

Metaverse Communication and Virtual Interaction: Exploring User Engagement in Immersive Digital Environments

Andyan Pradipta Utama¹, Dwi Swasono Rachmad², Umar Fauzi Bahanan³

¹ Universitas Mercu Buana, Indonesia

² Sekolah Tinggi Ilmu Komputer Cipta Karta Informatika, Indonesia

³ Ilmu Komunikasi, FISIP, Universitas Nasional, Indonesia

E-mail: ¹⁾ andyanpradipta@mercubuana.ac.id, ²⁾ dwi.swasono@stikomcki.ac.id,
³⁾ umarfauzi.bahanan@civitas.unas.ac.id

ABSTRACT

Immersive platforms such as Roblox, Zepeto, VRChat and Meta Horizon Worlds have become everyday venues where young Indonesians meet, talk and transact through avatars, yet firms and platform operators still know little about why some virtual encounters produce sustained engagement while others are abandoned after a single visit. Drawing on the stimulus–organism–response (S-O-R) framework, social presence theory and media richness theory, this study examines how communication richness and avatar self-identification shape user engagement through social presence, and whether virtual safety concern weakens the payoff of presence. Survey data from 438 Indonesian metaverse users aged 18–40 were analysed with partial least squares structural equation modelling (PLS-SEM), complemented by measurement invariance testing, multigroup analysis across access devices and importance–performance map analysis. Communication richness influenced engagement both directly ($\beta = 0.214$) and indirectly through social presence ($\beta = 0.193$), indicating complementary partial mediation. Avatar self-identification had no direct effect on engagement ($\beta = 0.061$, $p = 0.204$) but a significant indirect effect through social presence ($\beta = 0.143$), indicating full mediation. Virtual safety concern negatively moderated the social presence–engagement relationship ($\beta = -0.118$, $p = 0.005$), and the avatar–presence link was significantly stronger among VR-headset users than among PC and mobile users. The model explained 43.1% of the variance in social presence and 45.7% in engagement. The findings position social presence as the conversion mechanism through which metaverse design features become engagement, and identify interpersonal safety as a boundary condition that platform governance must address before immersion can deliver commercial or social value.

Keywords: avatar self-identification; communication richness; Indonesia; metaverse; PLS-SEM; social presence; user engagement; virtual safety

1. INTRODUCTION

The metaverse has become an increasingly important space for social interaction, particularly in Indonesia, where internet use continues to expand among younger generations (APJII, 2024). Although metaverse research has examined adoption and technology acceptance, limited attention has been given to the factors that sustain user engagement after adoption (Ball, 2022; Dwivedi et al., 2022). Media richness theory and media synchronicity theory explain how communication cues and real-time interaction facilitate information exchange and shared understanding (Daft & Lengel, 1986; Dennis et al., 2008), while social presence theory highlights the importance of feeling connected to others through mediated communication (Short et al., 1976; Biocca et al., 2003; Oh et al., 2018). Avatar identification also influences user behaviour and platform evaluations (Yee & Bailenson, 2007; Suh et al., 2011). However, previous studies have not sufficiently integrated communication richness, avatar self-identification, social presence, and multidimensional user engagement into a unified framework. Existing findings indicate that immersive technologies can enhance social presence (Hennig-Thurau et al., 2023), which is associated with psychological benefits (Barreda-Ángeles & Hartmann, 2022), but embodied interactions may also increase users' exposure to harassment and unwanted contact (Blackwell et al., 2019).

Furthermore, the Stimulus–Organism–Response (S-O-R) framework (Mehrabian & Russell, 1974) remains underexplored in immersive communication, while user engagement is often replaced by continuance intention or satisfaction rather than measured through its cognitive, emotional, and behavioural dimensions (Brodie et al., 2011; Hollebeek et al., 2014). Research also remains limited in emerging markets, where metaverse participation often occurs through PCs and mobile devices rather than VR headsets (Rolando & Chondro, 2025). Therefore, this study examines the effects of communication richness and avatar self-identification on social presence and user engagement, tests the mediating role of social presence and the moderating effect of virtual safety concerns, and explores differences across VR, PC, and mobile access. By integrating these relationships within the S-O-R framework, this study contributes to understanding how communication features, avatar identification, and perceived safety shape engagement in immersive digital environments.

1.1 Hypothesis Development

Media richness theory suggests that communication channels with diverse cues and immediate feedback reduce ambiguity and enhance interaction (Daft & Lengel, 1986). In metaverse environments, voice chat, avatar gestures, and shared virtual objects facilitate natural communication and shared understanding (Dennis et al., 2008), while strengthening users' perception of interacting with others (Biocca et al., 2003). Verbal and non-verbal cues and immediate responses are also important antecedents of social presence (Oh et al., 2018). Avatar self-identification may further enhance social presence because perceived similarity between users and their avatars strengthens identification and platform attitudes (Suh et al., 2011), avatar characteristics influence behaviour (Yee & Bailenson, 2007), and avatars help users express themselves and manage social relationships (Freeman & Maloney, 2021). Therefore, communication richness and avatar self-identification are expected to positively influence social presence (H1 and H2).

Communication richness and avatar self-identification may also directly increase user engagement, which encompasses cognitive, emotional, and behavioural dimensions (Brodie et al.,

2011; Hollebeek et al., 2014). Rich communication features make interactions more informative and entertaining, facilitate collaboration, and encourage voluntary participation (van Doorn et al., 2010). Similarly, identifying with an avatar can strengthen self-expression, personal connection, and motivation to participate in the virtual world (Suh et al., 2011). According to the Stimulus–Organism–Response (S-O-R) framework, environmental stimuli influence behavioural responses through internal psychological states (Mehrabian & Russell, 1974). Social presence, as the feeling of being with others, is associated with trust, enjoyment, and loyalty in e-commerce (Gefen & Straub, 2004), psychological benefits in social VR (Barreda-Ángeles & Hartmann, 2022), and realistic responses to immersive experiences (Slater, 2009), including greater attention and emotional investment in others (Rolando, 2025b). Accordingly, social presence is expected to positively influence user engagement (Rahardja et al., 2024; H5) and mediate the relationships between communication richness and engagement (H6a) and avatar self-identification and engagement (H6b), with the type of mediation determined empirically.

However, the relationship between social presence and engagement may depend on perceived virtual safety. Research identifies harassment, unwanted proximity, verbal abuse, and simulated touch as risks in social VR, where embodiment can make unwanted interactions feel more invasive (Blackwell et al., 2019). Privacy concerns regarding the collection and use of personal data, including voice and movement data, may further increase perceived risk (Malhotra et al., 2004; Dwivedi et al., 2022). Consequently, users with greater virtual safety concerns may perceive social presence as exposure rather than connection, weakening its positive relationship with engagement. Thus, virtual safety concern is expected to negatively moderate the relationship between social presence and user engagement (H7), as summarised in Figure 2.

2. METHODS

2.1 Research Design

The study adopted a cross-sectional, explanatory survey design within a post-positivist paradigm, appropriate for testing theoretically derived hypotheses about relationships among latent constructs. Partial least squares structural equation modelling (PLS-SEM) was selected as the analytical technique because the model combines a second-order construct, two mediation paths and a latent interaction, and because the study's aims are both explanatory and predictive, a combination for which PLS-SEM is recommended (Hair et al., 2019). The sequence of research activities, from problem identification to interpretation, is summarised in Figure 1.

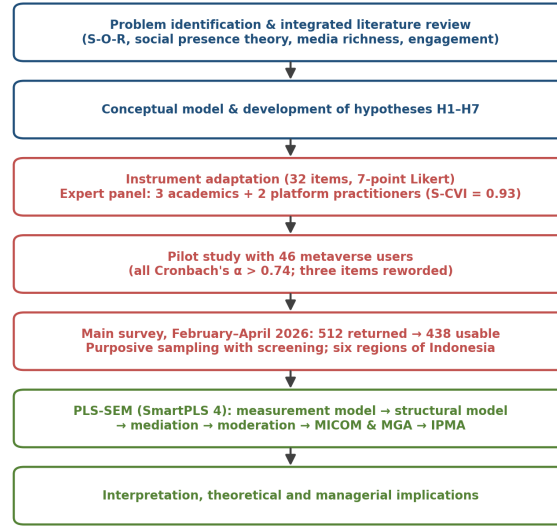


Figure 1 Research procedure

Source: Author's elaboration (2026).

The conceptual model tested in the study is presented in Figure 2. Communication richness and avatar self-identification are specified as stimuli, social presence as the organismic state, and user engagement as the response, with virtual safety concern moderating the presence–engagement path.

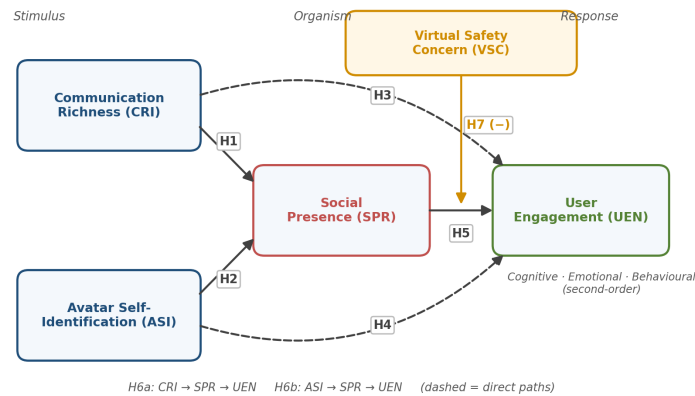


Figure 2 Conceptual model and hypotheses

Source: Author's elaboration based on Mehrabian and Russell (1974), Short et al. (1976) and Daft and Lengel (1986).

2.2 Population, Sampling and Sample Size

The target population comprised Indonesian residents aged 18–40 who had actively used at least one social or game-based metaverse platform in the previous three months. Due to the absence of a sampling frame, purposive sampling was employed, requiring respondents to have interacted through voice or text chat in a shared three-dimensional environment, customised an avatar, and

spent at least two hours on the platform in the previous month. Recruitment was conducted through Discord, Instagram, TikTok, university networks in Jakarta, Bandung, Surabaya, Yogyakarta, and Denpasar, and community-run Roblox and VRChat spaces.

The minimum sample size was determined using the inverse square root method (Kock & Hadaya, 2018), requiring at least 275 observations for a minimum path coefficient of 0.15 at a 5% significance level. To support multigroup analysis across three device groups, a larger sample was targeted. Of 512 questionnaires collected between February and April 2026, 41 were excluded for failing screening questions, 19 for failing attention checks, and 14 for excessive straight-lining, resulting in 438 valid responses (85.5%). Early and late respondents showed no significant differences in construct means (all $p > 0.21$), suggesting that non-response bias was unlikely to be a serious concern.

2.3 Data Collection Procedure

Data were collected through a self-administered online questionnaire in Bahasa Indonesia. The questionnaire opened with an information sheet explaining the purpose of the study, the voluntary nature of participation and the anonymity of responses, followed by an electronic consent item. Respondents were then asked to name the platform they used most often and to answer all subsequent items with reference to that platform. This anchoring reduces the ambiguity that arises when respondents average across several platforms with very different affordances. The questionnaire took a median of 11.4 minutes to complete. Respondents who completed the survey could enter a draw for one of twenty digital vouchers worth IDR 100,000, an incentive large enough to encourage completion but modest enough not to attract professional survey-takers.

2.4 Measurement

All constructs were measured with multi-item scales adapted from established sources and rated on seven-point Likert scales ranging from 1 (strongly disagree) to 7 (strongly agree). A seven-point format was chosen because the sample consisted of digitally literate young adults accustomed to fine-grained rating interfaces and because it increases the variance available for moderation analysis. The items were translated into Bahasa Indonesia and back-translated into English by two independent bilingual lecturers, and discrepancies were resolved by consensus. Content validity was assessed by a panel of three management and information systems academics and two practitioners responsible for community management on metaverse platforms; the scale-level content validity index was 0.93 (Rolando, 2025a). A pilot study with 46 metaverse users yielded Cronbach's alpha values above 0.74 for all constructs and led to minor rewording of three items for clarity. The constructs, sample items and sources are listed in Table 1.

Table 1. Constructs, sample items and sources

Construct	Items	Sample item	Adapted from
Communication richness (CRI)	5	“On this platform I can express emotions through voice, gestures and emotes at the same time.”	Daft & Lengel (1986); Dennis et al. (2008)
Avatar self-identification (ASI)	4	“My avatar is an expression of who I am.”	Suh et al. (2011)
Social presence (SPR)	5	“When I interact on this platform, I feel that other people are really there with me.”	Gefen & Straub (2004); Biocca et al. (2003)
User engagement (UEN) – cognitive	3	“Time passes quickly when I am on this platform.”	Hollebeek et al. (2014)
User engagement (UEN) – emotional	3	“I feel enthusiastic when I use this platform.”	Hollebeek et al. (2014)
User engagement (UEN) – behavioural	3	“I invest effort in contributing to activities and communities on this platform.”	Hollebeek et al. (2014); van Doorn et al. (2010)
Virtual safety concern (VSC)	4	“I worry that other users may behave inappropriately towards my avatar.”	Malhotra et al. (2004); Blackwell et al. (2019)

Note. All items rated on a seven-point Likert scale (1 = strongly disagree, 7 = strongly agree). The full instrument is available from the author on request.

User engagement was specified as a reflective–reflective higher-order construct with cognitive, emotional and behavioural dimensions, consistent with its conceptualisation as a multidimensional state (Brodie et al., 2011). Virtual safety concern combined items on interpersonal harassment risk, adapted from the social VR harassment literature (Blackwell et al., 2019), with items on the perceived misuse of personal data, adapted from the internet users' information privacy concerns scale (Malhotra et al., 2004). Gender, age, weekly usage frequency and access device were recorded as control and grouping variables.

2.5 Data Analysis

Analysis was conducted in SmartPLS 4 (Ringle et al., 2022) following the reporting guidelines of Hair et al. (2019). The measurement model was assessed through indicator loadings, internal consistency reliability (Cronbach's alpha, rho_A and composite reliability), convergent validity (average variance extracted, AVE) and discriminant validity using both the Fornell–Larcker criterion (Fornell & Larcker, 1981) and the heterotrait–monotrait ratio (HTMT), with 0.85 as the conservative threshold (Henseler et al., 2015). The higher-order engagement construct was estimated with the disjoint two-stage approach, in which latent variable scores of the three lower-order

dimensions obtained in the first stage serve as indicators of the higher-order construct in the second stage (Sarstedt et al., 2019).

The structural model was assessed through collinearity (inner VIF), coefficients of determination (R^2), effect sizes (f^2) and out-of-sample predictive power using PLSpredict (Shmueli et al., 2019). Path significance was determined through bias-corrected and accelerated bootstrapping with 5,000 subsamples and two-tailed tests. Indirect effects were tested with the same bootstrapping procedure, and the variance accounted for (VAF) was computed to characterise the magnitude of mediation. The moderating effect of virtual safety concern was estimated with the two-stage approach to latent interactions, and simple slopes were computed at one standard deviation above and below the moderator mean. To examine heterogeneity across access devices, the measurement invariance of composite models (MICOM) procedure was applied before multigroup analysis (Henseler et al., 2016). Finally, an importance–performance map analysis (IPMA) was conducted to translate the structural results into managerial priorities.

2.6 Validity, Reliability and Common Method Bias

Because all constructs were measured with self-reports from a single source at a single time point, several procedural and statistical safeguards against common method bias were employed (Podsakoff et al., 2003). Procedurally, anonymity was guaranteed and emphasised, predictor and criterion items were separated into different blocks with an intervening demographic section, item wording was varied to avoid a uniform response format, and respondents were told that there were no right or wrong answers. Statistically, Harman's single-factor test showed that a single unrotated factor accounted for 31.8 percent of total variance, well below the 50 percent threshold. The full collinearity assessment proposed by Kock (2015) yielded variance inflation factors between 1.28 and 2.41, all below 3.3, indicating that the model was not contaminated by common method variance. A theoretically unrelated marker variable, preference for printed over digital books, correlated weakly with the substantive constructs ($|r| \leq 0.07$), and partialling it out did not change the significance of any structural path.

3. RESULTS

3.1 Respondent Profile

Table 2 summarises the characteristics of the 438 respondents. Men made up a slight majority (53.2 percent), and nearly three quarters of respondents were aged 30 or younger, consistent with the youthful profile of metaverse users in Indonesia. Roblox was the most frequently named primary platform (29.2 percent), followed by Zepeto (18.7 percent) and VRChat (16.2 percent). Access devices were distributed across PCs or consoles (38.8 percent), mobile phones (33.8 percent) and VR headsets (27.4 percent). The VR share is higher than in the general user population, reflecting deliberate recruitment in VR communities to support the device comparison, and the implications of this over-representation are considered in Section 4.5. Most respondents used their primary platform between one and three times a week, and nearly half lived in Greater Jakarta.

Table 2. Respondent profile (n = 438)

Characteristic	Category	n	%
Gender	Male	233	53.2
	Female	205	46.8
Age	18–24 years	180	41.1
	25–30 years	144	32.9
	31–35 years	72	16.4
	36–40 years	42	9.6
Primary platform	Roblox	128	29.2
	Zepeto	82	18.7
	VRChat	71	16.2
	Fortnite (Creative mode)	63	14.4
	Meta Horizon Worlds	41	9.4
	Others (Spatial, Decentraland, The Sandbox)	53	12.1
Access device	PC / console	170	38.8
	Mobile phone	148	33.8
	VR headset	120	27.4
Usage frequency	Less than once a week	95	21.7
	1–3 times a week	194	44.3
	4 times a week or more	149	34.0
Region	Greater Jakarta	202	46.1
	West Java	77	17.6
	East Java	58	13.2
	Central Java & Yogyakarta	51	11.6
	Bali	23	5.3
	Other provinces	27	6.2

Source: Primary data processed (2026).

3.2 Measurement Model

Table 3 reports the results of the measurement model assessment. All indicator loadings exceeded 0.76, above the recommended threshold of 0.708, which means that each construct explains more than half of the variance of its indicators. Cronbach's alpha ranged from 0.762 to 0.870, rho_A

from 0.770 to 0.874, and composite reliability from 0.863 to 0.906, all within the range of satisfactory to good reliability without reaching the levels above 0.95 that would suggest redundant items (Hair et al., 2019). AVE values ranged from 0.646 to 0.747, confirming convergent validity. At the second stage, the three engagement dimensions loaded strongly on the higher-order construct (0.842 to 0.889), with the emotional dimension contributing most, and the higher-order construct itself met all reliability and validity criteria.

Table 3. Measurement model: loadings, reliability and convergent validity

Construct	Indicator loadings	α	rho_A	CR	AVE
Communication richness (CRI)	0.812; 0.784; 0.846; 0.771; 0.803	0.863	0.866	0.901	0.646
Avatar self-identification (ASI)	0.836; 0.872; 0.809; 0.788	0.846	0.851	0.896	0.684
Social presence (SPR)	0.791; 0.828; 0.857; 0.764; 0.812	0.870	0.874	0.906	0.658
Cognitive engagement (COG)	0.842; 0.868; 0.815	0.795	0.801	0.879	0.709
Emotional engagement (EMO)	0.877; 0.851; 0.829	0.812	0.816	0.889	0.727
Behavioural engagement (BEH)	0.818; 0.852; 0.797	0.762	0.770	0.863	0.677
User engagement (UEN, higher-order)	COG 0.861; EMO 0.889; BEH 0.842	0.831	0.834	0.898	0.747
Virtual safety concern (VSC)	0.768; 0.814; 0.842; 0.795	0.822	0.829	0.881	0.649

Note. α = Cronbach's alpha; CR = composite reliability (rho_c); AVE = average variance extracted. Higher-order loadings obtained in stage two of the disjoint two-stage approach. Source: SmartPLS 4 output (2026).

3.3 Discriminant Validity

Discriminant validity was established with both criteria, as shown in Table 4. Under the Fornell–Larcker criterion, the square root of each construct's AVE (on the diagonal) exceeded its correlations with all other constructs (below the diagonal). The HTMT ratios (above the diagonal) ranged from 0.118 to 0.741, well below the conservative 0.85 threshold, and bootstrapped 95 percent confidence intervals for HTMT did not include 1 for any pair (Henseler et al., 2015). The highest HTMT value was observed between social presence and engagement (0.741), which is theoretically expected since presence is hypothesised as the proximal antecedent of engagement, but the value remains comfortably below the threshold. Virtual safety concern correlated negatively and weakly with all other constructs, confirming that it captures a distinct evaluative dimension rather than a reversed form of engagement.

Table 4. Discriminant validity: Fornell–Larcker criterion and HTMT ratios

Construct	CRI	ASI	SPR	UEN	VSC
CRI	0.804	0.486	0.672	0.638	0.142
ASI	0.418	0.827	0.598	0.511	0.118
SPR	0.584	0.517	0.811	0.741	0.176
UEN	0.556	0.438	0.648	0.864	0.203
VSC	−0.124	−0.097	−0.151	−0.182	0.806

Note. Diagonal values are the square roots of AVE; values below the diagonal are latent variable correlations; values above the diagonal are HTMT ratios. Source: SmartPLS 4 output (2026).

3.4 Structural Model and Hypothesis Testing

Before interpreting the structural paths, collinearity among predictors was examined. As reported in Table 5, inner VIF values ranged from 1.02 to 1.87, far below the critical value of 3, so collinearity does not bias the estimates. The model explained 43.1 percent of the variance in social presence and 45.7 percent of the variance in engagement, both of which fall in the moderate range for consumer behaviour research and are substantial for a model with only two exogenous stimuli. PLSpredict yielded positive Q^2 predict values for both endogenous constructs (0.412 and 0.386), and for seven of the nine engagement indicators the PLS model produced lower root mean squared errors than the linear-model benchmark, indicating medium predictive power (Shmueli et al., 2019). The standardised root mean square residual was 0.061, below the 0.08 threshold, and the normed fit index was 0.912.

Table 5. Structural model quality

Endogenous construct	R ²	Adj. R ²	Q ² predict	Predictors (inner VIF)
Social presence (SPR)	0.431	0.428	0.412	CRI (1.21); ASI (1.21)
User engagement (UEN)	0.457	0.448	0.386	CRI (1.63); ASI (1.42); SPR (1.87); VSC (1.04); SPR×VSC (1.02)

Note. SRMR = 0.061; NFI = 0.912. Controls (gender, age, usage frequency) included for UEN. Source: SmartPLS 4 output (2026).

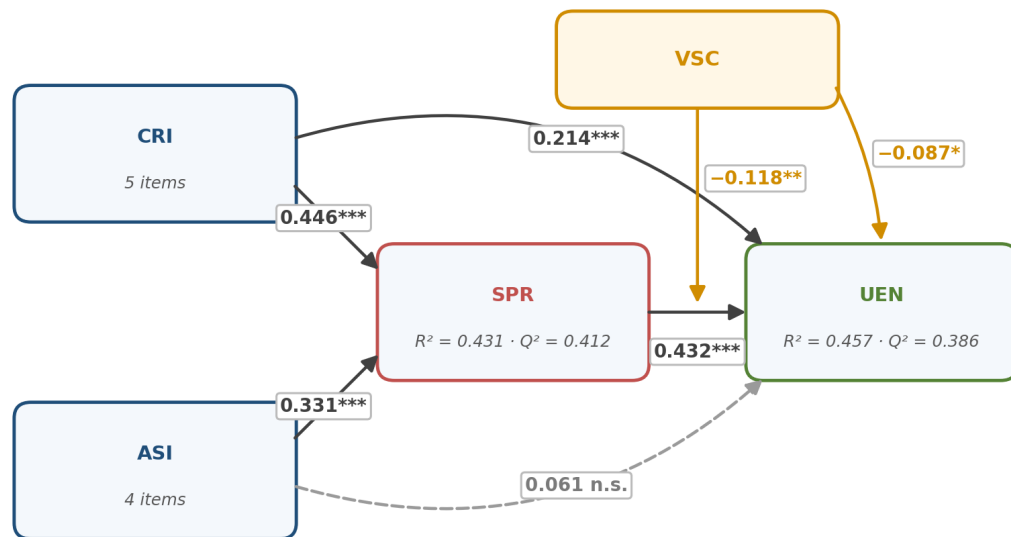
Table 6 reports the results of hypothesis testing, and Figure 3 displays the estimated structural model. Communication richness had a strong positive effect on social presence ($\beta = 0.446$, $t = 9.91$, $p < 0.001$) with a medium-to-large effect size ($f^2 = 0.288$), supporting H1. Avatar self-identification also increased social presence ($\beta = 0.331$, $t = 6.76$, $p < 0.001$, $f^2 = 0.158$), supporting H2. Communication richness had a significant direct effect on engagement ($\beta = 0.214$, $t = 4.12$, $p < 0.001$), supporting H3, although its effect size was small ($f^2 = 0.054$). By contrast, the direct path from avatar self-identification to engagement was weak and not significant ($\beta = 0.061$, $t = 1.27$, $p = 0.204$), and the confidence interval included zero, so H4 is not supported. Social presence was the strongest predictor of engagement ($\beta = 0.432$, $t = 8.47$, $p < 0.001$, $f^2 = 0.201$), supporting H5. Among

the controls, only usage frequency was related to engagement ($\beta = 0.096$, $p = 0.012$); gender ($p = 0.581$) and age ($p = 0.392$) were not.

Table 6. Hypothesis testing: direct and interaction effects

Hypothesis / path	β	SE	t	p	95% CI	f ²	Decision
H1: CRI → SPR	0.446	0.045	9.91	< 0.001	[0.356, 0.532]	0.288	Supported
H2: ASI → SPR	0.331	0.049	6.76	< 0.001	[0.232, 0.425]	0.158	Supported
H3: CRI → UEN	0.214	0.052	4.12	< 0.001	[0.111, 0.314]	0.054	Supported
H4: ASI → UEN	0.061	0.048	1.27	0.204	[-0.033, 0.156]	0.005	Not supported
H5: SPR → UEN	0.432	0.051	8.47	< 0.001	[0.330, 0.529]	0.201	Supported
H7: SPR × VSC → UEN	-0.118	0.042	2.81	0.005	[-0.199, -0.035]	0.027	Supported
VSC → UEN (main effect)	-0.087	0.039	2.23	0.026	[-0.163, -0.010]	0.014	—

Note. Bias-corrected and accelerated bootstrap, 5,000 subsamples, two-tailed. Source: SmartPLS 4 output (2026).



*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; n.s. = not significant (5,000 bootstrap subsamples)

Figure 3. Estimated structural model
Source: SmartPLS 4 output processed by the author (2026).

3.5 Mediation Analysis

The mediating role of social presence was examined through bootstrapped specific indirect effects, reported in Table 7 and decomposed in Figure 4. The indirect effect of communication richness on engagement through social presence was positive and significant ($\beta = 0.193$, $t = 6.21$, $p < 0.001$, 95% CI [0.135, 0.256]). Because the direct effect was also significant and of the same sign, the mediation is complementary and partial; social presence accounts for 47.4 percent of the total effect of communication richness (VAF). H6a is supported. The indirect effect of avatar self-identification through social presence was likewise significant ($\beta = 0.143$, $t = 5.30$, $p < 0.001$, 95% CI [0.093, 0.199]), whereas its direct effect was not, which indicates indirect-only, or full, mediation. H6b is supported. Taken together, the two results show that the two stimuli reach engagement by different routes: communication richness matters both in itself and through presence, whereas avatar self-identification matters only to the extent that it makes other people feel present.

Table 7. Mediation analysis: specific indirect effects through social presence

Path	Indirect β	t	95% CI	Direct β	Total β	VAF	Mediation type
H6a: CRI $\rightarrow$ SPR $\rightarrow$ UEN	0.193	6.21	[0.135, 0.256]	0.214***	0.407	47.4%	Partial (complementary)
H6b: ASI $\rightarrow$ SPR $\rightarrow$ UEN	0.143	5.30	[0.093, 0.199]	0.061 n.s.	0.204	70.1%	Full (indirect-only)

Note. *** $p < 0.001$; n.s. = not significant. VAF = indirect effect / total effect. Source: SmartPLS 4 output (2026).

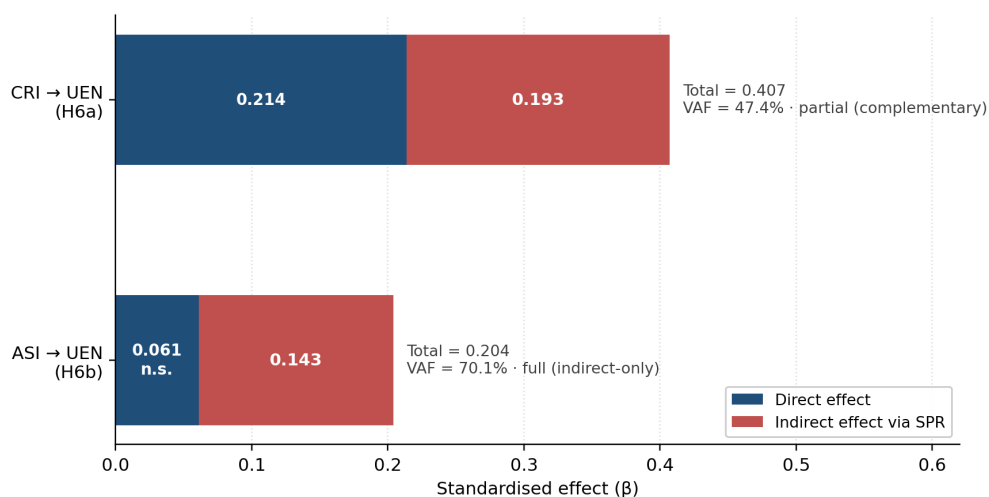


Figure 4 Decomposition of direct and indirect effects on user engagement

Source: Author's elaboration based on SmartPLS 4 output (2026).

3.6 Moderating Effect of Virtual Safety Concern

The interaction between social presence and virtual safety concern was negative and significant ($\beta = -0.118$, $t = 2.81$, $p = 0.005$), supporting H7. Adding the interaction term raised the explained variance in engagement by 1.5 percentage points, and its effect size ($f^2 = 0.027$) is small

in conventional terms but in line with the typical magnitude of moderating effects in field survey research, where interaction effects of this size are regarded as substantively meaningful. The simple slope analysis in Figure 5 shows how the moderation operates. For users with low safety concern (one standard deviation below the mean), each standard deviation increase in social presence was associated with an increase of 0.550 standard deviations in engagement; at the mean the slope was 0.432, and for users with high safety concern it fell to 0.314. The relationship remained positive and significant at all three levels, which means that safety concern attenuates rather than eliminates the value of presence. Because the moderated path lies on both mediation routes, the indirect effects were themselves conditional. The index of moderated mediation was significant for communication richness (-0.053 , 95% CI $[-0.091, -0.016]$) and for avatar self-identification (-0.039 , 95% CI $[-0.070, -0.011]$); the conditional indirect effect of communication richness, for instance, declined from 0.245 at low safety concern to 0.140 at high safety concern.

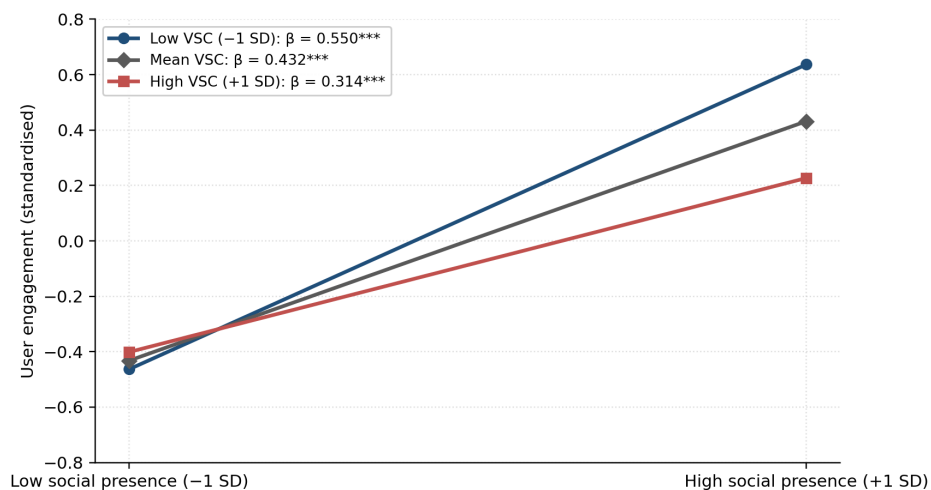


Figure 5 Simple slopes of social presence on user engagement at three levels of virtual safety concern

Source: Author's elaboration based on SmartPLS 4 output (2026).

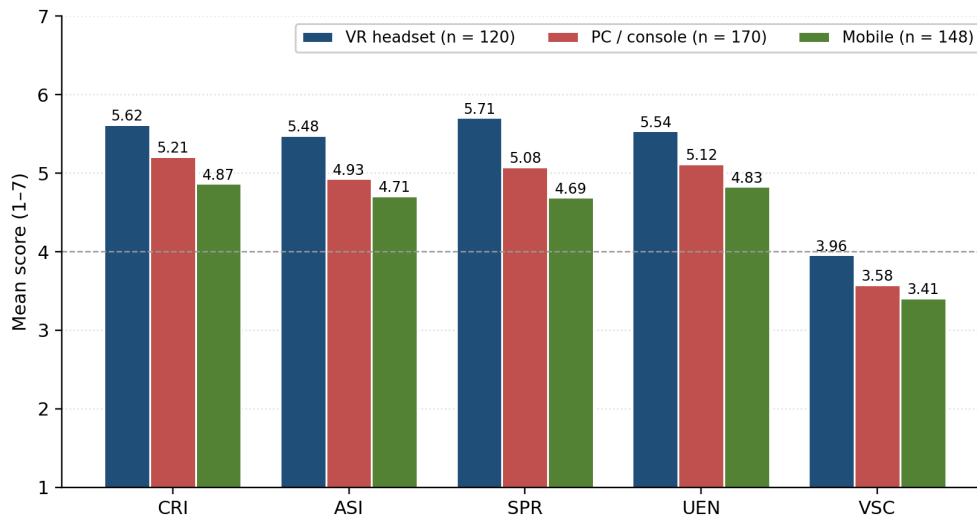
3.7 Subgroup Analysis by Access Device

To examine whether the experience of metaverse communication differs by access device, construct means were compared across VR-headset, PC/console and mobile users (Table 8 and Figure 6). One-way ANOVA showed significant differences for every construct. The largest difference was in social presence ($F(2, 435) = 30.90$, $p < 0.001$, $\eta^2 = 0.124$): Tukey post-hoc tests indicated that VR users reported higher presence than PC/console users, who in turn reported higher presence than mobile users (all pairwise $p < 0.05$). For communication richness, avatar self-identification and engagement, VR users scored significantly higher than mobile users, with PC/console users in between. Notably, VR users also reported the highest virtual safety concern ($M = 3.96$), although the effect size for this difference was small ($\eta^2 = 0.026$). This pattern suggests that the embodiment that intensifies presence in VR also heightens awareness of interpersonal risk.

Table 8. Construct means by access device and ANOVA results

Construct	VR headset (n = 120)	PC / console (n = 170)	Mobile (n = 148)	Total (n = 438)	F(2, 435)	η^2
CRI	5.62 (0.94)	5.21 (1.03)	4.87 (1.11)	5.21 (1.07)	17.51***	0.075
ASI	5.48 (1.08)	4.93 (1.17)	4.71 (1.24)	5.01 (1.20)	15.13***	0.065
SPR	5.71 (0.97)	5.08 (1.09)	4.69 (1.16)	5.12 (1.13)	30.90***	0.124
UEN	5.54 (0.91)	5.12 (0.98)	4.83 (1.03)	5.14 (1.01)	17.67***	0.075
VSC	3.96 (1.31)	3.58 (1.34)	3.41 (1.38)	3.63 (1.36)	5.71**	0.026

Note. Values are means (standard deviations) on a 1–7 scale. *** $p < 0.001$; ** $p < 0.01$. Source: Primary data processed (2026).

**Figure 6** Construct means by access device

Source: Primary data processed (2026).

3.8 Robustness Checks: Multigroup Analysis and IPMA

Mean differences do not necessarily imply that the structural relationships differ, so a multigroup analysis was performed comparing VR-headset users ($n = 120$) with non-VR users ($n = 318$). PC/console and mobile users were pooled because their path estimates did not differ significantly in a preliminary comparison and because separate groups would have reduced statistical power; the VR group exceeded the 99 observations required by the inverse square root method to detect paths of 0.25. The MICOM procedure established configural and compositional invariance for all constructs, with partial invariance at step three owing to the mean differences described above, which permits a meaningful comparison of path coefficients (Henseler et al., 2016). As Table 9 shows, the only significant difference concerned the path from avatar self-identification to social presence, which was markedly stronger for VR users ($\beta = 0.452$) than for non-VR users ($\beta = 0.287$;

$\Delta\beta = 0.165$, $p = 0.041$). The social presence–engagement path was also stronger in the VR group, but this difference was only marginally significant ($p = 0.093$). All other paths were statistically equivalent, and the direct path from avatar self-identification to engagement remained non-significant in both groups, which strengthens confidence that the full mediation result is not an artefact of pooling heterogeneous users.

Table 9. Multigroup analysis: VR-headset versus non-VR users

Path	VR (n = 120)	Non-VR (n = 318)	$\Delta\beta$	p (PLS-MGA)	Result
CRI → SPR	0.392***	0.463***	−0.071	0.384	No difference
ASI → SPR	0.452***	0.287***	0.165	0.041	Stronger in VR
CRI → UEN	0.168*	0.231***	−0.063	0.512	No difference
ASI → UEN	0.089 n.s.	0.052 n.s.	0.037	0.694	No difference
SPR → UEN	0.518***	0.394***	0.124	0.093	Marginal
SPR × VSC → UEN	−0.162*	−0.101*	−0.061	0.438	No difference
R² (SPR) / R² (UEN)	0.486 / 0.512	0.402 / 0.431	—	—	—

Note. *** $p < 0.001$; * $p < 0.05$; n.s. = not significant. MICOM established partial measurement invariance. Source: SmartPLS 4 output (2026).

Finally, an importance–performance map analysis was conducted with engagement as the target construct (Figure 7). Social presence and communication richness had the highest importance, with total effects of 0.432 and 0.407 respectively, while their performance scores, rescaled to 0–100, were moderate at 68.7 and 70.2. Avatar self-identification had roughly half the importance of these two constructs (0.204) and a slightly lower performance of 66.8. Virtual safety concern had a small negative total effect and a performance of 43.8, meaning that users on average held moderate concerns. The IPMA thus identifies social presence as the construct with the best combination of high importance and room for improvement, and it indicates that improving the richness of communication channels offers the most direct lever for raising presence.

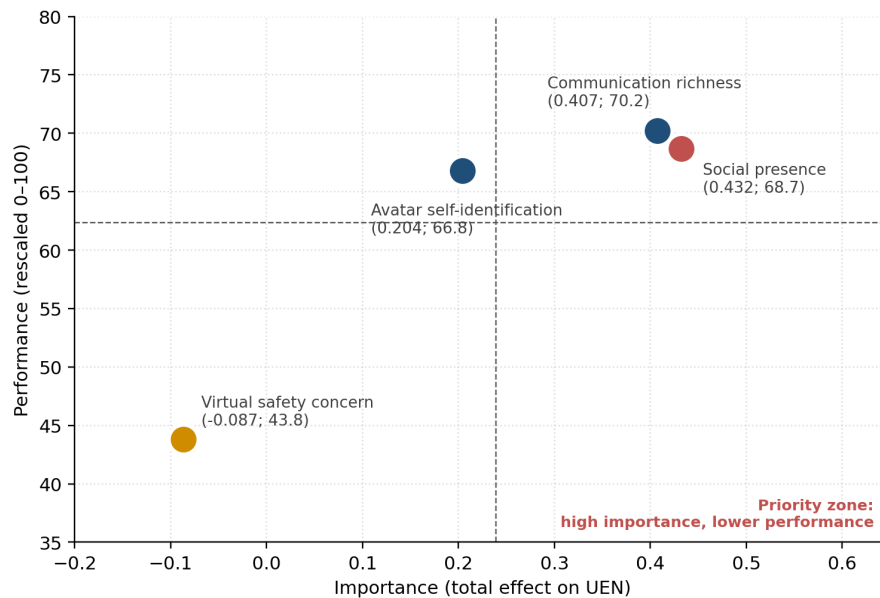
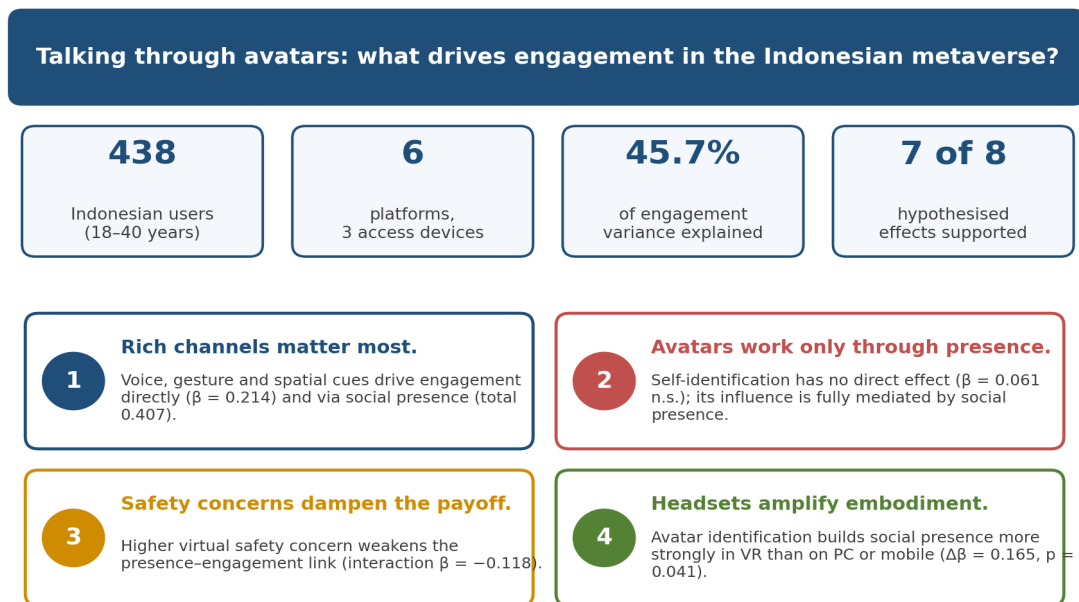


Figure 7. Importance–performance map for user engagement

Source: SmartPLS 4 IPMA output processed by the author (2026).

The principal findings of the study are summarised visually in Figure 8.



PLS-SEM, SmartPLS 4 · 5,000 bootstrap subsamples · SRMR = 0.061

Figure 8 Summary of key findings

Source: Author's elaboration (2026).

4. DISCUSSION

4.1 *Interpretation of the Main Findings*

The findings indicate that social presence is the strongest predictor of user engagement and mediates the effects of communication richness and avatar self-identification, although the two stimuli operate differently. Communication richness enhances engagement both by strengthening social presence and by making interactions more immersive and easier to coordinate, while avatar self-identification has no direct effect on engagement after social presence is considered, challenging the assumption that avatar customisation independently drives engagement through ownership and self-expression (Ronaldo & Mulyono, 2024). Instead, avatar identification appears to foster engagement by making interactions with others feel more personally meaningful. Virtual safety concern further moderates this relationship, reducing the engagement effect of social presence by approximately 43% among users with high concern compared with those with low concern (0.314 versus 0.550). Device differences reinforce this interpretation: VR users reported the strongest social presence and a stronger relationship between avatar identification and presence, but also the highest safety concern, suggesting that full embodiment intensifies both the benefits and perceived risks of metaverse communication.

4.2 *Dialogue with Prior Literature*

The findings extend Suh et al. (2011) by showing that, unlike platform attitudes and usage intentions, engagement is influenced by avatar self-identification entirely through social presence, highlighting the importance of measuring engagement as a multidimensional construct (Hollebeek et al., 2014). Consistent with Hennig-Thurau et al. (2023), VR users experienced stronger social presence, particularly because embodiment strengthened the relationship between avatar identification and presence, while communication richness remained important across devices. The moderation results support Blackwell et al. (2019) by demonstrating that virtual safety concerns reduce the engagement benefits of social presence, qualifying the psychological benefits identified by Barreda-Ángeles and Hartmann (2022). Finally, the direct and indirect effects of communication richness reinforce media richness theory (Daft & Lengel, 1986), suggesting that spatial, vocal, and gestural cues enhance both social presence and engagement, consistent with Dennis et al. (2008) on the benefits of synchronous, multi-cue communication channels.

4.3 *Theoretical Implications*

The study makes three theoretical contributions. First, it extends the S-O-R framework into immersive communication by specifying social presence as the organismic state and by showing that stimuli differ in how completely the organism absorbs their effects. This implies a refinement of the framework: in immersive settings, stimuli can be classified as channel-level stimuli, which have both direct and mediated effects, and self-level stimuli, whose effects are fully relational. Future S-O-R models of metaverse behaviour should therefore not assume that all stimuli share the same pathway to response. Second, the study clarifies the role of social presence theory in engagement research (Rolando & Pasaribu, 2024). Short et al. (1976) conceptualised social presence as a property of the medium; later research, notably Biocca et al. (2003), redefined it as a psychological state of the user. The present results support the latter view, since the same platforms produced systematically

different levels of presence depending on users' avatar identification and device, and they add that presence is a necessary but not sufficient condition for engagement, as its effect depends on perceived safety. Third, the study identifies interpersonal risk as a boundary condition for presence-based theories of engagement. Presence theories have tended to assume that feeling more present is always better. The negative moderation of virtual safety concern shows that this assumption holds for secure users but weakens for anxious ones, which introduces a risk-contingent qualification into the presence–engagement proposition.

4.4 Practical and Managerial Implications

For brands and marketers in Indonesia, the findings suggest prioritising communication richness over avatar customisation by creating interactive experiences such as co-creation challenges, guided group tours, and spatial-audio events, with social presence offering the greatest potential return and communication richness serving as its most direct driver. Platform operators should improve mobile accessibility through spatial audio, gesture libraries, and low-latency voice while treating safety as an engagement priority through effective blocking, muting, moderation, and transparent data practices, particularly in VR environments where presence and safety concerns are highest. For regulators and policymakers, guidance under Indonesia's Personal Data Protection Law (Law No. 27 of 2022) could address the collection of voice and motion data and encourage transparent moderation standards, while educators and universities should design interactive virtual events supported by clear codes of conduct and facilitators to promote student engagement and safety.

4.5 Alternative Explanations and Validity Considerations

Several alternative explanations should be considered. First, the relationships could reflect reverse causality: highly engaged users might invest more in their avatars and learn to use communication features more fully, thus reporting higher richness and identification. Cross-sectional data cannot rule this out. However, the full mediation of avatar identification argues against a simple reverse causal account, since engagement-driven identification would be expected to produce a direct correlation between the two constructs that remains after controlling for presence, which was not the case. Second, the results might reflect self-selection, since users who find a platform engaging are more likely to remain on it and be included in a sample of active users. This concern is real, but it would primarily restrict the range of engagement and thus attenuate rather than inflate the observed relationships. Third, common method bias could inflate the correlations among self-reported constructs. The procedural safeguards, the Harman and full collinearity tests and the marker variable analysis described in Section 2.6 all indicate that this bias is unlikely to account for the findings, and the presence of both a non-significant path and a negative interaction is difficult to reconcile with a uniform method factor. Fourth, the over-representation of VR users relative to the general population could distort the pooled estimates. The multigroup analysis shows, however, that all paths except one were statistically equivalent across device groups, and a reweighted estimation in which the VR

group was down-weighted to 12 percent of the sample did not change the significance of any hypothesis.

4.6 Boundary Conditions

The findings are most likely to apply to social and game-based platforms in which communication among users is central to the experience. They may apply less well to enterprise metaverse applications, such as virtual training or industrial digital twins, where engagement is shaped by task goals and organisational requirements rather than voluntary social interaction. They are also bounded by the age range of the sample, since users aged 18 to 40 are digitally fluent and likely to be comfortable with avatar-based self-presentation. Older users may find richness overwhelming rather than engaging, and the balance between presence and safety concern may differ for them. Culturally, the Indonesian context may have strengthened the role of social presence, since collectivist orientations and the value placed on togetherness (*kebersamaan*) may make the feeling of being with others especially rewarding. Replications in more individualistic settings could find weaker presence effects and relatively stronger direct effects of avatar identification through self-expression.

4.7 Limitations

Several limitations should be noted. First, the cross-sectional design limits causal inference, and although the model was grounded in theory, the direction of the relationships cannot be established with certainty. Second, purposive sampling through online communities and university networks may have favoured more active and socially connected users and cannot be regarded as representative of all Indonesian metaverse users. Third, all constructs were measured through self-reports; behavioural indicators such as session length, return frequency and in-world contributions would provide a stronger test of the behavioural dimension of engagement. Fourth, respondents answered with respect to their most-used platform, so the results pool platforms with different affordances; although platform dummies did not change the substantive conclusions, the sample was too small for platform-level multigroup analysis. Fifth, virtual safety concern combined interpersonal and data-related concerns in a single construct; the two may operate differently, with harassment concerns more closely tied to presence than data concerns. Sixth, the study did not observe actual incidents of harassment, so it cannot distinguish between concerns rooted in personal experience and those based on media reports or hearsay.

4.8 Future Research Agenda

Five directions for future research follow from these results. First, longitudinal panel designs with three or more waves, ideally linked to platform log data, could test whether richness and identification precede presence and engagement, or whether engagement feeds back into identification over time. Second, field experiments that vary specific communication features, for example enabling or disabling spatial audio or gesture libraries within the same branded world, would provide causal estimates of the richness effect and indicate which features matter most. Third, future

studies should separate interpersonal safety concern from data privacy concern and examine whether platform safety features, such as personal boundaries and visible moderators, reduce the moderating effect of concern, possibly in a moderated mediation design. Fourth, cross-cultural comparisons, for example between Indonesia, South Korea and Germany, could test whether collectivist orientations amplify the role of social presence, as suggested in Section 4.6. Fifth, research on older users and on enterprise applications of the metaverse would clarify the extent to which the model generalises beyond voluntary social platforms and young adults.

5. CONCLUSION

Using data from 438 Indonesian metaverse users, this study found that communication richness and avatar self-identification strengthen social presence, which is the strongest predictor of engagement; communication richness affects engagement directly and indirectly, whereas avatar self-identification operates only through social presence (Zahran & Rolando, 2025). Virtual safety concern weakens the relationship between presence and engagement, while the link between avatar identification and presence is strongest among VR headset users. Theoretically, the study extends the S-O-R framework to immersive communication by distinguishing the pathways through which channel-level and self-level stimuli influence engagement and identifying interpersonal risk as a boundary condition. Practically, the findings highlight the importance of rich, interactive communication and accessible safety features, with avatar customisation creating value primarily when it supports social interaction. As immersive platforms become increasingly integrated into socialising, education, and commerce, sustained engagement will depend on users feeling connected to others and safe, a conclusion that future longitudinal and behavioural research should further examine.

REFERENCES

- Asosiasi Penyelenggara Jasa Internet Indonesia. (2024). *Survei penetrasi internet Indonesia 2024*. APJII.
- Asosiasi Penyelenggara Jasa Internet Indonesia. (2024). *Survei penetrasi internet Indonesia 2024*. APJII.
- Ball, M. (2022). *The metaverse: And how it will revolutionize everything*. Liveright.
- Ball, M. (2022). *The metaverse: And how it will revolutionize everything*. Liveright.
- Barreda-Ángeles, M., & Hartmann, T. (2022). Psychological benefits of using social virtual reality platforms during the COVID-19 pandemic: The role of social and spatial presence. *Computers in Human Behavior*, 127, 107047. <https://doi.org/10.1016/j.chb.2021.107047>
- Barreda-Ángeles, M., & Hartmann, T. (2022). Psychological benefits of using social virtual reality platforms during the COVID-19 pandemic: The role of social and spatial presence. *Computers in Human Behavior*, 127, 107047. <https://doi.org/10.1016/j.chb.2021.107047>

- Biocca, F., Harms, C., & Burgoon, J. K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence: Teleoperators and Virtual Environments*, 12(5), 456–480. <https://doi.org/10.1162/105474603322761270>
- Biocca, F., Harms, C., & Burgoon, J. K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence: Teleoperators and Virtual Environments*, 12(5), 456–480. <https://doi.org/10.1162/105474603322761270>
- Blackwell, L., Ellison, N., Elliott-Deflo, N., & Schwartz, R. (2019). Harassment in social virtual reality: Challenges for platform governance. *Proceedings of the ACM on Human-Computer Interaction*, 3(CSCW), Article 100. <https://doi.org/10.1145/3359202>
- Blackwell, L., Ellison, N., Elliott-Deflo, N., & Schwartz, R. (2019). Harassment in social virtual reality: Challenges for platform governance. *Proceedings of the ACM on Human-Computer Interaction*, 3(CSCW), Article 100. <https://doi.org/10.1145/3359202>
- Brodie, R. J., Hollebeek, L. D., Jurić, B., & Ilić, A. (2011). Customer engagement: Conceptual domain, fundamental propositions, and implications for research. *Journal of Service Research*, 14(3), 252–271. <https://doi.org/10.1177/1094670511411703>
- Brodie, R. J., Hollebeek, L. D., Jurić, B., & Ilić, A. (2011). Customer engagement: Conceptual domain, fundamental propositions, and implications for research. *Journal of Service Research*, 14(3), 252–271. <https://doi.org/10.1177/1094670511411703>
- Daft, R. L., & Lengel, R. H. (1986). Organizational information requirements, media richness and structural design. *Management Science*, 32(5), 554–571. <https://doi.org/10.1287/mnsc.32.5.554>
- Daft, R. L., & Lengel, R. H. (1986). Organizational information requirements, media richness and structural design. *Management Science*, 32(5), 554–571. <https://doi.org/10.1287/mnsc.32.5.554>
- Dennis, A. R., Fuller, R. M., & Valacich, J. S. (2008). Media, tasks, and communication processes: A theory of media synchronicity. *MIS Quarterly*, 32(3), 575–600. <https://doi.org/10.2307/25148857>
- Dennis, A. R., Fuller, R. M., & Valacich, J. S. (2008). Media, tasks, and communication processes: A theory of media synchronicity. *MIS Quarterly*, 32(3), 575–600. <https://doi.org/10.2307/25148857>
- Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., Dennehy, D., Metri, B., Buhalis, D., Cheung, C. M. K., Conboy, K., Doyle, R., Dubey, R., Dutot, V., Felix, R., Goyal, D. P., Gustafsson, A., Hinsch, C., Jebabli, I., ... Wamba, S. F. (2022). Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, 66, 102542. <https://doi.org/10.1016/j.ijinfomgt.2022.102542>
- Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., Dennehy, D., Metri, B., Buhalis, D., Cheung, C. M. K., Conboy, K., Doyle, R., Dubey, R., Dutot, V., Felix, R., Goyal, D. P., Gustafsson, A., Hinsch, C., Jebabli, I., ... Wamba, S. F.

- (2022). Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, 66, 102542. <https://doi.org/10.1016/j.ijinfomgt.2022.102542>
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39–50. <https://doi.org/10.1177/002224378101800104>
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39–50. <https://doi.org/10.1177/002224378101800104>
- Freeman, G., & Maloney, D. (2021). Body, avatar, and me: The presentation and perception of self in social virtual reality. *Proceedings of the ACM on Human-Computer Interaction*, 4(CSCW3), Article 239. <https://doi.org/10.1145/3432938>
- Freeman, G., & Maloney, D. (2021). Body, avatar, and me: The presentation and perception of self in social virtual reality. *Proceedings of the ACM on Human-Computer Interaction*, 4(CSCW3), Article 239. <https://doi.org/10.1145/3432938>
- Gefen, D., & Straub, D. W. (2004). Consumer trust in B2C e-commerce and the importance of social presence: Experiments in e-products and e-services. *Omega*, 32(6), 407–424. <https://doi.org/10.1016/j.omega.2004.01.006>
- Gefen, D., & Straub, D. W. (2004). Consumer trust in B2C e-commerce and the importance of social presence: Experiments in e-products and e-services. *Omega*, 32(6), 407–424. <https://doi.org/10.1016/j.omega.2004.01.006>
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), 2–24. <https://doi.org/10.1108/EBR-11-2018-0203>
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), 2–24. <https://doi.org/10.1108/EBR-11-2018-0203>
- Hennig-Thurau, T., Aliman, D. N., Herting, A. M., Cziehso, G. P., Linder, M., & Kübler, R. V. (2023). Social interactions in the metaverse: Framework, initial evidence, and research roadmap. *Journal of the Academy of Marketing Science*, 51(4), 889–913. <https://doi.org/10.1007/s11747-022-00908-0>
- Hennig-Thurau, T., Aliman, D. N., Herting, A. M., Cziehso, G. P., Linder, M., & Kübler, R. V. (2023). Social interactions in the metaverse: Framework, initial evidence, and research roadmap. *Journal of the Academy of Marketing Science*, 51(4), 889–913. <https://doi.org/10.1007/s11747-022-00908-0>
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115–135. <https://doi.org/10.1007/s11747-014-0403-8>

- Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), 115–135. <https://doi.org/10.1007/s11747-014-0403-8>
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2016). Testing measurement invariance of composites using partial least squares. *International Marketing Review*, 33(3), 405–431. <https://doi.org/10.1108/IMR-09-2014-0304>
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2016). Testing measurement invariance of composites using partial least squares. *International Marketing Review*, 33(3), 405–431. <https://doi.org/10.1108/IMR-09-2014-0304>
- Hollebeek, L. D., Glynn, M. S., & Brodie, R. J. (2014). Consumer brand engagement in social media: Conceptualization, scale development and validation. *Journal of Interactive Marketing*, 28(2), 149–165. <https://doi.org/10.1016/j.intmar.2013.12.002>
- Hollebeek, L. D., Glynn, M. S., & Brodie, R. J. (2014). Consumer brand engagement in social media: Conceptualization, scale development and validation. *Journal of Interactive Marketing*, 28(2), 149–165. <https://doi.org/10.1016/j.intmar.2013.12.002>
- Kock, N. (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. *International Journal of e-Collaboration*, 11(4), 1–10. <https://doi.org/10.4018/ijec.2015100101>
- Kock, N. (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. *International Journal of e-Collaboration*, 11(4), 1–10. <https://doi.org/10.4018/ijec.2015100101>
- Kock, N., & Hadaya, P. (2018). Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. *Information Systems Journal*, 28(1), 227–261. <https://doi.org/10.1111/isj.12131>
- Kock, N., & Hadaya, P. (2018). Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. *Information Systems Journal*, 28(1), 227–261. <https://doi.org/10.1111/isj.12131>
- Malhotra, N. K., Kim, S. S., & Agarwal, J. (2004). Internet users' information privacy concerns (IUIPC): The construct, the scale, and a causal model. *Information Systems Research*, 15(4), 336–355. <https://doi.org/10.1287/isre.1040.0032>
- Malhotra, N. K., Kim, S. S., & Agarwal, J. (2004). Internet users' information privacy concerns (IUIPC): The construct, the scale, and a causal model. *Information Systems Research*, 15(4), 336–355. <https://doi.org/10.1287/isre.1040.0032>
- Mehrabian, A., & Russell, J. A. (1974). An approach to environmental psychology. MIT Press.
- Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology*. MIT Press.
- Oh, C. S., Bailenson, J. N., & Welch, G. F. (2018). A systematic review of social presence: Definition, antecedents, and implications. *Frontiers in Robotics and AI*, 5, 114. <https://doi.org/10.3389/frobt.2018.00114>

- Oh, C. S., Bailenson, J. N., & Welch, G. F. (2018). A systematic review of social presence: Definition, antecedents, and implications. *Frontiers in Robotics and AI*, 5, 114. <https://doi.org/10.3389/frobt.2018.00114>
- Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5), 879–903. <https://doi.org/10.1037/0021-9010.88.5.879>
- Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5), 879–903. <https://doi.org/10.1037/0021-9010.88.5.879>
- Rahardja, B. V., Rolando, B., Chondro, J., & Laurensia, M. (2024). MENDORONG PERTUMBUHAN E-COMMERCE: PENGARUH PEMASARAN MEDIA SOSIAL TERHADAP KINERJA PENJUALAN (Vol. 1, Issue 1). <https://journal.dinamikapublika.id/index.php/JUMDER>
- Ringle, C. M., Wende, S., & Becker, J.-M. (2022). SmartPLS 4 [Computer software]. SmartPLS GmbH. <https://www.smartpls.com>
- Ringle, C. M., Wende, S., & Becker, J.-M. (2022). *SmartPLS 4* [Computer software]. SmartPLS GmbH. <https://www.smartpls.com>
- Rolando, B. (2025a). RETAIL SUPPLY CHAIN MANAGEMENT: A SYSTEMATIC LITERATURE REVIEW ON RISK, SUSTAINABILITY, AND DIGITAL INTEGRATION. *LOGIS (Logistics, Operations and Global Integration Studies)*, 1(1), 1–13.
- Rolando, B. (2025b). THE IMPACT OF ARTIFICIAL INTELLIGENCE-BASED RECOMMENDATION SYSTEMS ON CONSUMER PURCHASE DECISIONS IN E-COMMERCE. *AIRA (Artificial Intelligence Research and Applied Learning)*, 4(2), 14–38.
- Rolando, B., & Chondro, J. (2025). THE INFLUENCE OF CUSTOMER REVIEWS ON TRUST AND ONLINE PURCHASE DECISIONS: A SYSTEMATIC LITERATURE REVIEW. *International Journal of Economics And Business Studies*, 2(1), 33–59.
- Rolando, B., & Pasaribu, J. P. K. (2024). The Role of Brand Equity and Perceived Value on Student Loyalty: A Case Study of Private Universities in Indonesia. *Jurnal Ilmiah Manajemen Dan Kewirausahaan (JUMANAGE)*, 3(1), 359–369.
- Ronaldo, B., & Mulyono, H. (2024). UNDERSTANDING CUSTOMER JOURNEYS: A SYSTEMATIC LITERATURE REVIEW OF AI-POWERED MARKETING PERSONALIZATION. *International Conference on Sustainable Economy and Business Practices*, 1(1).
- Sarstedt, M., Hair, J. F., Cheah, J.-H., Becker, J.-M., & Ringle, C. M. (2019). How to specify, estimate, and validate higher-order constructs in PLS-SEM. *Australasian Marketing Journal*, 27(3), 197–211. <https://doi.org/10.1016/j.ausmj.2019.05.003>

- Sarstedt, M., Hair, J. F., Cheah, J.-H., Becker, J.-M., & Ringle, C. M. (2019). How to specify, estimate, and validate higher-order constructs in PLS-SEM. *Australasian Marketing Journal*, 27(3), 197–211. <https://doi.org/10.1016/j.ausmj.2019.05.003>
- Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J.-H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: Guidelines for using PLSpredict. *European Journal of Marketing*, 53(11), 2322–2347. <https://doi.org/10.1108/EJM-02-2019-0189>
- Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J.-H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: Guidelines for using PLSpredict. *European Journal of Marketing*, 53(11), 2322–2347. <https://doi.org/10.1108/EJM-02-2019-0189>
- Short, J., Williams, E., & Christie, B. (1976). The social psychology of telecommunications. Wiley.
- Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. Wiley.
- Slater, M. (2009). Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1535), 3549–3557. <https://doi.org/10.1098/rstb.2009.0138>
- Slater, M. (2009). Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1535), 3549–3557. <https://doi.org/10.1098/rstb.2009.0138>
- Suh, K.-S., Kim, H., & Suh, E. K. (2011). What if your avatar looks like you? Dual-congruity perspectives for avatar use. *MIS Quarterly*, 35(3), 711–729. <https://doi.org/10.2307/23042805>
- Suh, K.-S., Kim, H., & Suh, E. K. (2011). What if your avatar looks like you? Dual-congruity perspectives for avatar use. *MIS Quarterly*, 35(3), 711–729. <https://doi.org/10.2307/23042805>
- van Doorn, J., Lemon, K. N., Mittal, V., Nass, S., Pick, D., Pirner, P., & Verhoef, P. C. (2010). Customer engagement behavior: Theoretical foundations and research directions. *Journal of Service Research*, 13(3), 253–266. <https://doi.org/10.1177/1094670510375599>
- van Doorn, J., Lemon, K. N., Mittal, V., Nass, S., Pick, D., Pirner, P., & Verhoef, P. C. (2010). Customer engagement behavior: Theoretical foundations and research directions. *Journal of Service Research*, 13(3), 253–266. <https://doi.org/10.1177/1094670510375599>
- Yee, N., & Bailenson, J. (2007). The Proteus effect: The effect of transformed self-representation on behavior. *Human Communication Research*, 33(3), 271–290. <https://doi.org/10.1111/j.1468-2958.2007.00299.x>
- Yee, N., & Bailenson, J. (2007). The Proteus effect: The effect of transformed self-representation on behavior. *Human Communication Research*, 33(3), 271–290. <https://doi.org/10.1111/j.1468-2958.2007.00299.x>
- Zahran, A. M., & Rolando, B. (2025). UNDERSTANDING THE INFLUENCE OF ONLINE REVIEWS ON BRAND REPUTATION IN THE DIGITAL AGE. *International Journal of Economics And Business Studies*, 2(1), 72–94.