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Innovation in immersive services: motivational drivers of continued metaverse use through VR headsets

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ABSTRACT

Metaverse platforms accessed through VR headsets represent a new form of digital service innovation; however, many users stopped using them after initial trials. Based on self-determination theory and the theory of planned behaviour, this study examines why people continue to use the metaverse and which motivational factors matter most. Survey data from 324 VR-headset users in the United States and the United Kingdom are used to test how different types of motivation are associated with attitudes, subjective norms, perceived behavioural control, and ultimately, continuance intention. The integrated model explains 83.4% of the variance in continuance intention.

The results showed that autonomous motivation, intrinsic motivation, and identified regulation are associated with more positive attitudes and, to a lesser extent, stronger subjective norms and higher perceived behavioural control, which, in turn, increased continuance intention. Introjected regulation had a negative effect on attitude and no meaningful links with subjective norms and perceived behavioural control, suggesting that obligation-based motives do not support continued use. External regulation had a strong positive effect on subjective norms, but this normative pathway was not associated with continuance intention, as subjective norms played no significant role once users gained direct experience. Attitude and perceived behavioural control were key proximal predictors of continuance intention, whereas subjective norms did not have a significant role once users gained experience.

This study is one of the first to focus specifically on users with recent metaverse experience through a VR headset and test an integrated SDT-TPB framework in a fully immersive setting. It contributes to studies on innovation in immersive services by showing how motivational and belief-based factors are associated with the long-term success of metaverse-based services and providing actionable knowledge for firms that experiment with these innovative channels. Since our sample consisted of early adopters in the United Kingdom/United States, both relatively individualistic cultures, the findings primarily reflected motivational and belief-based dynamics in Western immersive service contexts. Future studies should test whether the same SDT-TPB mechanisms generalise to more collectivist cultural settings.

Introduction

The metaverse is emerging as a new channel for consumer services, and thus, as a form of immersive service innovation (Chakraborty & Rana, 2025). Brands and service providers are experimenting with virtual stores, immersive showrooms, live events, and social spaces where consumers can explore products, interact with avatars, and receive services in real time (Kinzinger et al., 2025; Lombart et al., 2025). These initiatives suggest that the metaverse is a technological experiment and potential extension of service delivery and customer experience design. Beyond consumer markets, recent studies show that metaverse technologies are also used as knowledge-intensive infrastructures in organisational and supply chain contexts (Chen et al., 2023; Mahdikhani & Meena, 2024).

However, the diffusion of metaverse platforms has been uneven (Alexander et al., 2025). Initial enthusiasm and large investments have not always translated into stable user bases (Di Paolo et al., 2025). Adoption rates remain modest, and several reports highlight friction related to content quality, usability, and hardware constraints, such as comfort, price, and set-up effort (Chakraborty et al., 2024; Kim & Kim,

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2025a). Consequently, many users "try" metaverse experiences but do not return regularly (Shahzad et al., 2024). For firms that innovate with headset-based immersive services, the key challenge is to stimulate trial and understand which factors sustain continued use once novelty wears off (Nadeem et al., 2025).

Thus far, most academic works have focused on adoption rather than continuance. Studies based on the technology acceptance model (TAM) and unified theory of acceptance and use of technology (UTAUT) explain whether consumers intend to start using the metaverse, emphasising perceived usefulness, performance expectancy, social influence, and trust (Adhini & Prasad, 2024; Al-Adwan et al., 2023; Teng et al., 2022; Wu & Yu, 2024). These models are valuable at the early stage of technology diffusion, but they explain relatively little about why existing users decide to continue or discontinue use over time. A smaller body of work examined continuance intention using frameworks, such as expectation-confirmation models or extended TAM-type models, often in contexts, like education, virtual events, or tourism (Ali et al., 2025; Chakraborty et al., 2024; Di Natale et al., 2024). These studies highlight the importance of satisfaction, perceived usefulness, and specific gratifications (e.g. convenience, entertainment, and self-image expression), but often limit Metaverse access through 2D or mixed devices.

A second limitation concerns the user population. Since metaverse users are still a minority, many studies rely on non-users imagining future use or on mixed samples that do not clearly distinguish between smartphone/PC access and fully immersive use through VR headsets (Bruni & Galvagno, 2025). This makes it difficult to draw conclusions for firms that invest in rich, headset-based experiences, which often involve higher fixed costs, steeper learning curves, and complex service design. Recent works on metaverse gaming confirm the importance of constructs, such as perceived behavioural control, subjective norms, and tool usability (Mandal et al., 2025), but focus on gamers rather than on consumers who use metaverse environments as a channel for broader services and experiences.

A third gap relates to motivation quality. Most continuance studies emphasise what users think about metaverse platforms rather than why they are motivated to keep engaging with them (Chakraborty et al., 2024; Dwivedi et al., 2024). In immersive, hedonic environments, such as metaverse-based services, motivation is central to understanding whether an innovative channel becomes part of users' routines. Previous studies have examined motivations in contexts, such as entertainment media (Reinecke et al., 2014) and e-learning (Roca & Gagné, 2008), but applications to immersive metaverse settings remain limited and have rarely been integrated with belief-based predictors, such as attitude, subjective norms, and perceived behavioural control.

This study addresses these gaps by investigating the motivations associated with continuance intention among recent metaverse users who access the metaverse through VR headsets. We focus on users who already own and use a VR headset and have experience with metaverse environments, thereby targeting early adopters of immersive service innovations. The research question guiding the study is: *What motivational factors are linked to continuance intention to use the metaverse through VR headsets, and through which belief-based mechanisms do they operate?*

We address this question by integrating self-determination theory (SDT) with the theory of planned behaviour (TPB). Moreover, SDT, and specifically the organismic integration mini-theory (Deci and Ryan, 1980), distinguishes autonomous motivations from controlled motivations. Furthermore, TPB explains continuance intention through three proximal determinants: attitude, subjective norms, and perceived behavioural control (Ajzen, 1991). By combining these perspectives, we examined how different types of motivation shape belief-based evaluations and how these beliefs, in turn, are associated with continuance intention in an immersive, innovative service context.

This study makes three contributions. First, it advances metaverse studies by shifting the focus from adoption to continuance among actual VR headset users, thereby providing a more realistic picture of continuance intention in immersive services. Second, it extends the application of SDT and TPB to the metaverse by showing how autonomous and controlled motivations translate into attitudes, social norms, and perceived behavioural control and testing an integrated SDT-TPB model of continuance intention. Third, it offers actionable insights for innovation managers that experiment with metaverse environments, highlighting which motivational and belief-based levers are most relevant for supporting long-term use of metaverse-based services. Thus, this study complements existing works on metaverse adoption in supply chain and organisational settings (Chen et al., 2023; Mahdikhani & Meena, 2024; Wang & Zhang, 2024) by offering user-level behavioural knowledge that can inform the design and management of immersive service innovations.

Literature review

Studies on the metaverse can be grouped into three main streams. The first stream offers conceptual definitions and frameworks that describe the metaverse as a persistent, immersive, and socio-technical environment built on VR/AR and related technologies. The second stream examines the adoption of metaverse-related technologies, often using models, such as TAM and UTAUT, to explain behavioural intention to use. The third, more applied stream studies user behaviour in specific sectors, such as tourism, fashion, education, and retail. In the latter two streams, most empirical works still focus on metaverse access through desktop or mobile 2D interfaces and treat the metaverse primarily as a new front-end or channel for existing digital services (Farah et al., 2024; Wu & Yu, 2024). This emphasis on 2D access limits our understanding of the immersive and embodied features that are central to headset-based metaverse experiences.

Recent studies highlight that VR headsets can provide higher levels of social presence, embodiment, and emotional intensity than 2D interfaces, leading to qualitatively different user experiences and psychological responses. Headset-based VR can generate deeper engagement, stronger emotional reactions, and a heightened sense of presence compared with flat-screen environments, and 3D spaces are often associated with stronger flow, embodiment, and sustained engagement (Hennig-Thurau et al., 2025; Jo & Shin, 2024; Kuhne et al., 2023). However, most of these works either analyse entertainment or gaming contexts or do not restrict the analysis to actual headset users. Studies rarely isolate the behaviour of consumers who routinely use VR headsets to access metaverse-based services, even though these users face different cost, learning, and usability conditions than casual 2D users. These differences between headset-based VR and 2D digital interfaces are not merely technological but theoretically relevant for understanding user behaviour. Headset-based VR environments differ from 2D or mixed-device metaverse access along three distinct dimensions that alter the psychological experience of use. The first is embodiment: VR headsets create conditions in which users may experience the virtual environment through an embodied, first-person perspective, perceiving their digital avatar as an extension of the self. Studies on the Proteus effect show that this form of self-representation is not passive, as avatar appearance and bodily positioning in virtual space can be associated with changes in users' evaluations, attitudes, and behaviour in ways that screen-based navigation does not afford (Yee & Bailenson, 2007). The second dimension is spatial presence: the sense of "being there" that characterises immersive VR activates engagement mechanisms that intensify emotional and motivational responses beyond what flat-screen interfaces offer, as documented in direct VR versus 2D comparisons on presence, emotional states, and physiological outcomes (Kuhne et al., 2023). The third dimension is agency and control demands: navigating a three-dimensional, hardware-mediated environment involves motor-cognitive effort that encompasses device setup, spatial orientation, controller or hand-tracking management, and physical comfort calibration, all of which raise the relevance of perceived competence and control in ways that 2D access does not. These three features have direct implications for which motivational and belief-based mechanisms

are most salient in headset-based metaverse use, and they provide the theoretical basis for the SDT-TPB framework developed in this study.

In parallel, some studies have started to position the metaverse as a knowledge-intensive innovation at organisational and ecosystem levels. Chen et al. (2023) showed that metaverse applications for supply chain knowledge sharing and resilience depend on performance expectancy, facilitating conditions, trust, and sensory feedback. Mahdikhani & Meena (2024) used topic modelling to map metaverse applications and supply chain innovation across industries, emphasising how immersive technologies reshape information flows, coordination, and decision-making. Wang and Zhang (2024) found that firms' digital capabilities and entrepreneurial orientation explain metaverse-based entrepreneurial performance, pointing to the strategic and knowledge-based nature of metaverse innovation. Mandal et al. (2025) applied TPB to metaverse gaming and demonstrated that attitude, subjective norms, perceived behavioural control, and VR tool usability shape behavioural intentions. Together, these studies positioned the metaverse as a domain in which new forms of knowledge are created, shared, and leveraged. However, their emphasis lies primarily on organisational outcomes, supply-chain applications, and gaming, rather than on the continuance of consumer-facing, headset-based services.

From a user-behaviour perspective, most metaverse studies to date have examined adoption intention rather than continuance intention. Quantitative studies grounded in TAM and UTAUT focus on perceived usefulness, performance expectancy, effort expectancy, social influence, and trust as key drivers of intention to use metaverse platforms or metaverse-based applications (Adhini & Prasad, 2024; Al-Adwan et al., 2023; Teng et al., 2022; Wu & Yu, 2024). According to broader innovation studies, these models are well-suited to early stages of diffusion, when users are still evaluating whether to try a new technology. They are less explicit about the post-adoption phase, in which users decide whether the metaverse becomes part of their regular service routines once the initial novelty fades.

A smaller body of work investigated continuance intention in metaverse-related contexts. These studies often relied on expectation-confirmation models, extended TAM-type frameworks, or gratification-based approaches and examined specific settings, such as education, virtual stores, tourism, or simulated retail environments. For example, Ali et al. (2025) analysed continuance intention to use metaverse-based learning platforms, Chakraborty et al. (2024) studied continuance in metaverse virtual stores, and Di Natale et al. (2024) examined acceptance and continuance in an immersive VR/metaverse learning environment. Other works focused on embodied experiences, self-image expression or satisfaction in 2D, or mixed-device retail metaverse settings (Dwivedi et al., 2024; Jo, 2023; Kim & Kim, 2025b). These studies underscore the roles of satisfaction, perceived usefulness, and specific gratifications. However, they typically (i) do not limit their analyses to VR-headset users and (ii) devote limited attention to the quality of motivation or to belief-based mechanisms grounded in TPB.

Together, the existing work provides a useful but incomplete picture of metaverse use and reveals three gaps that are particularly relevant for innovation in metaverse-based services. First, previous studies rarely examined how motivation quality, namely the distinction between autonomous and controlled reasons for using the metaverse, relates to continuance intention and belief-based constructs, such as attitude, subjective norms, and perceived behavioural control. Motivation has been studied in contexts, such as entertainment media, e-learning (e.g., Reinecke et al., 2014; Roca & Gagné, 2008), and gaming (Mandal et al., 2025), but only limited works have combined SDT and TPB in immersive metaverse settings.

Second, most empirical metaverse studies still focus on adoption intentions in 2D desktop or mobile interfaces, or on mixed-device samples, rather than on continuance among users who access the metaverse through VR headsets in fully immersive environments. Even when VR headsets are included, they are not treated as the primary mode of access. Consequently, we know relatively little about how motivational orientations and belief-based evaluations operate for consumers who have already invested in a VR headset and who regularly use the metaverse as a channel for services and experiences.

Third, there is only limited integration between organisational-level metaverse innovation and user-level continuance studies. Some studies show that metaverse adoption can enhance knowledge sharing, resilience, and innovation in supply chains and entrepreneurial ecosystems (Chen et al., 2023; Mahdikhani & Meena, 2024; Wang & Zhang, 2024), but they do not examine how individual users' motivations and beliefs support or hinder the continued use of immersive metaverse services. For innovation outcomes to materialise, firms need to adopt metaverse technologies internally and sustain user engagement on the consumer side.

This study addresses these gaps by focusing on continuance intention among VR headset users and adopting a framework that combines motivation (SDT) and belief-based (TPB) predictors. This approach complements existing metaverse studies in three ways: it shifts the focus from adoption to continuance; it concentrates on fully immersive, headset-based use rather than mixed-device access; and it links user-level motivational quality and belief structures to broader debate on metaverse innovation. Table 1 summarises key studies on metaverse continuance and related outcomes and highlights how this study extends the literature by examining continuance intention to use the metaverse through VR headsets with an integrated SDT-TPB model.

Theoretical background

In line with previous works that treat continuance intention as a post-adoption decision (e.g., Di Natale et al., 2024), we conceptualised metaverse-based services as voluntary and largely hedonic activities. In this context, users have already tried the metaverse, often invested in a VR headset, and are now deciding whether this environment could remain part of their regular routines. At this stage, decisions are less about initial acceptance and more about whether ongoing use is enjoyable, personally meaningful, and manageable. Theoretical perspectives that emphasise autonomous motivation and belief-based evaluations provide complementary lenses to understand user behaviour in innovative digital services. Furthermore, SDT is well-suited to this context because it differentiates between autonomous and controlled motivations, and links them to sustained engagement in discretionary activities (Ryan & Deci, 2000). Additionally, TPB is useful for explaining continuance because it captures how users' experiences in the metaverse translate into evaluations, perceived social expectations, and feelings of capability and ease. However, TPB does not specify which deeper motivational processes are associated with these beliefs.

Integrating SDT and TPB addresses this limitation, as SDT identifies motivational orientations that can serve as higher-level antecedents of TPB constructs, while TPB specifies how these beliefs in turn shape continuance intention. Meta-analytic and empirical works show that combining SDT and TPB leads to more accurate and nuanced explanations of intentions than using either theory alone (Hagger & Chatzisarantis, 2009; Wunderlich et al., 2013).

Compared with technology acceptance frameworks, such as TAM and UTAUT, which are particularly strong in explaining adoption based on utilitarian value and performance expectancy, an SDT-TPB approach is better aligned with hedonic, immersive contexts. While perceived usefulness and effort expectancy remain relevant, metaverse environments often centre on enjoyment, curiosity, self-expression, and a sense of autonomy and control. This study's integrated framework captures these aspects by combining motivational quality with belief-based pathways, providing a richer basis for understanding why some users decide to keep using the metaverse and others do not.

Self-determination theory

Moreover, SDT suggests that individuals are naturally oriented toward personal growth and a coherent sense of self, and that motivation

Table 1
Key studies on metaverse continuance and related outcomes, and positioning of the present study.

Author(s) (year)	Context	Theory	Design	Outcome(s)	Gaps
Ali et al. (2025)	Metaverse in higher education	TAM + SDT	- Cross-sectional - Students sample - Metaverse learning platforms (2D/mixed access)	- Continuous intention to use metaverse for learning	- Integrates TAM+SDT but no TPB - Devices not restricted and not VR headset-focused
Chakraborty et al. (2024)	Metaverse-based virtual stores (India)	U&G Theory	- Longitudinal (N=508/474) - Metaverse accessed mainly via 2D interfaces/mixed devices	- Intention to use - Continuance intention to use metaverse virtual stores	- No SDT or TPB - not specific to VR headset users
Di Natale et al. (2024)	Metaverse-integrated VR learning (university in Italy)	EECM + UTAUT	- Experiment in an immersive VR/metaverse learning environment (N=25) - Students use VR headsets in a course setting	Acceptance and continuance intention to use immersive VR/ metaverse for learning	- Education context rather than consumer - no SDT - TPB variables not modelled
Dwivedi et al. (2024)	Metaverse retailing (simulated retail metaverse)	Embodied cognition, flow, self-concept, ECT, social presence	- Qualitative Study + experiment in simulated retail metaverse (N=356) (Roblox; 2D desktop)	- Continuance intention and self-image expression in the metaverse	- Strong focus on embodiment, experience and self-image rather than motivational quality - Simulated 2D retail metaverse
Fan et al. (2026)	General metaverse platforms (China)	Affordance theory + SDT + POT + S-O-R	- Multi-study: 2 online surveys (N=112/312) + offline VR experiment - Metaverse users with recent metaverse experience (China)	- Mediating role of psychological ownership between technological affordances and stickiness - Moderating effects of self-construal and technology propensity on the affordance	- Focus on general metaverse platform, not specifically on continuance intention - No SDT or TPB - VR headsets used only in the lab experiment
Jo (2023)	Metaverse use for tourism experiences (South Korea)	U&G Theory + TAM	- Cross-sectional (N=246) - Users who have used tourism-related content in the metaverse	Utilitarian, hedonic and symbolic benefits as key drivers for continuance intention	- No SDT or TPB - No specific focus on VR headsets users
Jo & Shin (2024)	General metaverse platforms (Korea)	TAM	- Cross-sectional (N=372) - No specific headset/3D device focus	Adoption intention and continuance intention	- Technology-centric view with no explicit motivational quality - Not limited to actual VR headset users
Kim & Kim (2025b)	Shopping in metaverse environments (South-Corea)	Consumption value framework	- Cross-sectional - 2D/mixed access	Consumer satisfaction and continuance intention	- No SDT or TPB - Does not distinguish VR headset users
Mandal et al. (2025)	Metaverse gaming	TPB / TAM	VR tools but not strictly headset-based	Orientation / intention	- No SDT, limited focus on continuance in service contexts
This study	Metaverse use via VR headset (UK/US)	SDT + TPB integrated model	- Cross-sectional (N = 324) - Actual VR headset users	Continuance intention to use metaverse via VR headsets	- Adds motivational quality (SDT) and TPB in one model - Focuses on actual VR headset users - Shifts from adoption to continuance

lies on a continuum (Deci & Ryan, 1980). At one end, people may act without a clear inner reason, or mainly because of external pressures, such as rewards or social expectations. Over time, these reasons can become increasingly internalised, such that behaviour is guided by personal goals and values. At the highest level of internalisation, motivation becomes intrinsic: individuals act because they genuinely enjoy the activity and find it inherently satisfying.

The key distinction is between controlled and autonomous forms of motivation. Controlled motivation is linked to external regulation, where behaviour is driven by external demands or rewards, and introjected regulation, where behaviour is driven by internal pressure (e.g. guilt or self-worth concerns). These motivations are often associated with less stable forms of engagement driven by obligation rather than choice. At the other end, autonomous motivation is related to identified regulation, where the behaviour is valued and aligned with one's goals, and intrinsic motivation, where people engage in an activity because it is inherently enjoyable or interesting. These motivations are consistently associated with more stable, self-endorsed engagement.

In this study, we used the perceived locus of causality (PLOC) scale (Ryan & Connell, 1989) to capture these distinct types of behavioural regulation. Furthermore, the PLOC scale asks respondents to indicate the reasons why they engage in a behaviour and classifies these reasons into intrinsic, identified, introjected, and external regulation. Applying this typology to metaverse use makes it possible to examine how different motivational regulations are associated with attitudes, perceived social expectations, perceived behavioural control, and ultimately, continuance intention to use the metaverse with a VR headset.

Theory of planned behaviour

Moreover, TPB posits that the closest predictor of behaviour is an individual's intention to perform that behaviour (Ajzen, 1991). In our context, the focal behaviour is the continued use of the metaverse with a VR headset. Intention is determined by three belief-based constructs: attitude, subjective norm, and perceived behavioural control.

Furthermore, TPB has been widely applied to explain user behaviour across various technological domains, such as mobile payments and IT, and, recently, AI-based tools, such as ChatGPT (Giovanis et al., 2022; Shi et al., 2024; Wunderlich et al., 2013). These studies consistently found that attitude, subjective norm, and perceived behavioural control are strong predictors of intention. These results validate the predictive power of TPB, but they leave open the question of which higher-level antecedents shape these belief-based perceptions. As noted by Hagger & Chatzisarantis (2009), TPB does not identify the motivational processes that give rise to attitudes, norms, and control beliefs.

By introducing SDT-based motivational regulations as antecedents of TPB constructs, we can address this limitation. In our model, SDT constructs are hypothesised to be associated with attitude, subjective norm, and perceived behavioural control, which in turn predict continuance intention. This structure preserves the core of TPB while enriching it with a motivational layer that is particularly relevant for voluntary,

hedonic use of metaverse services.

Based on the above-mentioned factors, our research model incorporates SDT motivations as antecedents that predict continuance intention indirectly through TPB belief-based constructs.

Hypothesis development

The integrated SDT-TPB model assumes that SDT-based motivational regulations are posited to be associated with TPB constructs, which in turn operate as proximal predictors of continuance intention. Autonomous and controlled motivations are expected to be associated with users' attitudes toward continued metaverse use through VR headsets, perceptions of social pressure, and perceived behavioural control in different ways. These three belief-based constructs then directly predict continuance intention.

By linking deeper motivations to belief-based evaluations, the model generates behavioural knowledge that organisations can use to evaluate and refine innovative service designs. The same logic can inform the design and management of other immersive or AI-based digital services, where understanding how motivational orientations feed into attitudes, norms, and control beliefs is crucial for sustaining adoption and long-term use. A distinctive feature of this study is that it situates the SDT-TPB framework in a headset-based, fully immersive metaverse context. As outlined above, this context differs from 2D or mixed-device environments along three theoretically relevant dimensions, namely embodiment, spatial presence, and agency and control demands, and these differences alter the relative salience of the SDT-TPB pathways in ways that previous literature has not explicitly addressed. In immersive VR environments, intrinsic motivation is expected to be especially central to attitude formation because enjoyment, curiosity, playfulness, and sensory stimulation are not peripheral benefits but core elements of how users evaluate and remember headset-based experiences. The hedonic payoff of immersive VR, rooted in sensory involvement and embodied interaction rather than screen-based content consumption, is expected to show a more direct and pronounced association with favourable attitudes toward continued use than would typically be observed in 2D settings. Simultaneously, the elevated hardware and spatial demands of headset-based use make perceived behavioural control a more critical pathway from motivation to continuance intention. Unlike 2D digital environments, where skills are more readily transferable and usability friction is lower, headset-based VR requires users to manage physical hardware, navigate spatial environments, and handle possible discomfort, which makes perceived competence a more consequential condition for converting motivation into intention. Finally, the private and embodied nature of headset-based use, an activity largely invisible to one's social network, provides theoretical grounds for expecting subjective norms to play a weaker role once users have accumulated direct immersive experience. These arguments extend previous SDT-TPB applications, which were developed primarily in physical activity and e-learning contexts (Arnautovska et al., 2019; Hagger & Chatzisarantis, 2009), by specifying that the technological form of access is not a methodological detail but part of the theoretical mechanism.

Autonomous motivations and TPB beliefs

Intrinsic motivation reflects engaging in an activity for inherent enjoyment and satisfaction (Deci & Ryan, 1980). In hedonic and immersive technologies, enjoyment is associated with sustained engagement and tends to translate into favourable evaluations and stronger confidence in continued use (Van der Heijden, 2004). In headset-based metaverse contexts, where use is voluntary and experience-driven, intrinsically motivated users should develop more positive attitudes, perceive greater social acceptance, and feel more capable of continuing use.

In SDT-TPB integrations, autonomous motives are treated as distal antecedents of TPB beliefs because they provide self-endorsed reasons that shape evaluative, normative, and control beliefs (Arnautovska et al., 2019; Hagger & Chatzisarantis, 2009). Therefore, we expect intrinsic motivation to strengthen all three TPB belief-based constructs. This mechanism is expected to be particularly pronounced in headset-based VR, where enjoyment is not limited to content appreciation but is embedded in sensory immersion, spatial presence, and embodied interaction, making the association between intrinsic motivation and attitude formation stronger than would be expected in 2D settings.

H1. *Intrinsic motivation positively affects attitude, subjective norms, and perceived behavioural control regarding continued use of the metaverse through VR headsets.*

Identified regulation reflects engaging in a behaviour because it is personally important and aligned with one's goals (Ryan & Connell, 1989; Ryan & Deci, 2000). Even in hedonic environments, users may continue because it is enjoyable and feels meaningful or beneficial. When motivations are internalised, they tend to support more stable engagement because the behaviour is perceived as self-congruent. From an SDT-TPB perspective, internalised motives should translate into more favourable attitudes and stronger normative and control beliefs because users can justify the behaviour through valued outcomes rather than external pressures (Hagger & Chatzisarantis, 2009). Thus, we expect identified regulation to contribute positively to the TPB belief-based determinants of continuance.

H2. *Identified regulation positively affects attitude, subjective norms, and perceived behavioural control regarding continued use of the metaverse through VR headsets.*

Controlled motivations and TPB beliefs

Introjected regulation reflects internal pressure (e.g., guilt, shame, and fear of exclusion) rather than genuine endorsement (Ryan & Deci, 2000). These reasons can prompt behaviour in some contexts, but they are typically associated with less self-determined engagement and more ambivalent evaluations. In a voluntary setting, pressure-based motives are less likely to be associated with positive beliefs that support long-term continuance.

Metaverse use through VR headsets is discretionary and competes with alternative leisure options. In such conditions, using the metaverse to avoid guilt or exclusion is not expected to be associated with positive attitudes or a robust sense of capability, and it may also weaken belief-based evaluations overall. Therefore, we expect introjected regulation to be negatively related to TPB belief-based constructs.

H3. *Introjected regulation negatively affects attitude, subjective norms, and perceived behavioural control regarding continued use of the metaverse through VR headsets.*

External regulation reflects behaviour shaped by external contingencies, such as rewards, sanctions, or explicit expectations (Ryan & Deci, 2000). Conceptually, this type of motivation is closest to the normative component of TPB, because it reflects perceived social demands and compliance. Therefore, it should map more directly onto subjective norms than attitude or perceived control.

In discretionary and hedonic services, obligation-based motives are less likely to be associated with genuinely positive evaluations or confidence. Instead, their main effect should be to increase perceived social pressure to keep using the metaverse. Hence, we expect external regulation to be positively associated with subjective norms.

H4. *External regulation positively affects subjective norms regarding continued use of the metaverse through VR headsets.*

TPB beliefs and continuance intention

Furthermore, TPB proposes that intention is shaped by attitude, subjective norms, and perceived behavioural control (Ajzen, 1991). With immersive technologies, previous studies often found attitude and perceived behavioural control to be strong predictors of continued use, because they reflect the user's evaluation of the experience and the perceived ability to manage the system (Jo, 2023). In post-adoption

settings, social influence may become less relevant as users rely more on their direct experience (Bhattacherjee, 2001).

Consistent with this logic, we expect attitude and perceived behavioural control to be the primary proximal predictors of continuance intention in the headset-based metaverse context, while subjective norms should play a weaker role once users have experience with the technology. Specifically, in the headset-based metaverse context, perceived behavioural control captures more than conventional ease of use: it encompasses users' perceived capacity to handle the physical, spatial, and technical demands of immersive hardware interaction, making it a more theoretically critical predictor of continuance intention than in non-immersive digital environments.

H5. *Attitude and perceived behavioural control positively predict continuance intention to use the metaverse through VR headsets, whereas subjective norms have a weaker effect.*

Mediation analysis

Additionally, following SDT-TPB integration studies, we examined whether attitude, subjective norms, and perceived behavioural control transmit the effects of motivational regulations on continuance intention (Arnautovska et al., 2019; Hagger & Chatzisarantis, 2009).

Fig. 1 summarises the integrated SDT-TPB model. In the following sections, we test this model empirically using data from VR headset users who regularly access the metaverse.

Methodology

Data for the study were collected in July 2024 through Prolific®, a platform widely used to ensure high-quality data (Palan & Schitter, 2018). The survey specifically targeted participants from the United Kingdom and the United States who reported experiences of VR and regularly accessed the metaverse using their VR headset. Participants were recruited based on two screening criteria: (i) current ownership of a VR headset and (ii) having accessed a metaverse environment through that headset at least once in the 30 days preceding the survey. While all participants had used a VR headset to access the metaverse in the past 30 days, many reported relatively low usage frequency (e.g., 1–5 times per month). We focused only on adults in the United States and the United Kingdom, mainly because these countries are among the Western markets with the highest sales of VR/XR headsets (D'Souza & Joshi, 2024). The survey was developed after a thorough literature review and consisted of two sections. In the first section, respondents' socio-demographic characteristics, along with their behaviours in using the metaverse with a VR headset, were recorded. The second section focused on the study's key variables, with all corresponding items measured on a five-point Likert scale. We measured all constructs with reference to metaverse use among VR headset users. At the beginning of the questionnaire, respondents were explicitly instructed as follows: "When answering the following items, think about your use of the metaverse via your VR headset". All constructs and measures were adapted from well-established and reliable measurement scales. The final sample consisted of N = 324 VR headset users, 36.1% of whom used their VR headset more than five times per month, and 35.5% of whom reported entering the metaverse through their VR headset (Table 2). The sample included users who vary in the intensity of their metaverse engagement, from occasional to frequent users. This heterogeneity reflects the current diffusion stage of headset-based metaverse services, where even "active" adopters may use the platform only occasionally due to content constraints, hardware fatigue, or competing leisure options (Hennig-Thurau et al., 2023). Crucially, all respondents had firsthand experience with the focal behaviour, which is the key criterion for studying continuance intention.

Data analysis followed the two-step approach proposed by Anderson and Gerbing (1988), utilising SPSS 29.0 and AMOS 29.0. In the first step, a confirmatory factor analysis (CFA) was conducted to evaluate the measurement model. In the second step, structural equation modelling (SEM) was employed to test the hypothesised relationships in the proposed model.

Results

To assess the presence of common method bias, Harman's single-factor test was conducted. The findings showed that the variance explained by the most prominent factor (29.9%) was below the recommended threshold of 50%, indicating that common method bias was not a concern in this study. Additionally, multicollinearity among the independent variables was evaluated using variance inflation factors (VIF). The results indicated no multicollinearity issues, as the VIF values for the four independent variables and three mediators ranged from 1.09 to 3.06, which is well below the commonly accepted cutoff of 5.0.

Beyond Harman's single-factor test, we conducted an additional, more stringent diagnostic for common method variance using an unmeasured latent method construct (a conservative partial common latent factor) loading on the indicators of the two focal endogenous constructs. Model fit remained stable relative to the baseline model (baseline: χ^2(df) = 414.05(277), CFI = .972, and RMSEA = .039 and SEM+method factor: χ^2(df) = 395.98(269), CFI = .974, and RMSEA = .038), and the focal structural paths retained the same sign and comparable magnitudes (ATT → CONT-INT: β = .731 versus .775; PBC → CONT-INT: β = .182 versus .137; SN → CONT-INT: β = −.057 versus −.058; INT-MO → ATT: β = .708 versus .805; and maximum $|\Delta\beta|$ = .097), suggesting that CMV is unlikely to account for the substantive findings.

The measurement model showed very good fit indices, consistent with established guidelines (Bagozzi & Yi, 1988): χ2 (df) = 364.50 (224); χ2 /df = 1.62; GFI = .91; CFI = .97; TLI = .96; RMSEA = .044; and SRMR = .05. To test the measurement model, standardised item loadings on the respective constructs were first assessed (all greater than 0.70) and then the internal consistency of each construct was examined using composite reliability (found to be greater than 0.70 for all constructs) and Cronbach's alpha (ranging from 0.77 to 0.91). The convergent validity of each construct was also examined, with the average variance extracted (AVE) found to be greater than 0.55 for all constructs (Table 3). Furthermore, discriminant validity was established as the square root of each construct's AVE exceeded the corresponding inter-construct correlations. Since attitude and continuance intention were highly correlated, we further inspected their discriminant validity. The latent correlation between ATT and CONT-INT was r = .874. To test whether the two constructs are empirically distinguishable despite this association, we compared the baseline measurement model with a model constraining the ATT-CONT-INT correlation to 1.0 (perfect correlation). The constraint significantly worsened model fit (χ^2_free = 599.748, df = 226 versus χ^2_constrained = 639.347, df = 227; $\Delta\chi^2(1)$ = 39.599, and $p < .001$), supporting discriminant validity. However, we acknowledge that the high correlation between attitude and continuance intention suggests a degree of conceptual proximity between evaluative and conative constructs in this post-adoption context. While this closeness is not unexpected among users who already have direct experience with VR-based metaverse environments, it could suggest that part of the high explained variance in continuance intention may reflect this conceptual overlap.

To test the hypothesised relationships, a structural equation model, with the maximum likelihood technique and application of a bootstrapping technique with bias-corrected confidence intervals (CIs) at 95% (bootstrap resamples n=5,000) was used. The fit indices revealed a very good fit, consistent with established guidelines (Bagozzi & Yi, 1988): χ^2 (df) = 414.1 (277); χ2 /df = 1.50; GFI = .91; CFI = .97; TLI = .96; RMSEA = .039; and SRMR = .05. Age, gender, and frequency of metaverse use through VR headset were included as control variables in the structural model by specifying direct paths to attitude, subjective norms, perceived behavioural control, and continuance intention. Gender was associated with perceived behavioural control only (β =

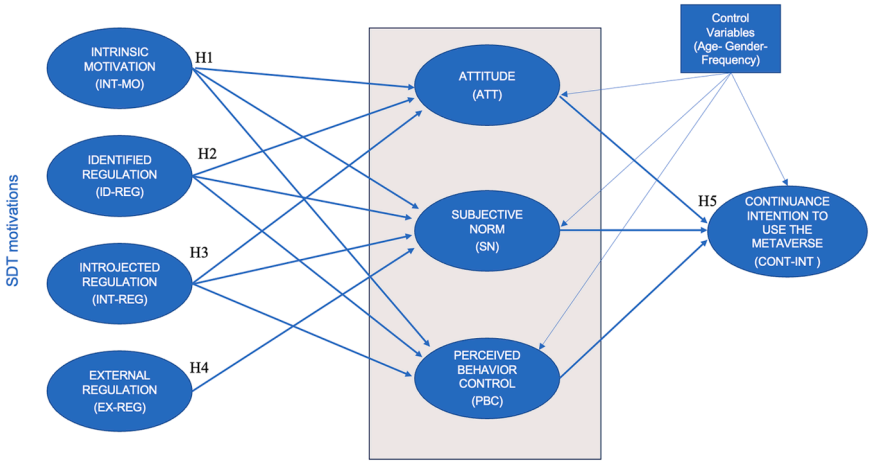

Fig. 1. Conceptual framework.

Table 2
Sample characteristics (N = 324).

Variable	Category	Freq.	%
Gender	Male	180	55.6
	Female	142	43.8
	N/A	2	0.6
Age (years)	18–24	34	10.5
	25–34	109	33.6
	35–44	100	30.9
	45–54	60	18.5
	55–64	7	4.6
	65+	5	1.9
Country	US	175	54.0
	UK	149	46.0
Education	Middle School	1	0.3
	High School	80	24.7
	Graduate	191	59.0
	Post-graduate	52	16.0
Frequency of VR headset use per month	1–5 times	207	63.9
	6–10 times	60	18.5
	11–15 times	22	6.8
	15+ times	34	10.5
	n.r.	1	0.3
Frequency of metaverse use via VR headset	Rarely	47	14.5
	Sometimes	162	50.0
	Often	77	23.8
	Always	38	11.7
Gamer/no gamer	Gamer	112	34.6
	No Gamer	212	65.4

.190, $p < .001$), with male respondents reporting higher PBC, whereas age and frequency of metaverse use were not significant ($p > .05$). Importantly, gender did not have a direct association with continuance intention: therefore, its role was limited to perceived competence rather than to motivation or behavioural intention. This finding should not be interpreted as evidence of inherent gender differences in ability. Rather, it more plausibly reflects differences in technology-related self-efficacy, prior exposure, confidence, and socialisation around hardware-intensive digital devices. In headset-based metaverse use, perceived behavioural control encompasses generic ease of use and confidence in managing physical hardware, navigating spatial environments and handling possible usability friction, dimensions that may be unequally distributed across user groups due to differential prior experience with gaming hardware and immersive technologies (Luo & Du, 2022; Vekiri & Chronaki, 2008). From a theoretical standpoint, since perceived behavioural control is also a condition for converting autonomous motivation into continuance intention within the SDT-TPB framework, a competence-confidence gap may attenuate the motivational pathway for users with lower PBC, a moderation that future studies should examine explicitly.

Table 4 reports the structural estimates. *Intrinsic motivation* positively predicted attitude ($\beta = .708$, $p < .001$), subjective norms ($\beta = .293$, $p < .001$), and perceived behavioural control ($\beta = .664$, $p < .001$), supporting H1. *Identified regulation* showed positive effects on attitude ($\beta = .305$, $p < .001$) and subjective norms ($\beta = .350$, $p < .001$), but not on perceived behavioural control ($\beta = .109$, $p = .270$); therefore, H2 received partial support. This suggests that VR-based metaverse services benefit far more from experiences that users find enjoyable, playful, or emotionally engaging than from experiences that are perceived as personally beneficial or aligned with one's goals. Thus, service designers should prioritise features that are associated with greater immersion, curiosity and interactivity, and stronger attitudinal responses and achieve greater continuance intention. Identified regulation remained relevant, but its comparatively smaller magnitude indicates this alone will not be as effective in sustaining engagement without accommodating intrinsically motivating elements. *Introjected regulation* had a negative effect on attitude ($\beta = -.160$, $p = .044$), while its associations with subjective norms ($\beta = -.211$, $p = .316$) and perceived behavioural control ($\beta = -.157$, $p = .113$) were not significant; hence, H3 was only partially supported. *External regulation* positively affected subjective norms ($\beta = .696$, $p = .003$), supporting H4. Finally, attitude ($\beta = .731$, $p < .001$) and perceived behavioural control ($\beta = .182$, $p = .032$) positively predicted continuance intention, whereas subjective norms did not ($\beta = -.057$, $p = .509$), supporting H5 in the expected direction.

Mediation analysis

To further examine the process implied by the integrated SDT-TPB model, we tested indirect, direct, and total effects of the four motivational regulations on continuance intention through TPB mediators using bias-corrected bootstrapped confidence intervals (Table 5). *Intrinsic motivation* exhibited significant indirect effects only through attitude ($\beta = .556$, $p = .001$) and perceived behavioural control ($\beta = .130$, $p = .030$). Simultaneously, its direct effect on continuance intention was not significant ($\beta = .179$, $p = .308$), yielding a positive and significant total effect ($\beta = .847$, $p = .001$). For *identified regulation* and *introjected regulation,* only the indirect effect through attitude was significant ($\beta = .135$, $p = .001$; $\beta = -.060$, $p = .039$). Their direct and total effects were not significant, suggesting that identified and introjected regulation support continuance mainly through more favourable evaluations rather than through social pressure or perceived capability. Finally, *external regulation* showed no significant direct, indirect, and total effects through subjective norms.

The full model explained 75.2% of the variance in attitude, 65.0% of the variance in subjective norms, 56.4% of the variance in perceived

Table 3
Measurement model results.

Constructs	Items	Mean (SD)	Factor Loading	α	CR	AVE
Continuance intention to use the Metaverse Al-Adwan et al. (2023)	*I plan to continue using the metaverse* (CONT-INT1)	4.35 (.53)	.860	.91	.91	.76
	I wish to continue using the metaverse (CONT-INT2)	4.33 (.52)	.886			
	I would like to keep using the metaverse (CONT-INT3)	4.33 (.51)	.875			
Attitude Teng et al. (2022)	*Using the metaverse is a good idea* (ATT1)	4.19 (.60)	.749	.79	.80	.57
	I think using metaverse services and platforms is enjoyable (ATT2)	4.37 (.52)	.791			
	I think the metaverse is an exciting concept (ATT3)	4.33 (.58)	.713			
Subjective Norms Al-Adwan et al. (2023)	*Most people who are important to me think I should use the metaverse* (SN1)	3.23 (.73)	.819	.79	.80	.58
	The experts who influence my behaviour think I should use the metaverse (SN2)	3.19 (.79)	.654			
	People whose opinions I value would prefer that I use the metaverse (SN3)	3.20 (.79)	.791			
Perceived Behavioural Control Al-Adwan et al. (2023)	*I'm able to use the metaverse without help (PBC1)*	4.31 (.54)	.774	.77	.79	.55
	I have no difficulty using the metaverse (PBC2)	4.17 (.67)	.660			
	I have the knowledge to use the metaverse (PBC3)	4.25 (.52)	.791			
Intrinsic motivation Goudas et al. (1994)	*I use the metaverse because I enjoy it* (INT-MO1)	4.34 (.56)	.839	.79	.80	.57
	I participate in the metaverse because it is fun (INT-MO2)	4.35 (.59)	.730			
	I engage in the metaverse because I find it satisfying (INT-MO4)	4.16 (.62)	.691			
Identified regulation Goudas et al. (1994)	*I use the metaverse because it is important to me* (ID-REG1)	3.36 (.91)	.835	.84	.84	.63
	I engage in the metaverse because I believe it is beneficial (ID-REG3)	3.51 (.88)	.776			
	I use the metaverse because it helps me achieve my goals (ID-REG4)	3.05 (.98)	.773			
Introjected regulation Goudas et al. (1994)	*I use the metaverse because I would feel guilty if I didn't* (INT-REG1)	1.84 (1.0)	.855	.87	.87	.69
	I participate in the metaverse because I feel I have to prove something (INT-REG2)	2.08 (1.2)	.864			
	I use the metaverse to prevent feeling excluded (INT-REG4)	2.26 (1.2)	.767			
External regulation Goudas et al. (1994)	*I participate in the metaverse because others expect me to (e.g. my community, my friends and peers)* (EX-REG2)	2.12 (1.1)	.880	.91	.91	.77
	I use the metaverse because I am supposed to (it is the right thing to do) (EX-REG4)	2.10 (1.1)	.867			
	I engage in the metaverse to achieve goals set by others (EX-REG5)	2.13 (1.2)	.891			

behavioural control, and 83.4% of the variance in continuance intention to use the Metaverse through VR headsets[1]. To contextualise the high explained variance in continuance intention and quantify the incremental contribution of the integrated framework, we estimated alternative model specifications. A TPB-only baseline model (ATT, SN, PBC → CONT-INT) explained R^2 (CONT-INT) = .751 (CFI = .923; RMSEA = .079), whereas the full integrated SDT → TPB model explained R^2 (CONT-INT) = .834 (CFI = .972; RMSEA = .039), yielding incremental explanatory power (ΔR^2 = .083). Removing ATT → CONT-INT reduced explained variance to R^2(CONT-INT) = .815 (CFI = .960; RMSEA = .043), and removing PBC → CONT-INT reduced it to R^2(CONT-INT) = .830 (CFI = .971; RMSEA = .040). Overall, these comparisons indicate that the high explained variance was not solely attributable to a single predictor and the integrated SDT → TPB framework provided meaningful incremental explanatory value beyond the TPB-only baseline.

Discussion

The results of this study provide important insights into the motivational mechanisms that are associated with continued use of the metaverse through VR headsets. Indeed, our findings were consistent with the theoretical argument that motivational and belief-based processes operate differently in headset-based, fully immersive metaverse environments compared with 2D or mixed-device digital contexts. In 2D or mixed-device environments, continuance may be more readily associated with perceived usefulness, satisfaction, convenience, and social influence, constructs that reflect the functional and socially visible dimensions of digital service use. Conversely, in headset-based VR, continuance appears to be more strongly associated with the experiential and competence-related dimensions of use. The strong associations

[1] The items of the two focal latent constructs show high mean levels with limited dispersion, consistent with restricted variance (ATT items: M = 4.19–4.37; CONT-INT items: M = 4.33–4.35; observed range = 3–5). This concentration at the upper end of the scale suggests that the corresponding latent variables are also likely to exhibit reduced variance, which can contribute to a high explained variance. Additionally, the sample comprises VR-headset owners with metaverse experience, implying self-selection (hardware investment), which may further compress variance and strengthen belief-intention associations.

Table 4
Test of direct effects[1].

Hypothesis	Path	STD. COEFF.	LB C.I. (95%) bias-corrected	UB C.I. (95%) bias-corrected	p value	Hypotheses supported
H1	INT-MO ->ATT	.708**	.558	.837	.001	Yes
	INT-MO -> SN	.293**	.144	.445	.001	Yes
	INT-MO -> PBC	.664**	.505	.808	.001	Yes
H2	ID-REG - > ATT	.305**	.133	.473	.001	Yes
	ID-REG - > SN	.350**	.157	.541	.001	Yes
	ID-REG - > PBC	.109	−093	.316	.270	No
H3	INT-REG ->ATT	−.160*	−.318	−.004	.044	Yes
	INT-REG ->SN	−.211	−.776	.212	.316	No
	INT-REG ->PBC	−.157	−.349	.040	.113	No
H4	EX-REG ->SN	.696*	.308	1.202	.003	Yes
H5	ATT -> CONT-INT	.731**	.417	1.080	.001	Yes
	SN -> CONT-INT	−.057	−.257	.129	.509	Partially
	PBC -> CONT-INT	.182*	.018	.367	.032	Yes

Note: Significant at: *p < 0.05; **p < 0.01; ***p < 0.001
Intrinsic Motivation (INT-MO), Identified Regulation (ID-REG), Introjected Regulation (INT-REG), External regulation (EX-REG), Attitude (ATT), Social Norms (SN), Perceived Behavioural Control (PBC), Continuance Intention (CONT-INT)

[1] Robustness check. Multi-group analyses splitting the sample into infrequent vs frequent headset-based metaverse users supported metric/structural invariance (ΔCFI≤+.003; ΔRMSEA≤+.0006; $\Delta\chi^2(16)=6.515$, p=.982; $\Delta\chi^2(32)=16.606$, p=.989) and confirmed invariance of key paths via targeted constraints for ATT→CONT-INT ($\Delta\chi^2(1)=.173$, p=.678) and INT-MO→ATT ($\Delta\chi^2(1)=.532$, p=.466), with stable group estimates (see Appendix A). Note that targeted single-path constraints were reported only for ATT→CONT-INT and INT-MO→ATT to verify invariance of the two most central pathways.

Table 5
Indirect, direct, and total effects (mediation analysis).

Path	Indirect effect	Direct effect	Total effect	C.I. (95%) bias-corrected	p
INT-MO->ATT -> CONT-INT	.556***	.179	.847**	(.318; .883)	.001
INT-MO->SN -> CONT-INT	-.018			(−.097; .032)	.505
INT-MO-> PBC -> CONT-INT	.130*			(.016; .286)	.030
ID-REG - > ATT -> CONT-INT	.135***	-.085	.050	(.050; .264)	.001
ID-REG - > SN -> CONT-INT	-.012			(−.060; .029)	.464
ID-REG - > PBC -> CONT-INT	.012			(−.005; .055)	.175
INT-REG ->ATT -> CONT-INT	−.060*	.169	.101	(−.143 −.002)	.039
INT-REG ->SN -> CONT-INT	.006			(−.010; .098)	.312
INT-REG -> PBC -> CONT-INT	−.015			(−.052; .001)	.073
EX-REG ->SN -> CONT-INT	−018	-.028	-.046	(−.100; .040)	.446

Note: Significant at: *p < 0.05; **p < 0.01; ***p < 0.001
Intrinsic Motivation (INT-MO), Identified Regulation (ID-REG), Introjected Regulation (INT-REG), External regulation (EX-REG), Attitude (ATT), Social Norms (SN), Perceived Behavioural Control (PBC), Continuance Intention (CONT-INT)

of intrinsic motivation with both attitude and perceived behavioural control were consistent with the embodied and sensorially immersive nature of VR: enjoyment, curiosity, and sensory engagement were not only desirable features but central to how users form evaluative judgements about the experience and develop a sense of mastery over the immersive interface. Moreover, in this context, perceived behavioural control was not simply a generic ease-of-use belief: it reflects users' perceived capacity to manage the physical, spatial, and hardware-mediated demands of headset-based interaction, a competence dimension that carries greater theoretical weight than in 2D settings, where usability barriers are lower and skills are more transferable. Finally, the non-significant role of subjective norms in the post-adoption phase was consistent with the private and embodied nature of headset-based use: an activity largely invisible to one's social network and experienced in first-person, immersive ways was expected to be less responsive to normative expectations once users have formed their own direct evaluations.

Using an integrated framework of SDT and TPB, these findings showed the central role of autonomous motivation. Intrinsic motivation was found to significantly predict all three core TPB constructs. However, its association with continuance intention was not direct. Rather, intrinsic motivation affected continuance intention only through attitude and perceived behavioural control, confirming a full mediation pathway consistent with Ajzen's (2020) updated view of TPB as a theory of volitional behaviour. Identified regulation, another form of autonomous motivation, was significantly associated with attitude and subjective norm but had no effect on perceived behavioural control. Its association with continuance intention was entirely mediated by users' attitudes, indicating that the sense of personal relevance and value alignment enhances user perceptions of the metaverse, even if not directly contributing to behavioural control.

A second important aspect of our findings concerned the role of controlled motivations. Introjected regulation showed a negative effect on attitude, as expected, but was not significantly related to subjective norms or perceived behavioural control, suggesting that feelings of obligation may even undermine how users evaluate metaverse use without strengthening social approval or perceived capability. In contrast, external regulation had a clear positive effect on subjective norms. Together, these results indicate that controlled motivation does not offer a solid basis for sustaining metaverse use in this voluntary, hedonic context: it can weaken attitudes and, at best, reinforce social pressure.

Among the TPB constructs, both attitude and perceived behavioural control were significant predictors of continuance intention, confirming their importance in sustaining user engagement in immersive contexts where user perception and ease of use are critical. Contrary to our expectations, subjective norms were not significantly associated with continuance intention, suggesting that once users have firsthand immersive experience, the role of external social expectations may diminish, reinforcing the need to consider experiential factors over normative influence in post-adoption contexts.

From an SDT perspective, these patterns suggest a decoupling between controlled motivation and continuance in voluntary, hedonic metaverse use. Furthermore, users who feel that they "should" use the metaverse to meet external expectations did not translate these pressures into more positive attitudes, stronger control beliefs, or higher

intention to continue. This is consistent with SDT's view that controlling forces can undermine perceived autonomy and limit the internalisation of the behaviour, especially in activities that are not required and compete with many other leisure and service options. In such settings, controlled motives may be sufficient to trigger occasional participation, but they appear too fragile to sustain repeated engagement over time.

The non-significant effect of subjective norms on continuance intention also aligned with work on post-adoption processes. Studies on information systems continuance suggest that normative influence tends to be stronger at the adoption stage and declines once users have accumulated direct experience and formed their own evaluations (e.g., Bhattacherjee, 2001). Our results fit this pattern: even though social expectations were present and partly reflected in external regulation and subjective norms, they did not play a decisive role in retaining users in the metaverse once autonomous motivations and perceived behavioural control were considered. A related finding deserves explicit attention. Although the model explains 65.0% of the variance in subjective norms, driven primarily by external regulation ($\beta = .696$), this high explanatory power does not translate into an indirect effect on continuance intention, because subjective norms themselves were not a significant predictor of continuance ($\beta = -.057$, $p = .509$). The indirect path EX-REG -> SN -> CONT-INT was accordingly non-significant ($\beta = -.018$, $p = .446$), and the slightly negative sign of this indirect effect simply reflected the non-significant negative coefficient of SN on continuance rather than any substantive suppression effect. This pattern revealed an important asymmetry: external social pressure was associated with users' perceptions of what others expect them to do, but these normative perceptions did not carry sufficient weight to sustain continued use once users had formed their own attitudes and sense of capability. In other words, the social environment can be mobilised through external contingencies, but it cannot substitute for these internal drivers of long-term engagement. While we attribute the non-significant role of subjective norms partly to these post-adoption dynamics, at least three additional explanations deserve consideration. First, VR headset use is typically a private, solitary activity: unlike social media or shared digital services, immersive metaverse use is largely invisible to one's social network, which may reduce the salience and enforcement of normative expectations. Second, our sample consists of early adopters who have already invested financially and technically in a VR headset; such individuals may be naturally less susceptible to normative pressure and more self-directed in their technology choices (Ryan & Deci, 2000). Third, the strong positive relationship between external regulation and subjective norms could attenuate the independent predictive contribution of subjective norms to continuance intention, as the variance shared between these two constructs may be partially reallocated when both are included simultaneously. Although VIF values remain below the conventional threshold, this high overlap warrants caution in interpreting the independent contribution of subjective norms. Together, these interpretations are not mutually exclusive; disentangling them would require designs that explicitly manipulate social visibility, recruit more heterogeneous samples, and vary the level of external regulation experimentally.

Beyond these contextual explanations, an important theoretical implication concerns the cultural specificity of the motivational processes. Studies on SDT have shown that autonomy-related constructs tend to have stronger effects in individualistic cultures, whereas controlled forms of motivation and normative expectations carry more weight in collectivist contexts (e.g., Hagger & Chatzisarantis, 2009; Ryan & Deci, 2000). This study focused on early adopters in the United Kingdom/United States, cultures that place a high value on personal autonomy, and so autonomous motivations may be salient predictors of continued use. Thus, while the SDT-TPB model provides useful insight for Western early adopters, this further highlights the need for cross-cultural comparisons to assess whether the findings can also be generalised beyond Western immersive service innovations.

Theoretical contributions

This study has several theoretical contributions. First, it adds to the limited body of empirical studies on metaverse continuance intention. By integrating SDT and TPB, it provides an empirical examination of how different types of motivation interact with belief-based predictors to explain continuance intention in immersive VR environments. This integrated model advances our understanding of user retention beyond initial adoption, which has been the predominant focus in prior metaverse literature (Al-Adwan et al., 2023; Di Natale et al., 2024; Wu & Yu, 2024).

Second, the study contributes to the refinement of TPB by corroborating its sufficiency assumption, that is, intentions are shaped by attitudes, norms, and control rather than by motivations directly (Ajzen, 2020). These findings support this theoretical stance by showing that autonomous motivations are associated with continuance intention only indirectly through TPB constructs, thereby reinforcing TPB as a theory of volitional behaviour that can accommodate motivational processes through appropriate mediation pathways.

Finally, this study challenges established assumptions in the technology adoption literature, particularly studies in the TAM2 framework (Overstreet et al., 2013; Schepers & Wetzels, 2007), by demonstrating that subjective norms, commonly found influencing initial adoption, do not significantly predict continued use in immersive metaverse contexts. This contrasts with their established importance in adoption-focused studies (Gupta et al., 2024; Teng et al., 2022) but aligns with previous studies (e.g., Bhattacherjee, 2001), suggesting that social influence tends to decrease once users have formed their own beliefs through direct experience. In immersive contexts, where users engage in solitary or personally meaningful ways, the expectations of others may have limited impact. This underscores a shift in user behaviour as digital experiences evolve from socially influenced to shaped by individualised, value-driven engagement.

Managerial implications

These results offer several implications for firms that deliver services through the metaverse. Autonomous motivations support continued use mainly through their effects on attitude and perceived behavioural control, while controlled motivations and subjective norms play a limited role. This means that long-term engagement depends less on external pressure or hype and more on how enjoyable, meaningful, and manageable the service feels to users.

First, the strong role of intrinsic motivation on attitude suggests that metaverse services should emphasise enjoyment, curiosity, and immersion. Simple replicas of websites are unlikely to keep users engaged. Service providers can support intrinsic motivation by offering interactive product or service exploration, playful elements, and options for creative self-expression (e.g., customisable avatars and spaces, experiential demonstrations, and light gamification). These features fit the hedonic nature of immersive environments and help to build favourable attitudes toward continued use.

Second, intrinsic motivation is linked to perceived behavioural control, which is a key predictor of continuance. Users are more likely to return when they feel able to navigate the environment and complete tasks without frustration. Therefore, firms should focus on usability: intuitive interfaces, clear onboarding, and simple tutorials or walkthroughs that lower the perceived effort of accessing services through VR headsets. Strengthening perceived behavioural control makes it more likely that autonomous motivations translate into actual continuance.

Finally, the limited role of controlled motivations and social norms suggests caution in the use of pressure-based tactics. Influencer campaigns, social proof, or messages, such as "everyone is moving to the metaverse," may help trigger initial trials, but they are not sufficient to keep users engaged. Instead, firms should present metaverse services as

attractive options that add value and autonomy, rather than as mandatory channels, and invest in experiences that users themselves find enjoyable, useful, and easy to use. An additional implication concerns the gender-based difference in perceived behavioural control. Since perceived control is a key predictor of continuance intention, ensuring that all users feel capable of navigating the immersive environment is strategically important. Service providers should develop inclusive first-use experiences specifically calibrated to reduce perceived technical barriers: simplified device setup wizards, step-by-step guided spatial navigation, embodied tutorials that demonstrate interaction mechanics in context, and peer-support or community-based mechanisms that allow users to seek help without signalling a deficit. These interventions are relevant for any user group with lower initial PBC and are not limited to gender: the underlying goal is to equalise perceived competence across the user base so that autonomous motivations can more readily translate into continued engagement.

Limitations and future studies

While this study offers several theoretical and managerial insights, it also has limitations that suggest directions for future studies.

A first boundary condition concerns the usage context represented in our sample. Respondents were predominantly non-gamers and accessed metaverse-based services through VR headsets, which directly addressed a major gap in the literature that has largely examined gaming-centric use cases and screen-based (2D/mobile) access modalities (Mandal et al., 2025). Accordingly, this empirical setting constitutes a core strength and point of novelty of the study: it enhances the relevance of our findings for immersive service innovations where embodied interaction, experiential quality, and usability/control demands are central predictors of continuance intention (e.g., social and experiential consumption, education, and virtual events). Importantly, an additional multi-group robustness check comparing gamers versus non-gamers supports the stability of the core structural relationships across these profiles (see Appendix B). Simultaneously, since metaverse-as-gaming contexts are characterised by distinctive platform affordances, social dynamics, and game-specific motivations, future studies should replicate our model in explicitly game-centric contexts and directly compare headset-based versus screen-based access modalities to establish boundary conditions.

Second, the data came from a non-probability sample of VR headset owners in the United Kingdom and the United States who regularly access the metaverse. This focus on VR-headset users in Western, individualistic countries was appropriate for early adopters of immersive services, but limits generalisability. Therefore, future studies should test the integrated SDT-TPB model using participants from collectivist cultures (e.g., East Asia, the Middle East, and Latin America) to examine whether normative pressures and motivation yield alternative pathways to continuance intention.

Third, the study relied on a cross-sectional survey and self-reported continuance intention, which restricts causal inference about the links between motivations, beliefs, and behaviour. Longitudinal designs, or field studies that combine survey data with platform usage logs, would provide stronger evidence on how motivational orientations and TPB constructs are associated with actual usage over time. The cross-sectional design also does not allow us to establish whether the observed gender-based difference in perceived behavioural control reflects accumulated prior experience with gaming or immersive hardware, dispositional confidence, socialisation patterns, or some combination of these factors. Experimental studies that control for prior VR exposure would allow researchers to test whether this gap narrows with use and whether it moderates the association between autonomous motivation and continuance intention, as the SDT-TPB framework would suggest.

Overall, these limitations indicate that these findings should be seen as an initial step towards understanding the key motivations associated with continued metaverse use through VR headsets.

Conclusions

This study examined the motivations associated with continuance intention to use the metaverse through VR headsets. We integrated SDT and TPB to link different types of motivation (autonomous versus controlled) to attitudes, subjective norms, perceived behavioural control, and continuance intention. Using data from VR-headset users in the United States and the United Kingdom, we tested this model in a real early-adopter context of immersive services.

The results showed that autonomous motivations (intrinsic enjoyment and identified regulation) are linked to continuance. They operate largely through more positive attitudes and higher perceived behavioural control, which in turn increases continuance intention. Introjected regulation showed negative but non-significant associations with the TPB constructs and, therefore, does not support continuance. In contrast, as hypothesised, external regulation had a strong positive effect on subjective norms, while not contributing meaningfully to attitude or perceived behavioural control. Within the TPB part of the model, perceived behavioural control emerged as a key proximal predictor of continuance intention, whereas subjective norms did not play any role once users had adopted and gained experience.

The study contributes to studies on the metaverse in three ways. First, it shifts the focus from adoption to continuance in metaverse-based services, addressing the question of why users keep using immersive channels after initial trials. Second, it applies an integrated SDT-TPB framework in a fully immersive, headset-based setting, showing how different qualities of motivation relate to belief-based evaluations and, in turn, continuance intention. Third, it highlights the central roles of autonomous motivation and perceived behavioural control in sustaining metaverse use among VR-headset users.

For managers, the results indicate that metaverse offerings should prioritise experiences that are enjoyable, personally meaningful, and easy to use. Reducing friction, complexity, and perceived constraints is likely to be more effective for long-term engagement than relying on social pressure, short-term incentives, and hype. Investments in content design, usability, and support that strengthen users' sense of autonomy and control are essential for turning experimental metaverse initiatives into stable service channels.

This study has several limitations in terms of sample, cross-sectional design, and self-report measures. Therefore, future studies should use cross-cultural, longitudinal, and experimental designs and combine survey data with behavioural usage indicators. Even with these limitations, this study offers a clear message that in metaverse-based innovative services, long-term engagement depends less on external pressure and more on autonomous motivation and the perceived ease of using immersive channels.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the authors used ChatGPT 5.4 for grammar correction and stylistic improvements. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

CRediT authorship contribution statement

Marco Galvagno: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Roberto Bruni:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Conceptualization. **Courtney Chrimes:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization.

Appendix A

Multi-group invariance and robustness (Infrequent vs Frequent users).

Table A, Table B, Table C, Table D, Table E.

Table A
Approximate fit across nested multi-group models.

Model	Constraints imposed	CFI	RMSEA	ΔCFI vs Unconstrained	ΔRMSEA vs Unconstrained
M0	Unconstrained (configural)	.947	.037	—	—
M1	Measurement weights (metric)	.949	.036	+.002	−.001
M2	Structural weights	.950	.035	+.003	−.002
M3	Structural covariances	.948	.035	+.001	−.002
M4	Structural residuals	.948	.035	+.001	−.002
M5	Measurement residuals (strict)	.944	.036	−.003	−.001

Table B
Nested chi-square difference tests.

B1. Comparisons vs Unconstrained (M0)			
Comparison	**$\Delta\chi^2$**	**Δdf**	**p**
M1 vs M0 (Measurement weights)	6.515	16	.982
M2 vs M0 (Structural weights)	16.606	32	.989
M3 vs M0 (Structural covariances)	57.367	60	.573
M4 vs M0 (Structural residuals)	59.904	64	.622
M5 vs M0 (Measurement residuals)	104.678	88	.108
B2. Incremental comparisons beyond metric invariance (M1)			
Comparison	**$\Delta\chi^2$**	**Δdf**	**p**
M2 vs M1 (Structural weights)	10.092	16	.862
M3 vs M1 (Structural covariances)	50.852	44	.222
M4 vs M1 (Structural residuals)	53.389	48	.275
M5 vs M1 (Measurement residuals)	98.163	72	.022

Table C
Group-specific standardized coefficients (freely estimated).

Path	Infrequent β	p	Frequent β	p
SN → CONT-INT	−.101	.285	−.101	.260
PBC → CONT-INT	.191	.043	.172	.043
ATT → CONT-INT	.726	.004	.655	.003
INT-MO → ATT	.657	.001	.733	.001

Table D
Invariance test for ATT → CONT-INT.

Model	χ^2	df	CFI	RMSEA
S0 (ATT → CONT-INT free)	823.306	567	.947	.037
S1 (ATT → CONT-INT constrained equal)	823.479	568	.947	.037

$\Delta\chi^2(1) = .173$, $p = .678$; $\Delta CFI = .000$; $\Delta RMSEA = .000$.

Table E
Invariance test for INT-MO → ATT.

Model	χ^2	df	CFI	RMSEA
S0 (INT-MO → ATT free)	823.306	567	.947	.037
S1 (INT-MO → ATT constrained equal)	823.838	568	.947	.037

$\Delta\chi^2(1) = .532$, $p = .466$; $\Delta CFI = .000$; $\Delta RMSEA = .000$.

Overall, the infrequent vs frequent multi-group analysis supports the stability of the SDT→TPB mechanisms across usage-intensity profiles (metric invariance and invariant structural paths), with focal coefficients that are virtually identical or very closely aligned across groups.

Appendix B

Multi-group invariance and robustness (Gamers vs No Gamers).
Table F, Table G, Table H.

Table F
Approximate fit across nested multi-group models.

Model	Constraints imposed	CFI	RMSEA	ΔCFI vs Unconstrained	ΔRMSEA vs Unconstrained
M0	Unconstrained (configural)	.954	.035	—	—
M1	Measurement weights (metric)	.955	.034	+.001	−.001
M2	Structural weights	.956	.034	+.002	−.001
M3	Structural covariances	.950	.035	−.004	−.000
M4	Structural residuals	.950	.035	−.004	−.000
M5	Measurement residuals (strict)	.928	.041	−.026	−.006

Table G
Nested chi-square difference tests.

G1. Comparisons vs Unconstrained (M0)			
Comparison	**$\Delta\chi^2$**	**Δdf**	**p**
M1 vs M0 (Measurement weights)	14.872	16	.534
M2 vs M0 (Structural weights)	25.689	32	.777
M3 vs M0 (Structural covariances)	79.142	60	.050
M4 vs M0 (Structural residuals)	85.321	64	.039
M5 vs M0 (Measurement residuals)	216.932	88	<.001
G2. Incremental comparisons beyond metric invariance (M1)			
Comparison	**$\Delta\chi^2$**	**Δdf**	**p**
M2 vs M1 (Structural weights)	10.818	16	.821
M3 vs M1 (Structural covariances)	64.270	44	.025
M4 vs M1 (Structural residuals)	70.449	48	.019
M5 vs M1 (Measurement residuals)	202.060	72	<.001

Table H
Group-specific standardized coefficients (freely estimated).

Path	Gamer β	p	Non-gamer β	p
SN → CONT-INT	.007	.962	.008	.966
PBC → CONT-INT	.184	.044	.166	.037
ATT → CONT-INT	.721	.006	.711	.006
INT-MO → ATT	.714	.001	.689	<.001

Overall, the gamers vs non-gamers multi-group analysis supports the stability of the SDT→TPB mechanisms across gaming profiles (metric invariance and invariant structural paths), with virtually identical focal coefficients across groups.

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