising from people's actions when sensing, understanding, learning, analysing, and solving problems (Bratman et al., 2012). Gestalt psychology places a strong emphasis on how comprehensive cognitive experiences are. According to this theory, people experience and comprehend stimuli as cohesive wholes rather than discrete components, and cognitive processes work to impose structure and order on sensory information (Wagemans et al., 2012). In a digital or virtual environment, people are frequently more engaged and immersed when they feel a strong sense of embodied presence. This increased sensation of presence may have a favourable impact on their satisfaction with the technology. Higher levels of user satisfaction can be attributed to an advantageous user experience motivated by a strong sense of embodied presence (Shin, 2018). Users who are happy with the technology are likelier to have a favourable viewpoint toward it and express a stronger intention to use it in the future. Branches of ecological psychology posit how people's interactions with their physical and social surroundings influence their cognitive experiences. It stresses affordances and perception-action connection. The same may apply in the metaverse, where cognitive processing may augment the embodiment present with the virtual space, resulting in better long-term association with the technology. Thus, both cognitive experiences can mediate in the path of embodied presence and co-presence to its relationship with continuance intention. Based on the above discussion, the following hypotheses are proposed.

> *Hypothesis 6a: Cognitive experience significantly mediates the relationship of the embodied presence to continuance intention.*
>
> *Hypothesis 6b: Cognitive experience significantly mediates the relationship of the embodied co-presence to continuance intention.*

Like the previous hypothesis, cognitive experience can augment the relationship function of embodied presence and co-presence to self-image expression. Cognitive bias theories state that cognitive processing can alter how individuals perceive themselves, resulting in self-serving bias (Acciarini et al., 2021). These biases reinforce particular thoughts or impressions, affecting one's self-image. Thus, cognitive experience in the metaverse can alter self-image expressions arising from the embodiment. Due to the cognitive overload, some users of the metaverse can discover that embodied presence and co-presence give them the confidence to articulate certain parts of their self-image. Thus, cognitive processing can positively build the relationship

between embodied presence and co-presence with self-image expression. Based on the above discussion, the following hypotheses are posited.

Hypothesis 7a: Cognitive experience significantly mediates the relationship of the embodied presence to self-image expression.

Hypothesis 7b: Cognitive experience significantly mediates the relationship of the embodied co-presence to self-image expression.

The sensory and perceptual interactions people have with the outside environment while using their bodies and senses are referred to as physical experiences. Bodily sensations, including pain, pleasure, pressure, warmth, coolness, and comfort, are all considered physical experiences (Allen-Collinson & Owton, 2015). Theories associated with sensory perceptions suggest that these feelings offer insightful information on the state of the body and how it interacts with the outside world (Heller et al., 2019). Previous research has posited that the virtual world can attempt to create or make users perceive the physical world or physical entity within the virtual realm (Berger, 2020). Physical experience includes adjusting to and reacting to many environmental factors, such as the terrain, weather, and surroundings.

Regarding the metaverse, adjusting to the virtual world based on the surrounding elements can also represent physical experience (Berger, 2020). Embodiment is a relatively intertwined concept with physical experience. Previous research has asserted that creating avatars and agency movements can result in real-world experience (Park & Kim, 2022). However, the context of real-world experience is not conceptualised in terms of physical experience. Most of the literature on sports has explained that physical experience can enlarge physical joy, resulting in continued activity (Heller et al., 2019). However, this finding is not conceptualised in the context of digital medium on how perceived physical experience in the metaverse can augment continuation intention. However, based on the above discussion, it can be posited that physical experience can significantly mediate the relationship of embodied presence and co-presence to continuation intention.

Hypothesis 8a: Physical experience significantly mediates the relationship of the embodied presence to continuance intention.

Hypothesis 8b: Physical experience significantly mediates the relationship of the embodied co-presence to continuance intention.

Similar to the previous hypotheses, it can be posited that physical experience can also mediate significantly in the relationship of embodied presence and co-presence to self-image expression. Physical experiences greatly influence self-image, mainly how people see their bodies and physical attractiveness (McComb & Mills, 2021). Positive bodily experiences can encourage the expression of a more positive self-image. In the context of the metaverse, developers build such bodily connections through avatars and social avatars to develop a positive physical experience. Self-image in the metaverse may be influenced by how people react to bodily sensory cues, including touch, warmth, and physical sensations of the devices. Such perceived physical experience might support the expression of a good self-image. The metaverse allows users to create avatars similar to the physical world, in how an individual changes their appearance to match the real or social self (Zimmermann et al., 2022). Thus, most physical expectations and reality merge with the metaverse world. Based on the above discussion, the following hypothesis is posited.

> *Hypothesis 9a: Physical experience significantly mediates the relationship of the embodied presence to self-image expression.*
>
> *Hypothesis 9b: Physical experience significantly mediates the relationship of the embodied co-presence to self-image expression.*

4.2. Method

4.2.1. Study Design and Experiment Conditions

The proposed hypotheses are tested using a 3x3 factorial experimental design. The 3x3 factorial design represents the conditions of embodied presence and embodied co-presence. Embodied presence is measured using three conditions: high ownership and agency (3), medium ownership and agency (2), and low ownership and agency (1). Embodied co-presence is measured using three conditions: high social avatar and interaction (3), avatar and interaction (2), and low avatar and interaction (1). The experimental design specifies the six experimental situations as listed in Table 2. The study was put into practice with the help of the platform "Roblox", where an imaginary metaverse world was created with eight fictional retail outlets. The retail outlets represent general consumable stores with a variety of consumer product lines available.

The metaverse users were identified through game and technology forums based on their discussions and knowledge about the metaverse, which they shared in the forums. Besides

forum users, students and professionals identified through snowball technique were also invited to participate in the experiment and survey. In the first phase 985 metaverse users were identified, of which 380 users gave consent to take part in the experiment, and finally, 360 users participated in the experiment and survey. For the purpose of experimentation, nine metaverse worlds were made to fit in with the 3x3 factorial design. The exploration of the metaverse can extend up to 3 hours and a minimum of 45 minutes when pre-tested with eight users. 360 participants participated in the experiment, in which 40 participants were placed

Table 2: Conditions of the two experimental variables

	Embodied Presence (Ownership and Agency)
Low (coded as 1)	The users will be able to see the metaverse in a first-person view. The user will be able to see the places in a 360-degree view. However, the ownership of the avatar and movements is not visible.
Medium (coded as 2)	The users will be able to see the metaverse in a third-person view. The person's avatar is visible, but the avatar is more static, and the body movements of the avatar are not possible, except for navigating across the metaverse.
High (coded as 3)	The users will be able to see the metaverse in a third-person view. The person's avatar is visible, the avatar is more dynamic, and the body movements of the avatar are possible, including navigating across the metaverse.
	Embodied Co-presence (Social avatars and interaction)
Low (coded as 1)	Embodied Co-Presence presents that users can see the names of the other users in the metaverse, but no avatar or interaction is possible with the other avatars or users.
Medium (coded as 2)	Embodied Co-Presence presents that users can see the other users' avatars in the metaverse, but no interaction is possible with the other avatars or users.
High (coded as 3)	Embodied Co-Presence presents that users can see other users' avatars in the metaverse. Also, interaction with other avatars is possible in the metaverse.

across each of the nine blocks. The participants were asked to navigate in a metaverse-simulated setup created using Roblox, which was created by the authors with the help of a third-party virtual developer. The experiment happened in the following manner: the participants were allocated to respective blocks, and following their interaction with the metaverse, all the users were asked to fill out a survey instrument consisting of the study questionnaire. From the 360 users who participated in the experiment, 356 usable responses were used in the study analysis to investigate the hypotheses. Prior research has endorsed the use of a threshold criterion of at least 10 cases per variable (Nunnally, 1967) or a minimum of 100 to 200 samples (Boomsma, 1987) for evaluating structural equation modeling. The sample size requirements set forth by Nunnally (1967) and Boomsma (1987) were satisfied in this research. The socio-demographic description of the sample is provided in Appendix E.

4.2.2. Experiment Procedures and Manipulation Validations

The metaverse was created with the help of five technical students who assisted in making the metaverse based on the experimental conditions. The created metaverse was used only for the purpose of the experiment. The nine blocks represent the manipulations of the 3x3 conditions as proposed in Table 2, representing the variables embodied presence and co-presence. The experiment's operationalisation followed these steps: The users were asked to tour the metaverse and explore the available retail stores. Following that, the users were requested to respond to a survey incorporating the study questionnaire. The experiment circumstances are selected based on the knowledge presented in Study 1. The conditions for embodied presence were chosen based on the interactions with the users, suggesting that agency and ownership were the main variables to describe the variable. Similarly, the conditions for embodied co-presence (avatar and interaction) were chosen based on the insights from the participants of Study 1. The conditions were validated through pilot testing to check whether the conditions explained the variance as coded.

4.2.3. Experiment Validations

Thirty metaverse users accepted to participate in the experiment validation tests. The participants were placed into the six conditions proposed in Table 2. 15 participants were allocated to test the embodied presence conditions with five samples dispersed to each of the three conditions in the variable. Similarly, 15 participants were allocated to the conditions of embodied co-presence. Two statements were posed to the pilot sample representing the specific conditions measured on a 5-point Likert scale (5 - strongly agree to 1 - strongly disagree) : (1) I feel immersed with the metaverse and be glad to continue to revisit this. (2) I can process my cognition and express my real self in the metaverse. The participants answered the two questions representing the six conditions of the two experimental variables. The ANOVA findings showed the continuance intention ($F = 12.650$; $df = 2,12$; $p < 0.05$) and experience with self-expression ($F = 24.500$; $df = 2,12$; $p < 0.05$) significantly differed across the conditions of embodied presence. The findings concerned with the embodied co-presence indicated that the responses significantly differed across the conditions of embodied co-presence in terms of continuance intention ($F = 7.143$; $df = 2,12$; $p<0.05$) and experience with self-expression ($F = 10.182$; $df = 2,12$; $p<0.05$). Thus, the results of the ANOVA imply that the opinions and responses differed across the conditions of the two variables, also expressing the variance present across the conditions.

4.2.4. Questionnaire and Measurement

The study made use of validated scales from earlier research. The scales were revised to better reflect the study's setting. Seven academic authorities and six business professionals involved in creating and studying the metaverse reviewed the questionnaire. The questionnaire was divided into three sections: (1) the explanation section, (2) the item scales, and (3) the socio-

Table 3: Results of Measurement Model (CFA)

Construct	Items	Mean	Std. Dev	Factor Loadings	CR	AVE
Cognitive Experience	CE1	3.348	1.0939	0.838***	0.892	0.727
	CE2	3.466	1.1165	0.845***		
	CE3	3.393	1.1783	0.875***		
Physical Experience	PE1	3.412	1.1655	0.821***	0.918	0.691
	PE2	3.429	1.0841	0.812***		
	PE3	3.444	1.0253	0.861***		
Self-Image Expression	MSIE1	3.407	1.0587	0.835***	0.860	0.678
	MSIE2	3.516	1.0474	0.823***		
	MSIE3	3.348	1.1319	0.834***		
	MSIE4	3.353	0.9940	0.802***		
Continuance Intention	CI1	3.328	1.1850	0.904***	0.836	0.761
	CI2	3.550	1.1821	0.874***		
	CI3	3.342	1.1870	0.884***		
	CI4	3.457	1.1895	0.885***		
	CI5	3.438	1.5751	0.815***		

Note: CA represents “Composite Reliability”; AVE represents “Average Variance Extracted”; CFA Fit indices: $\varkappa 2/df = 2.54$; GFI = 0.927, CFI = 0.966 (Good fit>0.9); RMSEA=0.066 (Good fit <0.06).
Note: ***denotes p<0.001

demographic data. The scale for cognitive experience is derived from Dong et al. (2017), physical experience from Fernández-Bustos et al. (2019) and Yang et al. (2020), self-image expression from Chen and Chen (2020), and continuance intention from Yang and Lin (2015). All items are measured on a five-point Likert scale, with five representing strongly agree and one representing strongly disagree. The experimental variables, embodied presence, and embodied co-presence are coded as dummy variables, in which the higher experimental condition is coded as 3, the medium condition as 2, and the lower condition is coded as 2. The items of the individual constructs are given in Appendix F.

4.2.5. Analysis

The proposed hypotheses and the model were tested using two-step structural equation modelling (CB-SEM) using SmartPLS. In SmartPLS, two methods are used to estimate SEM:

partial least squares SEM (PLS-SEM) and covariance-based SEM (CB-SEM). Theories are primarily approved or rejected using CB-SEM, although theory verification and extension are assisted by PLS-SEM (Hair et al., 2016). Though SmartPLS is predominantly known by the PLS estimation method, the software implemented the CB-SEM estimation technique in version SmartPLS 4 (Ringle, 2022). Some research has already used CB-SEM-based analysis in SmartPLS 4 (Ayanwale & Molefi, 2024; Ayanwale & Ndlovum, 2024; Balakrishnan et al., 2024). Previous research has justified using structural equational modelling to test the relationship between experimental conditions and the investigated variables (Balakrishnan & Dwivedi, 2021). The confirmatory factor analysis (CFA) was used as a first step. In the CFA, the reliability, content, convergent, and discriminant validity requirements were tested, and thus, the model is evaluated to be free from systematic and random errors from the sample. The hypotheses were examined using co-variance-based structural equation modelling using SmartPLS in addition to the confirmatory factor analysis. The total, direct, and indirect effects were also investigated to comprehend the mediation impact in the model for the put-forward hypotheses. The mediation effects were calculated with the 5000 bootstrap samples using the percentile bias corrected method. The Common Method Bias (CMB) standards were also tested to determine whether the data was free of any internal biases.

Further to SEM, ANN (Artificial Neural Network) is used to validate the results of SEM. As proposed by Liébana-Cabanillas et al. (2017) and Leong et al. (2020), the independent variables in the SEM analysis are used as the input neurons in the ANN model (Appendix I). Non-normal data distribution and non-linear correlations between the exogenous and endogenous variables are two reasons the ANN should be used. Furthermore, the ANN exhibits robustness against small sample sizes, noise, and outliers. Additionally, it can support non-compensatory models, in which an increase in one element is not necessarily required to offset a reduction in another. The ANN analysis is implemented using IBM's SPSS neural network module. The analysis uses multilayer perceptron and sigmoid activation functions, with 70% of the data allocated as a training set and the remaining as a testing set. A ten-fold cross-validation procedure is carried out to avoid the over-fitting issues associated with RMSE (Root Mean Square of Errors). Sensitivity analysis is conducted to determine the predictive power of each input variable.

4.3. Results

4.3.1. Measurement Model and Common Method Bias

The measurement model (confirmatory factor analysis) showed the content and validity results. Based on the satisfying results, the structural equation modelling test is performed. The measurement model results showed that the factor loadings of the individual items of the construct were above 0.60, which confirmed the requirements for content validity (Portney and Watkins, 2000; Nunnally, 1978). The construct validity is above 0.70, ensuring the data's consistency across the items and constructs. The details of the reliability and content validity are given in Table 3. Table 3 also shows the AVE (Average Variance Extracted) value to be above 0.50, which confirms the convergent validity requirements (Fornell and Larcker, 1981). Table 4 shows the inter-correlation values among the employed constructs; the table's diagonal represents the squared root of the AVE values. It can be found that the values in the table's diagonal are more than the respective inter-correlation values. Thus, this confirms the discriminant validity requirements (Fornell and Larcker, 1981). Thus, the measurement model satisfies the reliability, content, convergent, and discriminant validity requirements (Bagozzi *et al*., 1991).

Table 4: Discriminant validity and descriptive statistics of measures

	Cognitive Experience	Continuation Intentions	Physical Experience	Self-image expression
Cognitive Experience	**0.853**			
Continuation Intentions	0.279	**0.873**		
Physical Experience	0.272	0.339	**0.831**	
Self-image expression	0.474	0.527	0.476	**0.823**

The diagonal value represents √AVE, and the off-diagonal values represent inter-construct correlations for respective variables.

The fit indices of the confirmatory factor analysis exhibited a good fit. Further to the measurement model, we employed CMB (Common Method Bias; Podsakoff *et al*., 2003) to check whether the data is free from internal data bias. Previous articles have used and recommended CMB using experimental and survey-based research (Balakrishnan et al., 2020). Though various methods of CMB analysis are available, MacKenzie and Podsakoff (2012) suggested the common latent factor (CLF) method to check the data is constructively free from any internal bias. To test CLF, the standardised estimates of the CLF model and a non-CLF model are compared to check whether the difference is above 0.05. The results indicated that all the items of the constructs established a value less than 0.05, which passed the test of common latent factor and confirmed the data is free from CMB issues. Thus, given that the

measurement model and CMB analysis satisfied the requirements, a structural equational modelling analysis was performed.

4.3.2. Structural Model

Table 5 shows the results of the hypotheses proposed in Figure 2. Two models are provided in Table 5, the first indicating the hypothesis results without any mediating effect and the second indicating the hypothesis results with the mediating effect. It can be seen from model one that all the hypotheses are significant. Hypothesis 2 exhibits a higher value than other hypotheses ($\beta = 0.366$), which shows the strength of the relationship of embodied presence to self-image expression. Similarly, the relationship of embodied co-presence to self-image expression was also found to be highly significant (Hypothesis 4; $\beta = 0.332$). Hypothesis 1 and 3 also exhibited a strong relationship similar to other hypotheses. Hypothesis 1, which investigated the relationship of embodied presence to continuance intention, showed a significant relationship ($\beta = 0.292$). Also, hypothesis 3, which investigated the relationship of embodied co-presence to continuance intention, showed a significant relationship ($\beta = 0.271$). The relationship of self-image expression to continuous intention is highly significant ($\beta = 0.329$). Thus confirming the validity and robustness of the model. The model fit indices of the structural equation modelling are found to be good, and the same is provided in the footnote of Table 5.

Table 5: Standardised estimates of the proposed model

Hypotheses	Endogenous Variable	Exogenous Variable	Model 1		Model 2	
			Standardised Coefficients	T values	Standardised Coefficients	T values
Hypothesis 1	Continuance Intention	Embodied Presence	0.292	5.704***	0.306	5.489***
Hypothesis 2	Self-Image Expression		0.366	7.891***	0.182	3.268***
Hypothesis 3	Continuance Intention	Embodied Co-Presence	0.271	5.793***	0.262	5.686***
Hypothesis 4	Self-Image Expression		0.332	7.249***	0.186	3.330***
Hypothesis 5	Continuance Intention	Self-Image Expression	0.329	4.863***	0.332	4.373***

Notes: *** represents values significant at a 99% confidence level. Model fit indices (model 1): $\chi 2$ /df = 2.90; GFI =0.951; NFI = 0.95; CFI = 0.970; RMSEA = 0.065. Model 1 represents the values without mediating paths (Appendix G), and Model 2 represents those with mediating paths (Appendix H).

Model 2 showed the results of the five hypotheses in the presence of the mediating variables, cognitive experience and physical experience. Model 2 also showed a significant relationship among the five hypotheses. However, the strength of the relationship is weak in contrast to that of model one. Hypothesis 5, which investigated the relationship of self-image expression to continuance intention, showed much strength in model 2 ($\beta = 0.332$). Hypothesis 2 and 4 results

in Model 2 were less compared to Model 1. Model 2 results confirm that the indirect variance is influenced by cognitive experience and physical experience. Among the four paths that investigated the indirect effect of cognitive experience, one path is significant (Hypothesis 7a), confirming that cognitive experience can partially mediate the relationship of embodied presence to self-image expression. Cognitive experience failed to create any indirect effect in the relationships concerning the remaining three hypotheses (H6a, H6b, and H7b). Two of the four paths that investigated the indirect effect of physical experience were significant (H9a and H9b). The results confirm that physical experience can partially mediate the relationship of embodied presence to self-image expression and embodied co-presence to self-image expression. The results of the mediating effects are given in Table 6.

Table 6: The results of total, direct, and indirect effects in the model

	Effects	**Effects of EP on CI (H6a)**	**Effects of ECP on CI (H6b)**	**Effects of EP on SIE (H7a)**	**Effects of ECP on SIE (H7b)**
Mediating Effects of Cognitive Experience	Total Effects (std. dev, lower bound, upper bound)	0.413*** (0.039, 0.333, 0.488)	0.381** (0.042, 0.295, 0.460)	0.369*** (0.047, 0.275, 0.458)	0.335*** (0.046, 0.241, 0.421)
	Direct effect (std. dev, lower bound, upper bound)	0.306*** (0.056, 0.193, 0.416)	0.262*** (0.046, 0.174, 0.353)	0.181*** (0.053, 0.073, 0.288)	0.186*** (0.056, 0.073, 0.292)
	Indirect effect (std. dev, lower bound, upper bound)	0.023ns (0.031, -0.080, 0.042)	0.006ns (0.009, -0.031, 0.009)	0.132*** (0.036, 0.067, 0.210)	0.036ns (0.019, -0.080, 0.042)
	Effects	**Effects of EP on CI (H8a)**	**Effects of ECP on CI (H8b)**	**Effects of EP on SIE (H9a)**	**Effects of ECP on SIE (H9b)**
Mediating Effects of Physical Experience	Total Effects (std. dev, lower bound, upper bound)	0.413*** (0.039, 0.333, 0.488)	0.381** (0.042, 0.295, 0.460)	0.369*** (0.047, 0.275, 0.458)	0.335*** (0.046, 0.241, 0.421)
	Direct effect (std. dev, lower bound, upper bound)	0.306*** (0.056, 0.193, 0.416)	0.262*** (0.046, 0.174, 0.353)	0.181*** (0.053, 0.073, 0.288)	0.186*** (0.056, 0.073, 0.292)
	Indirect effect (std. dev, lower bound, upper bound)	0.007ns (0.012, -0.017, 0.033)	0.013ns (0.024, -0.033, 0.061)	0.056*** (0.023, 0.018, 0.109)	0.114*** (0.037, 0.048, 0.197)

All the estimates are standardised, and *** denotes values significant at 99 % level, and ns denotes insignificant values: n=356, bootstrap iterations=5000. (Bias corrected method). Notes: EP indicates Embodied Presence; ECP denotes Embodied Co-Presence; CI denotes Continuance Intention; SIE denotes Self Image Expression.

4.3.3. ANN results

The ANN analysis results that predicated continuation intention indicated the mean RMSE values to be 0.471 and 0.389 for training and testing, respectively. Though the RMSE values relatively indicated a normal fit, the values were less than 0.50, which showed an acceptable

fit. Also, the adjusted R2 was found to be 0.378, which is moderately acceptable. In the case of predicting self-expression, the mean RMSE values are found to be 0.499 for training and 0.442 for testing, which is higher than the values that predicted continuation intention. This analysis showed the model's relative strength, which predicted the intention to continue. The complete view of the results is given in Table 7. Table 8 shows the sensitivity analysis results and the importance of the variable score. The normalised importance score for embodied presence and co-presence is too similar while predicting continuation intention and self-expression. Overall, the model fit of ANN results did not express a robust fit as projected in the SEM analysis. However, the sensitivity importance analysis shown in Table 8 indicated that the results are similar to model 2 compared to model 1, which exhibits the importance of the indirect effects produced by the mediating variables (cognitive and physical experience). The model structure of ANN is given in Appendix G.

Table 7: RMSE Values (N=356) for ANN analysis

Dependent Variable	Training			Testing		
	SSE	**RMSE**	**N**	**SSE**	**RMSE**	**N**
Continuation Intention	40.171	0.462	259	29.173	0.417	97
	54.657	0.475	242	15.036	0.363	114
	57.385	0.481	248	16.675	0.393	108
	64.159	0.507	250	10.714	0.318	106
	62.208	0.495	254	15.746	0.393	102
	50.306	0.448	251	16.902	0.401	105
	57.342	0.472	257	22.565	0.477	99
	50.707	0.454	246	23.287	0.460	110
	47.966	0.443	244	21.795	0.441	112
	56.955	0.469	259	4.947	0.226	97
Mean	54.186	0.471		17.684	0.389	
Standard Deviation	6.739	0.019		6.537	0.070	
Self- Expression	60.069	0.495	245	13.319	0.346	111
	63.502	0.502	252	25.328	0.493	104
	58.777	0.501	234	28.531	0.484	122
	62.332	0.499	250	12.829	0.348	106
	64.07	0.516	241	19.489	0.412	115
	57.204	0.482	246	23.374	0.461	110
	61.075	0.502	242	27.372	0.490	114
	61.682	0.504	243	26.858	0.488	113
	62.218	0.508	241	18.596	0.402	115
	55.926	0.485	238	28.804	0.494	118
Mean	60.686	0.499		22.450	0.442	
Standard Deviation	2.537	0.010		5.742	0.057	

Note: SSE=Sum square of errors, RMSE=Root mean square of errors, N=sample size.

5. Discussion

This research employed an exploratory sequential mixed method design to explore the proposed conceptual model in Figure 1. Study one expanded the conceptual model using a qualitative research design through in-depth interviews. The insights of Study 1 were used to reframe the conceptual model into a hypothetical model, as proposed in Figure 2. The hypothetical model is empirically investigated in Study 2. Five direct relationships and eight indirect relationships were explored using structural equation modelling. The results of study 1 and study 2 are discussed in this section, followed by a highlighting of the contribution of this research. The results were also validated using artificial neural networks to check the sensitivity and importance of the relationships.

Hypothesis 5 establishes a highly significant relationship both in model 1 and model 2, showing the strength in the relationship between self-image expression and continuous intention. Self-image theory explains that humans tend to perceive themselves differently in different contexts. Previous research has asserted that creating strong self-perception in a technology medium can have long-term effects on technology usage (Schlosser, 2020). Users in the metaverse can build a strong self-image about themselves routing from their embodied perception, thus resulting in a strong intention to continue with the metaverse. While looking deeper into the results of embodiment, it can be seen that hypothesis 1 is significantly higher in both model 1 and model 2, explaining that embodied presence can be crucial in building continuance intention. Previous research has found that when technology users feel congruent with it, they tend to reflect long-term associations (Yan et al., 2021). Also, embodied presence can create a deeper interaction and bonding with the technology, subsequently fostering long-term intentions (Zhang et al., 2022). Yang et al. (2015) expressed that users who feel their presence in technology can develop strong intentions to continue it. Thus, embodied presence is a significant predictor of continuance intention.

Table 8: Sensitivity - Importance score in ANN

	Continuance Intention		Self-Expression	
Neural Networks	**Embodied Copresence**	**Embodied Presence**	**Embodied Copresence**	**Embodied Presence**
NN1	0.511	0.489	0.430	0.570
NN2	0.389	0.611	0.460	0.540
NN3	0.505	0.495	0.477	0.523
NN4	0.487	0.513	0.473	0.527
NN5	0.513	0.487	0.502	0.498

NN6	0.506	0.494	0.495	0.505
NN7	0.455	0.545	0.474	0.526
NN8	0.494	0.506	0.454	0.546
NN9	0.488	0.512	0.416	0.584
NN10	0.526	0.474	0.454	0.546
Average Importance	0.487	0.513	0.464	0.536
Normalised Importance	0.951	1.000	0.864	1.000

Similarly, embodied co-presence is also a significant predictor of continuance intention (Hypothesis 3). Embodied Co presence signifies the importance of social presence and interaction in the metaverse. Previous research has found that social interactions and social presence in the virtual world can develop strong continuing intentions among users. While social elements in the metaverse can create a social world (Koohang et al., 2023), the interaction facility available can develop a stronger affinity with the metaverse (Tan et al., 2023). This confirms the results of hypothesis 3.

Hypotheses 2 and 4 investigated relationships of embodied presence and co-presence to self-image expression. The results of hypotheses 2 and 4 were found to be significant in both model 1 and model 2. However, the results in model 2 are relatively weaker than those in model 1. Concerning hypothesis 2, Shin (2022) states that the idea behind creating avatars in the metaverse is to develop strong self-image associations among the users. Thus, avatars can develop strong self-image associations with the users of the metaverse. Self-development theories propose that humans seek congruent elements to contextualise their real selves in a given space. So, in this context, the avatar and agency implanted in the metaverse can build such an association, allowing users to self-express themselves. Hypothesis 4 found that embodied co-presence can develop self-image expression. Social cognitive theory supports that individuals develop their social self based on the social elements and interactions around them. Previous research has supported that more than the social self, individuals tend to create their self based on these interactions. Thus, in the metaverse space, the co-presence of the other avatars and interactions can aid in better self-image expression.

Hypotheses 6a, 6b, 7a, and 7b investigate the indirect role of cognitive experience in the relationship of embodied presence and embodied co-presence to continuance intention and self-image expression. On the other hand, 8a, 8b, 9a, and 9b investigate the indirect role of physical experience in the relationship of embodied presence and embodied co-presence to continuance intention and self-image expression. Cognitive experience significantly mediated the

relationship of embodied presence to self-image expression (Hypothesis 7a) but failed to create any indirect relationship for hypotheses 6a, 6b, and 7b. The results imply that cognitive experience can positively intervene in the relationship of embodied presence to self-image expression. Previous research has supported the idea that cognitive experience can create self-image perceptions (Acciarini et al., 2021). However, the other three hypotheses concerned with cognitive experience are insignificant. Though previous research has supported that cognitive experience can develop a long-term attachment to technology (Balakrishnan & Dwivedi, 2021), the variable still failed to create any mediating effect. The results explain that cognitive experience does not impact continuance intentions. Cognitive bias theory states that a high level of mental processing may hinder feelings and associations with the object or activity (Acciarini et al., 2021). Thus, a high cognitive experience may not have helped the embodiments increase their impact with continuance intentions.

In the case of hypotheses 8a, 8b, 9a, and 9b, the results indicate that 9a and 9b are significantly supported for indirect effect, whereas 8a and 8b were insignificant. The results echoed a similar pattern as we discussed above. The physical experience helped to impact the relationships associated with embodiments and self-image expression indirectly but not with the continuance intention. Otherwise, this also shows how physical experience helps in building self-image experience. Physical experience can help individuals realise their real selves (Fernández-Bustos et al., 2019), thus increasing the likelihood of self-image expression relationships. On the other hand, physical experience may have a focused reality, which would have created a dissonance towards the metaverse and physical world, leading to the question of the continuance intention.

5.1. Theoretical Contribution

This research contributes to various theoretical knowledge in the following ways: (1) by extending the embodied cognitive theory in the context of embodied presence and embodied co-presence, (2) by introducing cognitive and physical experience in the context of the metaverse and under the banner of flow theory, (3) by extending the self-concept in the context of the metaverse through the lens of embodiment, (4) by contributing to the conceptual paths of the metaverse, (5) by extending the available knowledge to the following theories; Perceptual Control Theory (PCT; Powers et al., 1960; Powers, 1973), Extended Mind Theory (Clark & Chalmers, 1998), Expectation Confirmation Theory (ECT; Oliver, 1980), Social Presence Theory (Gunawardena, 1995), and Self-disclosure theory (Cozby, 1973).

Cognitive embodiment theories are primarily used in gesture, communication, and perceptual psychology research. So far, the branches of this research have not extended much to research specific to technology-based interactions. Though this research provided a view of embodied interaction specific to the metaverse, the results and implications can broadly help more related studies extend their knowledge. For example, Cosentino and Giannakos (2023) emphasised the role of cognitive embodiment in multisensory interaction; combining the present research results with the existing knowledge in theory will open a broad discussion perspective among the researchers. This research has advanced the context of cognitive embodiment in the context of the metaverse and has shed light on understanding the deeper dimensions of this concept through Study 1. Moreover, this research has classified embodied cognition from the individual (presence) and social (co-presence) viewpoint, thus advancing the theoretical integration with social psychology theories. Previous research has used flow theory to conceptualise their understanding concerning experience. Also, various dimensions of experience have been investigated previously, and this research has advanced such understanding by introducing cognitive and physical experience. Most of the research which has discussed the applications of mental processing in technology to gain experience has never directly introduced the concept of cognitive experience. Based on the qualitative insights from Study 1, this research has conceptualised cognitive experience. Likewise, the role of physical experience is mainly explored in the context of physical world activities such as sports. However, this research has extended the concept of physical experience in the context of the metaverse and related the same to embodied cognitive theory. This research has integrated the embodiment and flow theories from the metaverse perspective.

While research in the metaverse is keen on explaining the importance of avatars to develop an immersed experience (Park & Kim, 2022), research in the metaverse never realised to explore the psychological positivity behind those embodied selves. This research has connected the concept of embodiment with self-image expression to provide more meaningful insight into how users of the metaverse process their self-expressions. Self-image and expressions are essential notions that allow users to feel the reality with the metaverse. Thus, this research has built the bridge to understand the relationship between embodiment and self-concept theories. Also, most of the research on the metaverse has explained different dimensions of the metaverse individually, and this research has provided a holistic view by combining the embodiment, experience, and self-concepts in a singular context. This research has provided more insights into the existing knowledge available in the metaverse literature.

In the process of strengthening the argument, theoretical backgrounds and hypotheses, this research has extended the theoretical knowledge of various theories in the context of the metaverse. Perceptual Control Theory (PCT; Powers et al., 1960; Powers, 1973) and Extended Mind Theory (Clark & Chalmers, 1998) have been primarily used in the cognitive psychology domain to understand human comprehension and perceptions, and this research has extended the theoretical knowledge in terms of embodiment and experience in metaverse context. Expectation Confirmation Theory (ECT; Oliver, 1980) has been considerably used in information systems research for the past two decades. This research has further extended its line of knowledge in terms of the metaverse. This research has knitted the embodiment and ECT, especially by connecting the relationship between embodiment and continuance intention. Social Presence Theory (Gunawardena, 1995) and Self-disclosure Theory (Cozby, 1973) fundamentally support the framework of social psychology. The path between embodiment and self-image expression extends a better understanding of these theories.

5.2. Practical Implications

From a broad angle, these research results will aid business-level understanding of the users, intermediaries and platforms, and firms and industries (Polyviou & Pappas, 2022). This research has allowed business decision-makers to understand the user interactions in the metaverse and their subsequent developments. Similarly, the intermediaries and developers, designers, and academics working in this area will comprehend more important embodiment functions in the metaverse. This research has highlighted the importance of embodied presence and co-presence in creating strong continuance intention. So, marketers and developers should focus on creating or allowing users to customise their avatars to create a more physical experience among the users. Enhancing the authenticity and expressiveness of avatars can make users feel more physically present with others by incorporating realistic motions, expressions, and gestures. Creating extraordinarily natural and detailed virtual worlds enhances the feeling of co-presence. Users can interact and explore environments resembling real-world places or fanciful settings, giving them the impression that they are physically present. Social presence can also be enhanced by creating games and activities that invite user interaction and cooperation. Shared activities can make people feel closer to one another. Shared experiences make people feel more connected to one another, whether they involve playing video games together, doing crossword puzzles, or going to virtual concerts. These embodiment techniques can result in users expressing a highly congruent self-image, resulting in continuance intentions.

Similarly, it is equally important to generate cognitive experience and physical experience, which can intervene in developing greater self-image expression. Creating a welcoming and comfortable space where people are encouraged to explore many facets of their identity is essential. Strong privacy settings let users decide who can see their personal information and expressions. Users benefit from feeling safe when expressing their self-image in this way. Based on the inputs from Study 1, adding full-body motion tracking can enable users to walk around and communicate naturally in the metaverse. For a more realistic physical experience, this also involves tracking head, hand, and body motions. On the other hand, staying at the forefront of cognitive development is necessary. The metaverse should be updated and improved constantly based on user feedback and new technology.

6. Conclusions

This research is operationalised as two studies. Study 1 explored the inherent relationship between embodiment, experience, and intentions and developed a hypothetical model. Study 2 investigated the model by employing a 3x3 factorial research design. The results implied that embodied presence and co-presence are essential to developing continuance intentions. Also, it is crucial to create self-image perceptions among the metaverse users through the lens of cognitive and physical experience. Overall, the role of the embodiment will reflect better when users perceive their self-image, which can result in long-term association with the metaverse. Moreover, the research results are validated using ANN analysis to confirm that the results of model 2 are similar to the ANN results. Thus confirming that the intervening role of experience is critical in the metaverse development and implementations.

7. Limitations and future research directions

Study 1 provided vast insights, of which only a few were taken to develop the hypothetical model. Future research can use these insights to build their models: (1) the role of objects, spatial content and environmental effects in the metaverse can be investigated as a dimension of the embodiment, (2) the role of personality types among the users can be employed as a moderator to understand how that interacts with the self-image perceptions, (3) other intentions like; recommendation or psychological addiction should be explored through the lens of embodiment and self-concept to arrive at a holistic understanding, (4) the role of auditory and sensory appeals can be employed as dimensions of physical experience and a model to understand its role towards understanding real and ideal self can be developed. Also, this research has applied only embodied presence and co-presence as the primary experimental

variable, and future research should incorporate multiple factorial designs concerning embodiment using large sample sizes. The metaverse used in this research is simulated -to match a realistic setting. However, real-time research in the metaverse will provide more valuable feedback conceptually.

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Appendices

Appendix A: Benefits of metaverse adoption identified in prior literature

Reference(s)	Highlighted metaverse benefit	Details
Wongkitrungrueng and Suprawan (2023); Capatina et al. (2024)	Immersive Experience	Users interact with digital environments and other users similarly to real-life interactions. The underlying technologies that underpin various metaverse platforms—such as virtual reality, augmented reality, blockchain, spatial computing, and artificial intelligence—may vary, impacting the features and experiences that users can enjoy.
Oh et al. (2023); Hennig-Thurau et al. (2023)	Socialisation	Collaboration and sociability are made possible by the metaverse. In shared virtual environments, users can interact with others worldwide, promoting new kinds of community building, collaboration, and communication.
Sylaiou et al. (2024); Ribeiro et al. (2024)	Creative Expression	Users can express themselves creatively in the Metaverse in various ways, such as constructing virtual locations or producing and disseminating digital music, art, and other media.
Zhao et al. (2023)	Decentralisation	Decentralisation—a state in which people have more authority over their digital identities, possessions, and experiences—is the goal of several metaverse iterations. For instance, blockchain technology can prove digital asset ownership and guarantee authenticity and security in the metaverse.
Buhalis et al. (2023); Zabel et al. (2023)	Interoperability	A vital component of the metaverse is interoperability, enabling users to switch between various virtual environments and platforms easily.
Dwivedi et al. (2023)	Business Opportunities	Creating and exchanging digital assets, virtual events and experiences, virtual real estate development, and more are just a few new economic prospects the metaverse offers. New industries and sources of income may result from this.
Yoo et al. (2023); Leong et al. (2023)	Social Commerce	In the metaverse, social commerce is a new trend that allows users to search for and buy goods and services directly from virtual surroundings. Companies can incorporate e-commerce features into virtual worlds, giving customers a flawless online purchasing experience.
Tan et al. (2023); Arya et al. (2024)	Promotions	In the metaverse, advertising is just as common as in the real world. To target customers while they are absorbed in virtual experiences, brands can display adverts within virtual surroundings, such as billboards, posters, and branded objects.
Kim et al. (2023); Hennig-Thurau et al. (2023)	Presence and Movement	Users can navigate virtual surroundings and interact with objects and other users in the metaverse by using their embodied presence. With input devices like keyboards, mice, gaming controllers, or motion-tracking gadgets like VR controllers, users can manipulate the movements of their avatars.

Appendix B: Interviewee details in study 1

Participant Code	Gender	Age Bracket	Level of Education	Previous Experience with Metaverse	Interview duration (minutes)	Time Spent on the metaverse (minutes)
P1	Female	36-45	Bachelors	Yes	24	21
P2	Female	18-25	Masters	No	26	33
P3	Male	18-25	Masters	Yes	29	41
P4	Female	18-25	Bachelors	Yes	33	33
P5	Male	Above 45	Masters	Yes	34	33
P6	Female	26-35	Bachelors	Yes	36	35
P7	Female	36-45	Masters	No	42	38
P8	Female	18-25	Bachelors	Yes	30	36
P9	Male	18-25	Bachelors	No	36	38
P10	Female	26-35	Bachelors	Yes	22	32
P11	Male	36-45	Masters	Yes	15	18
P12	Male	Above 45	Masters	No	34	38
P13	Female	26-35	Masters	Yes	33	22
P14	Male	36-45	Masters	No	22	28
P15	Female	Above 45	PhD	No	18	20
P16	Male	18-25	Masters	No	17	20
P17	Female	26-35	Masters	Yes	70	51
P18	Male	26-35	Masters	No	27	22
P19	Female	36-45	PhD	Yes	28	24
P20	Male	Above 45	PhD	No	26	25
P21	Female	Above 45	Masters	No	29	31
P22	Female	26-35	PhD	No	30	31
P23	Female	26-35	Masters	No	32	33
P24	Male	18-25	Masters	Yes	35	30
P25	Female	18-25	Masters	No	29	30
P26	Male	36-45	PhD	Yes	29	24
P27	Male	18-25	Masters	Yes	28	24
P28	Male	26-35	PhD	No	25	29
P29	Male	Above 45	PhD	Yes	30	31
P30	Female	26-35	Masters	Yes	31	29

Appendix C: Indicative questions during the interview process (Study 1)

Source: Created by authors

How many times have you used or experienced the metaverse before and how was the present experience?

How do feel the embodied connection of yourself in the metaverse in contrast to the real world?

How do you relate yourself in the metaverse among the other structures you see there?

In what way do you think the metaverse make it easy for you?

How do you feel connected physically in the metaverse?

In what way do you feel that your body is connected in the metaverse?

How do you express yourself in the metaverse?

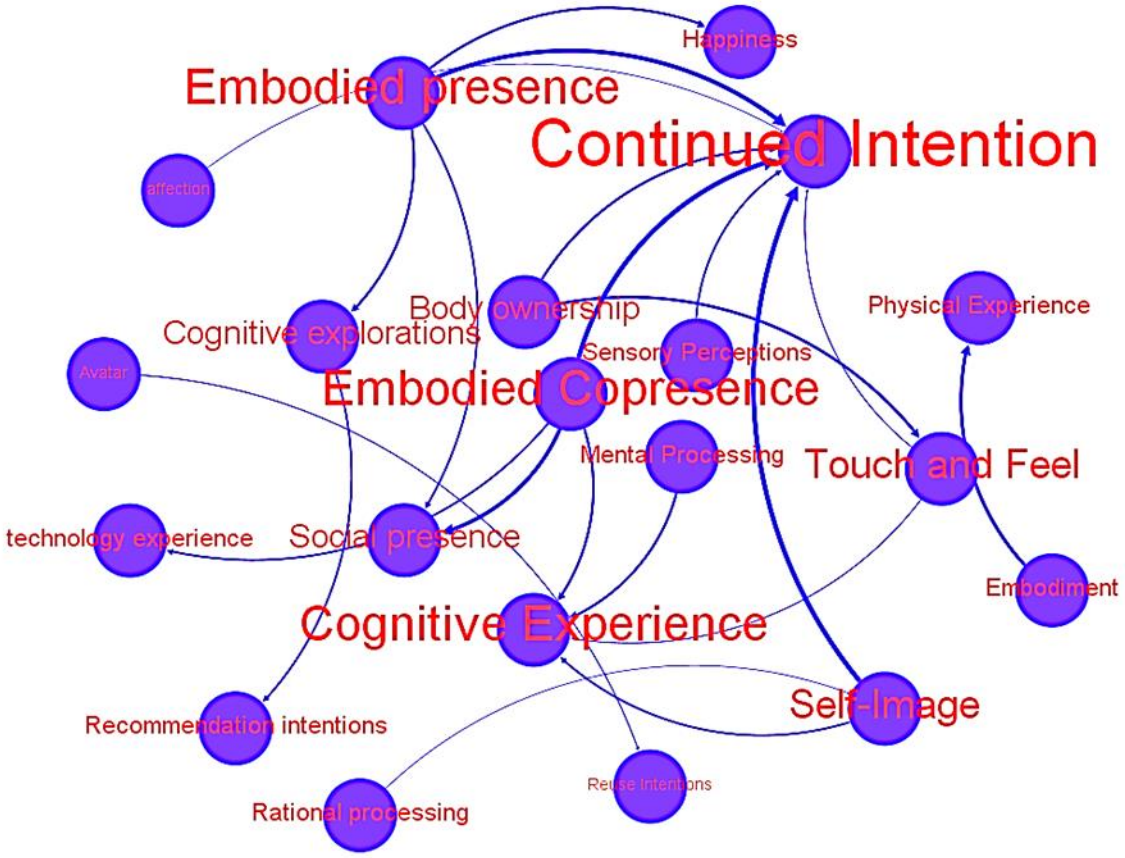
What kind of experience do you felt during your interaction in the metaverse?

How would you state the experience in the metaverse?

What would be your present and future intentions of using the metaverse?

Appendix D: Thematic analysis diagram

Source: Created by authors



Appendix E: Socio-demographic details of participants in study 2.

Variables		N	%
Gender	Male	170	0.48
	Female	186	0.52
Occupation	Students	196	0.55
	Working Professionals	138	0.39
	Business	22	0.06
Education	Higher Education	89	0.25
	Under Graduate	102	0.29
	Post Graduate	134	0.38
	PhD	31	0.09
Work Experience	< 1 year	212	0.60
	1 to 2 years	98	0.28
	Above 2 years	46	0.13
Previous Metaverse Experience	Gaming	256	0.72
	Education	54	0.15
	Product Demos	22	0.06
	Healthcare	11	0.03
	Other Media	13	0.04

Appendix F: Items of the construct used in study 2.

Cognitive Experience (Source: Adapted from Dong et al. (2017) and rephrased by authors)

Using the metaverse for shopping greatly impresses me

I find shopping through the metaverse is very interesting

The metaverse shopping have indeed attracted me

Physical Experience (Source: Adapted from Fernández-Bustos et al. (2019) and Yang et al. (2020) and rephrased by authors)

I feel my experience in the metaverse is similar to the traditional store

I can confirm that the quality and performance in the metaverse is similar to traditional store

The offerings and descriptions in the metaverse shopping is similar to the traditional store

Continuance Intentions (Source: Adapted from Yang and Lin (2015) and rephrased by authors)

I will continue to use the metaverse shopping in the future

Given the platform is available, I plan not to stop using the metaverse shopping

I have strong intention to continue using the metaverse shopping as it is necessary

My need for using the metaverse shopping will increase in future

In future, I still need to use the metaverse shopping to support my daily plan

Self-Image Expression (Source: Adapted from Chen and Chen (2020) and rephrased by authors)

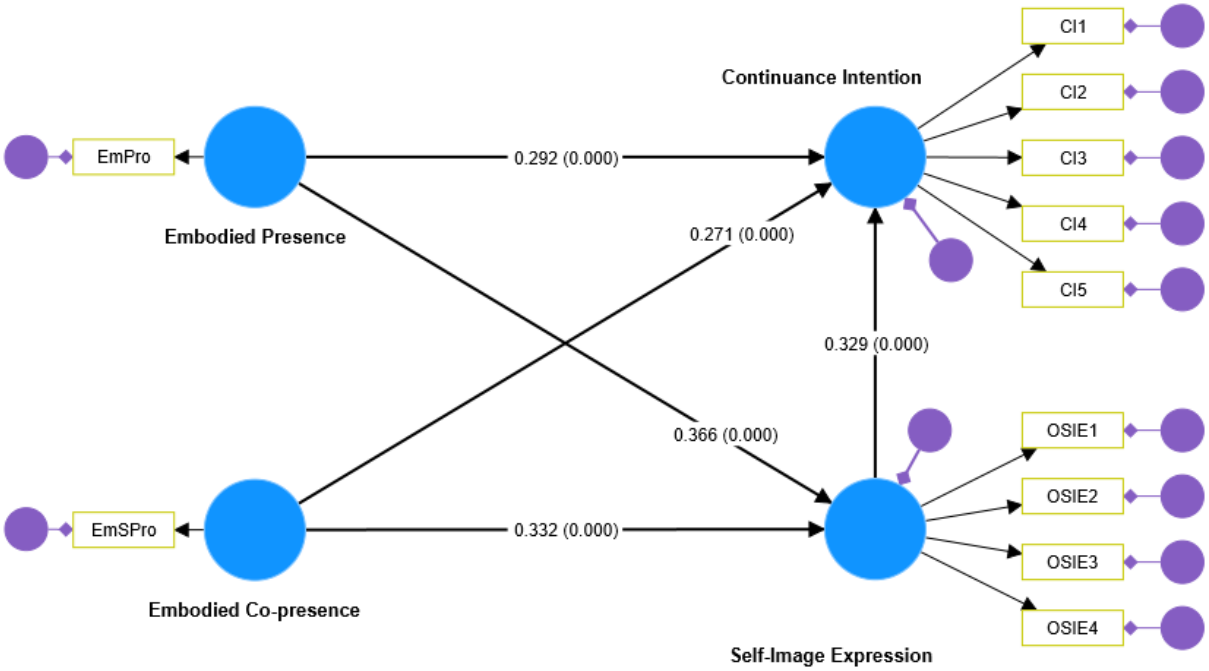
Seeing and using the virtual goods sold in the metaverse enhances my self-image to others.

Seeing and using the virtual goods sold in the metaverse improves my self-expression to others.

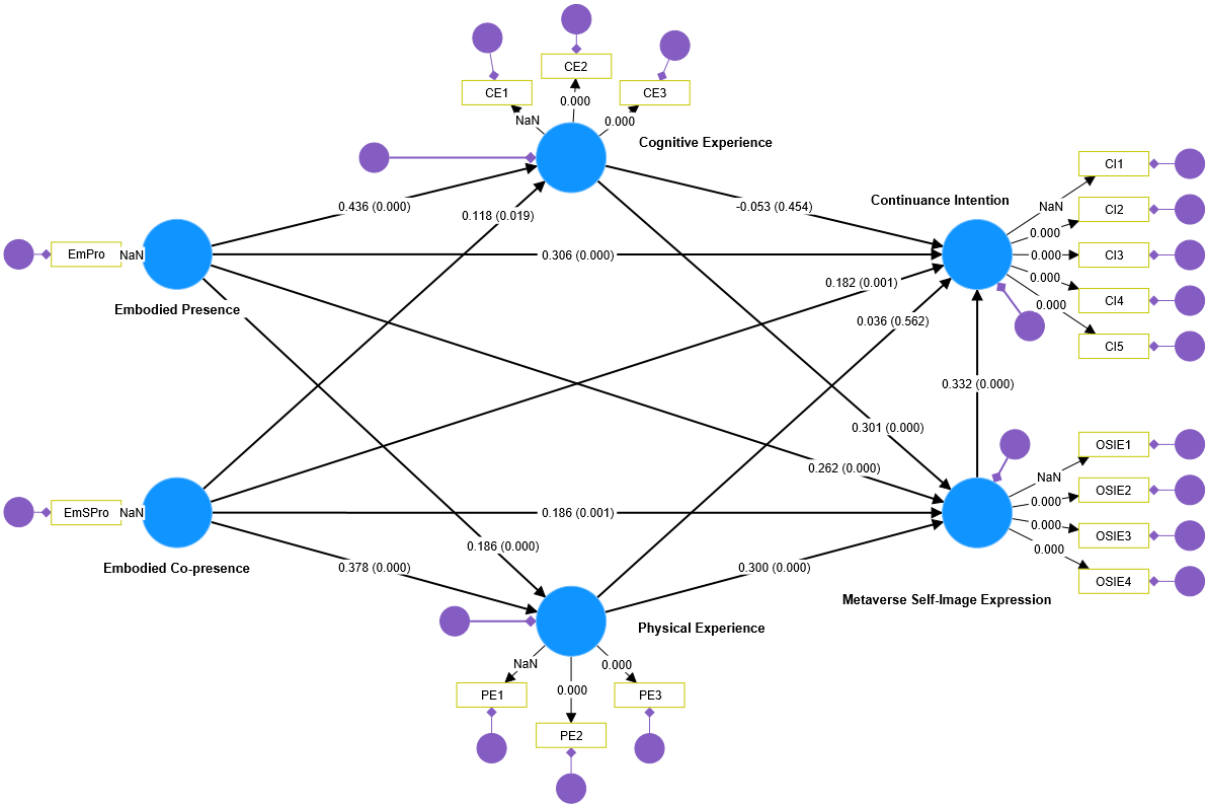
Seeing and using the virtual goods sold in the metaverse makes a good impression on other people.

Seeing and using the virtual goods sold in the metaverse improves the way I am perceived.

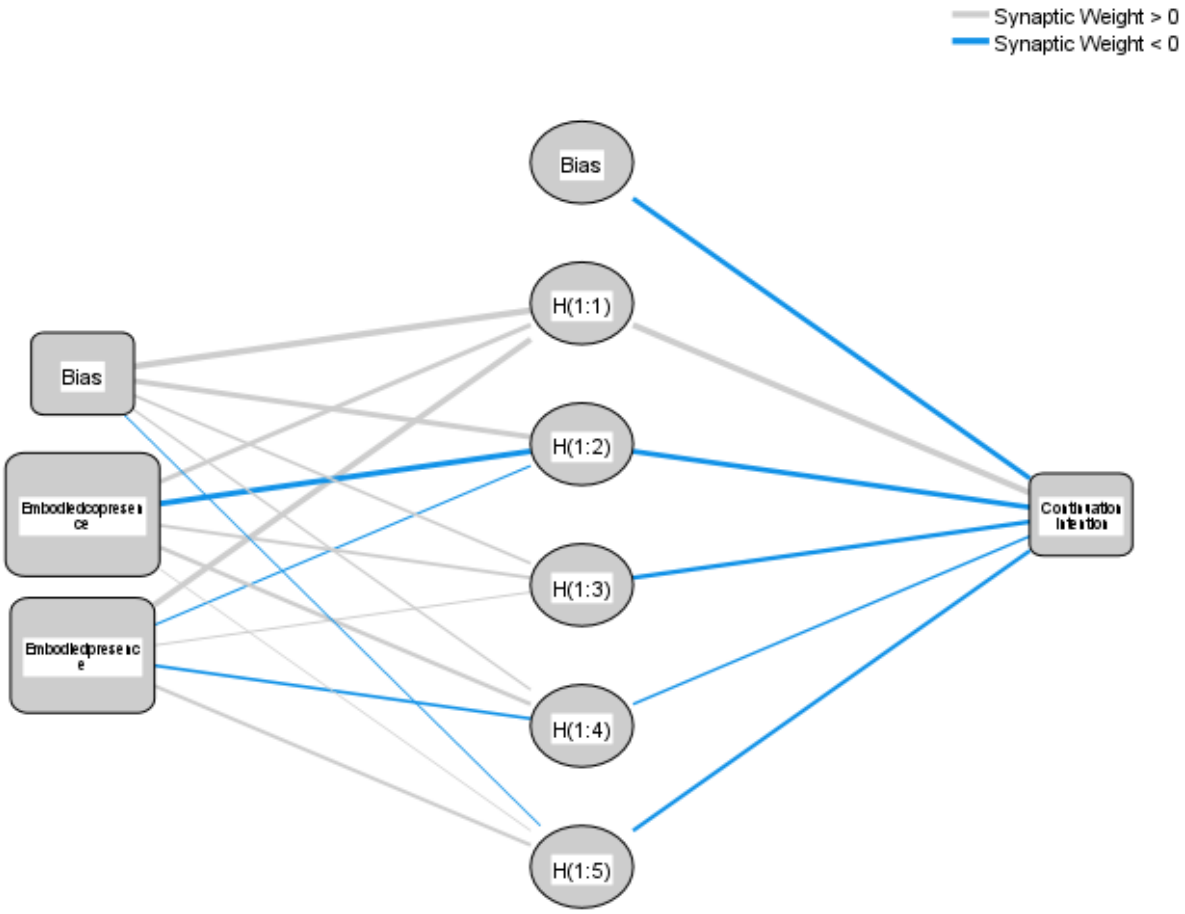
Appendix G: The results of Model 1



Appendix H: The results of Model 2



Appendix I: ANN Model



Hidden layer activation function: Hyperbolic tangent

Output layer activation function: Identity