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Article

Future Marketing in Metaverse: How Do Virtual Influencers Impact Customers' Stickiness?

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Abstract: Research on metaverse marketing is gaining increasing scholarly attention, particularly studies examining virtual influencer marketing, which provides a novel perspective and approach to the marketing industry. While the current literature on virtual influencers predominantly focuses on comparing them with human influencers, the present study investigates how virtual influencer characteristics affect user stickiness in the metaverse through the mechanism of multidimensional trust. Grounded in the Stimulus–Organism–Response (SOR) theoretical framework, this study conceptualizes virtual influencer characteristics (physical attractiveness, social attractiveness, and homophily) as stimuli, multidimensional trust (institution-based, characteristics-based, and process-based) as the organism, and user stickiness as the response. A survey of 327 respondents in Ho Chi Minh City, Vietnam, was conducted, and data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). Results demonstrate that physical attractiveness and homophily positively influence all three dimensions of trust, whereas social attractiveness only significantly impacts institution-based trust. All three trust dimensions significantly enhance user stickiness in the metaverse. These findings contribute to the theoretical understanding of virtual influencer marketing within metaverse environments and provide managerial insights for developing effective marketing strategies that leverage virtual influencers to build user trust and promote platform engagement.

Keywords: Metaverse marketing; Virtual influencer characteristics; Multidimensional trust; SOR theory; User stickiness; PLS-SEM

1. Introduction

The rapid advancement of technology has ushered in the era of the metaverse and artificial intelligence, where technological elements have blurred the boundaries between the real and virtual worlds [1]. The metaverse which is a collective virtual space blending augmented reality, virtual reality, and blockchain has shifted from a futuristic concept to an essential marketing ecosystem [2]. As work and life increasingly depend on the Internet, user stickiness defined as the time spent on a network platform during a visit session or a specific period [3] has become a critical metric for understanding user engagement. User stickiness is increasingly regarded as the loyalty of Internet users [4,5], and repeated visits serve as positive indicators of customer engagement [6]. The more users are attached to a platform, the greater the evidence that the platform possesses attractive qualities, functioning as a word-of-mouth mechanism that helps reach broader audiences [3]. Consequently, user stickiness represents an important aspect for exploring and understanding user psychology on the metaverse platform. The metaverse, a

complex and continuously evolving concept [7], has been defined as a massively scaled and interoperable network of real-time 3D virtual worlds in which users can experience synchronously and persistently [8]. The global metaverse market size was valued at approximately USD 155–183 billion in 2025 and is projected to surpass USD 3,000 billion by 2035, expanding at a CAGR exceeding 32% [2,9]. North America currently dominates the market with over 37% share, while the Asia-Pacific region is estimated to expand at the fastest rate [2]. In Vietnam, the potential economic impact of the metaverse by 2035 is estimated at 17 billion dollars per year, equivalent to nearly 2.4% of total GDP [10], indicating significant potential for further exploitation. These market projections are echoed in recent peer-reviewed marketing scholarship, which documents the metaverse's rapid transition from an experimental novelty into a mainstream marketing environment that is reshaping brand–consumer interaction [11].

Virtual influencers who are computer-generated digital characters that influence social media platforms [12] have become a prominent and significant topic in the marketing literature [13]. These digital entities can be fictional characters operated by third parties such as freelancer creators, digital agencies, or brands [14]. Owing to rapid technological advancement, virtual influencers have begun to exhibit human-like characteristics and are being considered as alternatives to human influencers [12]. Their average engagement rate with users is approximately three times higher than that of human influencers [15]. This engagement advantage is further supported by recent peer-reviewed evidence showing that virtual influencers can significantly enhance consumer engagement, particularly when they are designed with more human-like, anthropomorphic characteristics [16]. Recent research has revealed that virtual influencers enable hyper-personalized, cross-platform, and gamified campaigns that foster engagement among diverse audiences [17], and that trustworthiness and authenticity positively influence customer engagement [18]. Moreover, AI-driven virtual influencers create authentic connections with younger demographics by offering tailored content and reinforcing emotional ties [19,20]. In Vietnam, brands have gradually begun using virtual influencers as brand ambassadors, including Viettel's Vi An, Fitty, and E.M.O.I [21,22,23].

Despite growing interest, several research gaps persist. First, most studies on virtual influencers focus on comparing them with human influencers [12,24] without in-depth examination of virtual influencer characteristics within the metaverse context. Recent research by Joel-Edgar et al. [25] has found that brand trust diminishes more significantly when an AI-powered virtual influencer is blamed compared to a human influencer, highlighting the critical importance of understanding trust mechanisms. Second, while trust has been identified as a critical factor in technology adoption [26], no specific study has examined the multidimensional trust framework in metaverse marketing, particularly regarding user trust in virtual influencers. Third, although user stickiness has been studied in various online contexts, research on this topic within the metaverse platform remains limited [27,28]. Fourth, the SOR theory has not been extensively applied to examine how virtual influencer characteristics, as environmental stimuli, affect trust and subsequent user stickiness in the metaverse.

This study aims to: (1) evaluate the impact of virtual influencer characteristics on multidimensional trust and user stickiness in the metaverse; (2) examine how the three dimensions of trust including institution-based, characteristics-based, and process-based affect user stickiness; and (3) investigate strategies marketers can

implement to enhance customer engagement through virtual influencers. The research was conducted in Ho Chi Minh City, Vietnam's most populous city [29] and the region with more than 22 million active social media accounts [30], making it suitable for research on virtual influencer marketing.

2. Literature Review

2.1. Marketing in the Metaverse

Research topics on the metaverse are increasing, and various aspects are being studied more deeply [7]. The metaverse can be defined as a socio-economic immersive cyber-physical ecosystem that shapes interactions based on user values, norms, and common goals [31]. Marketing in the metaverse allows brands to maximize creativity through activities within virtual environments [32], and the growth of the metaverse brings unprecedented opportunities and challenges for marketers [33,34]. Prior research has examined metaverse marketing from multiple angles, including consumer behaviors in virtual environments, consumer experiences before purchase in virtual reality contexts, and gaps in existing research [35]. Studies have covered domains such as branding [36,37], advertising [38,39], and bibliometric analysis of the field [40]. However, no specific study has examined virtual influencer characteristics affecting user trust and stickiness in the metaverse context.

2.2. SOR Theory

The Stimulus–Organism–Response (SOR) model, introduced by Mehrabian and Russell [41], explains and predicts the impact of different environmental stimuli on human cognition, emotion, and behavior. This theory provides a comprehensive framework for understanding customer behavior [42] and has been widely applied in various fields, including studies on user stickiness [43,44,45]. The framework comprises three components: stimulus (S), organism (O), and response (R). A stimulus is an external environmental factor; the organism reflects the psychological transformation mechanism by which users receive stimuli and convert them into information; and the response reflects consumer behavior when reacting to external stimuli [41,46].

In this study, the SOR framework is operationalized as follows. The stimulus is represented by virtual influencer characteristics (physical attractiveness, social attractiveness, and homophily), which serve as external environmental stimuli influencing user beliefs and perceptions. Prior research has demonstrated that virtual idol characteristics function as stimuli [47], and visual stimuli of beauty activate the brain's reward centers, thereby influencing judgment [48]. The organism is represented by multidimensional trust, as multiple studies have identified trust as a cognitive intermediary state mediating the relationship between stimuli and responses [49,50]. The response is user stickiness, which has been extensively studied as an outcome variable [51,52,53].

Importantly, the metaverse setting is not a neutral substitute for conventional social media in this model: it changes the mechanism through which each stimulus operates. Because the metaverse affords synchronous, embodied, and persistent interaction rather than static or asynchronous content exposure [7,8], the stimulus constructs examined here take on metaverse-specific meaning. Physical attractiveness is expressed through a persistent, movable avatar rather than a fixed profile image, so favorable judgments are formed under conditions of avatar embodiment and

continuous visual presence rather than a single static impression. Social attractiveness is enacted through real-time, co-present interaction within a shared virtual space, a form of immersion unavailable on conventional platforms that intensifies the social-presence cues on which this construct depends. Homophily is signaled not only through stated values but through shared participation in the same persistent virtual world, which strengthens the sense of a common environment between user and virtual influencer. Because these stimuli operate through immersion, avatar embodiment, and virtual presence, the organism-level response (trust) and the behavioral response (stickiness) are expected to be more strongly and durably activated in the metaverse than in a conventional social media setting, which is the theoretical basis for treating the metaverse as a distinct boundary condition rather than an interchangeable research setting.

2.3. Virtual Influencer Characteristics

Virtual influencers are characters based on computer-generated images (CGI) that resemble humans in appearance, personality, and behavior [54,55]. They serve as spoke-characters for companies to achieve promotional effectiveness [56]. This study focuses on three characteristics. Physical attractiveness refers to the degree to which one's facial image elicits favorable reactions from others [57], and it is an important factor determining first impressions and subsequent attitudes [47]. Social attractiveness refers to the ability to direct favorable attention to oneself through social skills and behaviors [58,59]. Homophily refers to the degree to which communicating individuals perceive themselves as similar [60], promoting communication and serving as a prerequisite for trust [61,62].

2.4. Multidimensional Trust

Trust is defined as an individual's willingness to take risks to fulfill a need without prior experience or credible information [63,64]. In the metaverse context, trust in new technology must be established before adoption [26,65]. This study employs the three-dimensional trust framework [66,67]: institution-based trust, which concerns individual perceptions of the institutional environment; characteristics-based trust, which reflects the belief that another party has beneficial characteristics; and process-based trust, which is built over time through relationships and repeated interactions.

2.5. User Stickiness

User stickiness refers to the time spent on a network platform during visit sessions or specific time periods [3] and the frequency and duration of website visits, reflecting a platform's ability to attract and retain user attention [68,69]. The two most important aspects of stickiness are duration and frequency [4]. In the metaverse context, enhanced experiences affect follower satisfaction and increase user stickiness intentions [70], and stickiness has been shown to be determined by psychological factors such as positive attitude and trust [71,72].

2.6. Hypothesis Development

2.6.1. Physical Attractiveness and Trust

According to Fiske and Neuberg [73], people have the instinct to form a positive or negative first impression depending on how attractive or likable an individual is. Physical attractiveness is defined as the degree to which one's facial image elicits favorable reactions from others [57]. It is an important factor determining a user's first impression, affecting their attitude and behavior

immediately afterward [47], and influencing personal perceptions of others [74]. People who are physically attractive tend to have stronger socially desirable traits and personalities than those who are less attractive [75]. In advertising, advertisers tend to recruit trustworthy celebrities where physical attractiveness plays a positive role in redirecting customer behavior [76]. People often believe that attractive individuals are more trustworthy [77]. Beautiful things not only create positive images but also activate trust and a sense of safety [78]. Moreover, physical attractiveness has been shown to enhance trust in human interaction [79], and one study confirmed that physical attractiveness, specifically a smile, has a positive impact on customer trust [80]. In the context of marketing in the metaverse, the physical characteristics of virtual influencers are expected to significantly impact user trust, as a virtual influencer with physical appeal reinforces user trust, thereby avoiding the uncanny valley effect. Therefore:

H1a: Physical attractiveness positively impacts institution-based trust.

H1b: Physical attractiveness positively impacts characteristics-based trust.

H1c: Physical attractiveness positively impacts process-based trust.

2.6.2. Social Attractiveness and Trust

Social attractiveness refers to the ability to direct favorable attention to oneself. When a person is respected, chosen, admired, accepted, desired, and sought after by others, this indicates that they hold a high status in the eyes of others [58]. In Yu et al. [47], social attractiveness was shown to enhance fans' desire to communicate and interact with virtual idols, helping fans develop relationships, and this relationship can in turn affect trust formation. Physical and social attractiveness are two aspects of interpersonal attraction [81], and this attraction brings about positive feelings toward others [82]. Social attractiveness is defined as an individual's appeal through social skills and behaviors, including factors such as appearance management, behaviors, and social skills [59]. Multiple studies have confirmed that social attractiveness has an impact on trust [83,84]. In the context of virtual influencer marketing, social attractiveness can be manifested through the behavior, reactions, and actions of virtual influencers toward social issues, which will affect user trust, as virtual influencers with social appeal may lead users to believe that they are reliable and thus place trust in the platform. Therefore:

H2a: Social attractiveness positively impacts institution-based trust.

H2b: Social attractiveness positively impacts characteristics-based trust.

H2c: Social attractiveness positively impacts process-based trust.

2.6.3. Homophily and Trust

Homophily was defined as the degree to which people who interact are similar in beliefs, education, social status, and the like [85]. According to McCROSKEY et al. [60], homophily is the degree to which two communicating individuals perceive themselves as similar, which is considered a cause of communication. Homophily has two dimensions: attitude homophily and background homophily [86]. In the context of this study, attitude homophily is primarily used to understand individual behavior in a social context. Individuals tend to interact more with those who share similarities [62], and when users perceive similarities between themselves and influencers, they are more likely to continue to reinforce emotional bonds. Homophily has been widely studied as a prerequisite for trust [61,62,87,88]. In the relationship between actors and contracts, homophily has been proven to lead to smoother coordination and enhance trust [89]. When users perceive consistency in attitudes and beliefs with virtual

influencers, it reinforces trust and creates a stronger connection with the platform [90]. Therefore:

H3a: Homophily positively impacts institution-based trust.

H3b: Homophily positively impacts characteristics-based trust.

H3c: Homophily positively impacts process-based trust.

2.6.4. Institution-Based Trust and User Stickiness

Institution-based trust is the notion that structural factors such as laws and legislation increase the likelihood of a good result and that the environment is safe to engage with technology [91,92]. This dimension is divided into structural assurance and situational normality [67,93,94]. Structural assurance indicates that mechanisms such as guarantees, regulations, promises, legal remedies, or other procedures are thought to promote success [94]. H. Wang et al. [95] indicated that institution-based trust affects user stickiness, focusing on relying upon an institution or third party to build trust. Additionally, studies on trust affecting user stickiness have examined the antecedents of user stickiness in virtual communities [96]. In the metaverse context, when virtual influencers give users a comfortable feeling, it leads to greater engagement with the platform. Thus:

H4: Institution-based trust positively impacts user stickiness in the metaverse.

2.6.5. Characteristics-Based Trust and User Stickiness

Characteristics-based trust is defined as one's belief that another party has one or more characteristics beneficial to oneself [64]. This dimension includes three characteristics: benevolence, competence, and integrity [64,66,67]. Although not officially mentioned as a composite in previous studies, the individual characteristics of characteristics-based trust have been proven to impact user stickiness: benevolence trust [97,98], competence trust [99,100], and integrity trust [97,99,100]. When virtual influencers in the metaverse meet the criteria of characteristics-based trust, trust will be built, thereby further strengthening stickiness. Thus:

H5: Characteristics-based trust positively impacts user stickiness in the metaverse.

2.6.6. Process-Based Trust and User Stickiness

Process-based trust refers to a general propensity to trust others, which can also influence an individual's beliefs and intentions toward a web-based vendor [92]. Al-Kfairy et al. [93] indicated that process-based trust is the extent to which a person is willing to rely on others in various situations. Process-based trust stresses the need to be receptive to a trustor's demands based on prior successful collaboration and the desire to maintain the connection [66]. H. Wang et al. [95] confirmed that process-based trust affects user stickiness, with two typical levels of interaction: connection and reciprocity. Prior studies have established a strong relationship between trust and user stickiness [101,102]. In the context of virtual influencers in the metaverse, if users develop close relationships with virtual influencers and brands through repeated interactions, this will enhance their continued use and engagement with the platform. Thus:

Figure 1 illustrates the conceptual framework of this study, depicting virtual influencer characteristics (physical attractiveness, social attractiveness, and homophily) as stimuli, the three dimensions of multidimensional trust as the organism, and user stickiness as the response, together with the corresponding hypotheses.

H6: Process-based trust positively impacts user stickiness in the metaverse.

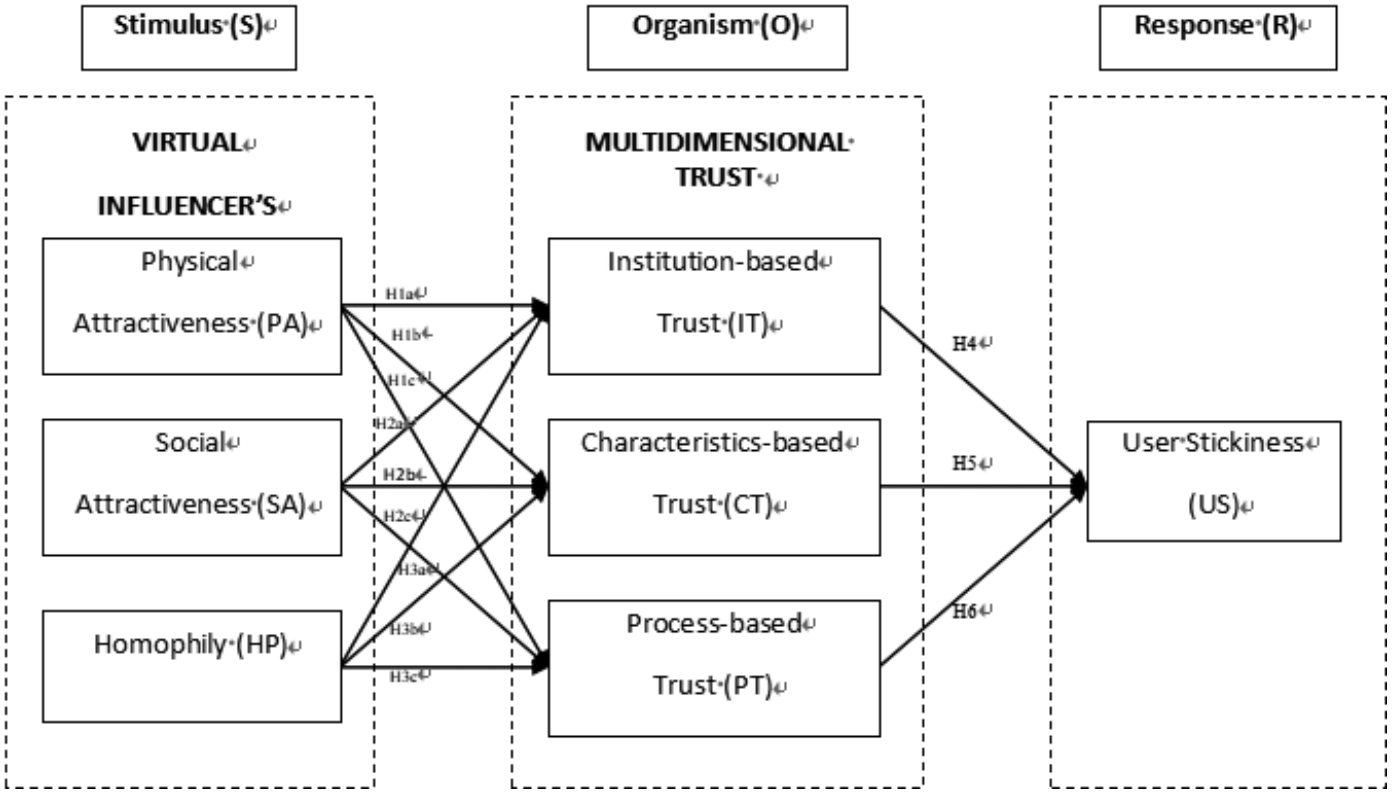

Figure 1. Conceptual framework

3. Research Methodology

This study employs a causal research design with a quantitative approach. A cross-sectional survey was conducted using Google Forms, distributed through social networks to respondents in Ho Chi Minh City, Vietnam. The questionnaire utilized a 7-point Likert scale ranging from strongly disagree (1) to strongly agree (7). Measurement items were adapted from established scales: physical attractiveness and social attractiveness from McCROSKEY et al. [60], homophily from McCroskey et al. [103] and Z. Xu et al. [86], institution-based trust from Al-Kfairy et al. [93] and McKnight et al. [67], characteristics-based trust from McKnight et al. [67], process-based trust from Al-Kfairy et al. [93], and user stickiness from Qu et al. [52].

Non-probability judgmental sampling was employed due to geographical constraints. The minimum sample size was calculated using G*Power software (103 respondents) and an a priori sample size calculator for structural equation models (170 respondents). A total of 327 valid responses were collected, exceeding both minimum thresholds. Data were analyzed using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method, which allows researchers to estimate complex models without imposing distributional assumptions on the data [104].

Regarding respondent screening, participants first indicated their general awareness and prior exposure to virtual influencers before proceeding to the substantive items; the demographic results reported in Section 4.1 (78% aware of virtual influencers, 45.9% following them on social media, 59% reporting basic awareness of virtual influencers within metaverse platforms) reflect this self-reported exposure. The questionnaire did not, however, include a dedicated filter item requiring respondents to name or confirm interaction with a specific metaverse platform before continuing, so it cannot be fully verified whether all respondents were evaluating virtual influencers within an immersive metaverse environment as opposed

to conventional social media contexts in which virtual influencers also appear.

The questionnaire was developed from the established scales cited above and translated into Vietnamese by the research team to match the language of respondents. A separate formal pilot test and back-translation procedure were not conducted prior to the main data collection, and future studies are encouraged to incorporate formal pilot testing, back-translation, and structured item-refinement procedures to further strengthen instrument validity. Before accessing the questionnaire, all participants were provided with information about the study and gave their informed consent electronically through Google Forms. Participation was voluntary, and participants were informed of their right to withdraw at any time without penalty. Confidentiality and privacy were maintained throughout the study, and no identifying information was collected. All participants were aged 18 years or older.

4. Results

4.1. Demographic Profiles

Table 1. Demographic Profiles (N = 327)

Demographic	Category	Frequency	Percentage
Gender	Female	236	72.2%
	Male	91	27.8%
Age	18 - 20 years old	83	25.4%
	21–25 years old	192	58.7%
	26–30 years old	31	9.5%
	> 30 years old	21	6.4%
Job	Students	274	83.8%
	Self-employed	14	4.3%
	Paid employee	31	9.5%
	Professional	8	2.4%

Source: by authors

As shown in **Table 1**, the majority of respondents were female (72.2%) and aged under 25 years (84.2%). Students constituted 83.8% of respondents. Among the participants, 78% were aware of and had basic knowledge of virtual influencers, and 45.9% followed virtual influencers on social media. Regarding understanding of virtual influencers in the metaverse, 59% had basic awareness, with 1.5% self-identifying as experts.

4.2. Common Method Bias

Common method bias (CMB) is an issue arising from survey data collected from a single information provider [105]. The study used a cross-sectional approach to examine the potential risk of CMB [106] combined with statistical methods for analyzing research data [107]. In terms of procedure, informed consent was obtained from all participants prior to data collection, and efforts were made to ensure the anonymity of participants while evaluating their responses in a neutral manner without categorizing them as right or wrong. From a statistical perspective, Harman's single-

factor test was employed. According to Chou et al. [108], the method model includes factor loadings linking the method effect latent variables to substantive indicators. The most significant variable explained by a single component was 29.72%, which fell below the minimum threshold of 50%. This result indicates that CMB was not a concern in this dataset. In addition to this statistical detection method, several procedural remedies recommended by Podsakoff et al. [101] were incorporated into the research design prior to data collection to minimize the risk of CMB. First, respondent anonymity was protected throughout the survey, and no identifying information was requested, which is intended to reduce social desirability bias and evaluation apprehension. Second, participants were explicitly informed that there were no right or wrong answers and that responses would be used solely for academic research purposes, which is intended to reduce respondents' motivation to answer in a manner they perceive as expected or desirable. Third, all constructs were measured using established, validated scales adapted from prior peer-reviewed studies, with items worded as clearly and concisely as possible to reduce item ambiguity, a further source of common method variance. These procedural safeguards, combined with the statistical evidence from Harman's single-factor test, provide converging support that common method bias did not materially affect the study's findings.

4.3. Measurement Model Assessment

Reliability was evaluated using Cronbach's alpha, Dijkstra–Henseler (rho_a), and composite reliability. All values exceeded the 0.7 threshold (minimum values: 0.740, 0.743, and 0.836, respectively), confirming significant reliability across all constructs. Convergent validity was assessed through average variance extracted (AVE), with all seven constructs exceeding the 0.5 threshold, as presented in **Table 2**.

Table 2. Reliability and Convergent Validity

Construct	Items	Loadings	Cronbach's α	rho_a	CR (rho_c)	AVE	VIF
CT	CT1	0.730	0.820	0.827	0.882	0.653	1.436
	CT2	0.850					2.302
	CT3	0.885					2.586
	CT4	0.758					1.516
HP	HP1	0.834	0.834	0.835	0.889	0.668	1.903
	HP2	0.800					1.750
	HP3	0.789					1.762
	HP4	0.845					2.049
IT	IT1	0.785	0.740	0.743	0.836	0.561	1.582
	IT2	0.712					1.411
	IT3	0.751					1.328
	IT4	0.745					1.390
PA	PA2	0.756	0.821	0.828	0.882	0.651	1.647
	PA3	0.806					1.746
	PA4	0.862					2.089
	PA5	0.800					1.816
PT	PT1	0.815	0.830	0.842	0.879	0.594	1.785
	PT2	0.814					1.951
	PT3	0.750					1.617
	PT4	0.755					1.782
	PT5	0.714					1.641

Continuation Table:

Construct	Items	Loadings	Cronbach's α	rho_a	CR (rho_c)	AVE	VIF
SA	SA1	0.796					2.972
	SA2	0.787					2.759
	SA3	0.728	0.843	0.938	0.874	0.581	2.039
	SA4	0.778					2.477
	SA5	0.720					1.115
US	US1	0.802					1.607
	US2	0.908	0.840	0.852	0.904	0.759	2.544
	US3	0.898					2.481

Source: by authors

Multicollinearity among indicators was assessed using the variance inflation factor (VIF). All VIF values ranged from 1.115 (SA5) to 2.972 (SA1), well below the conservative threshold of 3.3 and the conventional threshold of 5, indicating that multicollinearity was not a concern for any construct in the measurement model.

Discriminant validity was assessed using the Fornell–Larcker criterion, cross-loadings, and the Heterotrait-Monotrait (HTMT) ratio. The square root of AVE for each construct exceeded its correlations with other constructs. All cross-loadings showed items loading more strongly on their own constructs, and all HTMT values were below the 0.9 threshold. These results, presented in **Table 3** and **Table 4**, confirmed satisfactory discriminant validity.

Table 3. Fornell-Larcker Criterion

	CT	HP	IT	PA	PT	SA	US
CT	**0.808**						
HP	0.722	**0.817**					
IT	0.666	0.705	**0.749**				
PA	0.695	0.685	0.613	**0.807**			
PT	0.726	0.591	0.605	0.580	**0.771**		
SA	0.521	0.635	0.574	0.542	0.369	**0.762**	
US	0.704	0.563	0.707	0.553	0.668	0.369	**0.871**

Source: by authors

Table 4. HTMT Assessment (< 0.9)

	CT	HP	IT	PA	PT	SA	US
CT							
HP	0.875						
IT	0.848	0.882					
PA	0.841	0.826	0.779				
PT	0.883	0.703	0.746	0.693			

Continuation Table:

	CT	HP	IT	PA	PT	SA	US
SA	0.532	0.623	0.566	0.573	0.343		
US	0.853	0.670	0.890	0.660	0.780	0.354	

Source: by authors

4.4. Structural Model Assessment

The structural model was assessed using a bootstrapping process with 5,000 subsamples and 95% bias-corrected confidence intervals. The results are presented in **Table 5**.

Overall model fit was assessed using the standardized root mean square residual (SRMR), d_ULS, d_G, and the normed fit index (NFI). For the estimated model, SRMR = 0.109, which is above the conventional 0.08 threshold typically applied to confirmatory factor models but within the range commonly observed for more complex, exploratory PLS path models; d_ULS = 5.556 and d_G = 2.151; the chi-square statistic was 3030.826; and NFI = 0.595. Given that SRMR and NFI were developed primarily for covariance-based SEM and tend to be conservative when applied to PLS-SEM, especially with reflective models containing several constructs and Likert-scale indicators, these values are reported for transparency but are interpreted alongside the R^2, Q^2, and f^2 results as the primary evidence of the model's explanatory and predictive adequacy. Consistent with this interpretation, the elevated SRMR and the modest NFI are explicitly acknowledged as a limitation of the present model; accordingly, the robustness of the findings is judged primarily on the reliability, validity, R^2, Q^2, and predictive-relevance results rather than on these covariance-based fit indices alone.

Table 5. Structural Model Results

Hypothesis	Path	β	SD	T	2.5%	97.5%	p	Result
H1a	**PA → IT**	0.210	0.057	3.672	0.099	0.323	0.000	Supported
H1b	**PA → CT**	0.369	0.070	5.285	0.241	0.517	0.000	Supported
H1c	**PA → PT**	0.345	0.077	4.457	0.198	0.499	0.000	Supported
H2a	**SA → IT**	0.174	0.050	3.481	0.087	0.282	0.001	Supported
H2b	**SA → CT**	0.039	0.060	0.651	-0.075	0.158	0.515	***Unsupported***
H2c	**SA → PT**	-0.072	0.056	1.299	-0.179	0.037	0.194	***Unsupported***
H3a	**HP → IT**	0.451	0.060	7.504	0.323	0.555	0.000	Supported
H3b	**HP → CT**	0.444	0.073	6.092	0.293	0.579	0.000	Supported
H3c	**HP → PT**	0.401	0.079	5.102	0.242	0.550	0.000	Supported
H4	**IT → US**	0.376	0.067	5.641	0.241	0.501	0.000	Supported
H5	**CT → US**	0.284	0.067	4.271	0.153	0.417	0.000	Supported
H6	**PT → US**	0.234	0.069	3.385	0.101	0.372	0.001	Supported

Note: β = Original sample; M = Sample mean; SD = Standard deviation; T = T-statistic.
Source: by authors

Of the 12 hypotheses, 10 were supported. Physical attractiveness significantly impacted all three trust dimensions (H1a, H1b, H1c: $p < 0.05$). Social attractiveness only significantly affected institution-based trust (H2a: $p < 0.05$), while its effects on characteristics-based trust (H2b: $p = 0.515$) and process-based trust (H2c: $p = 0.194$) were not significant. Homophily significantly influenced all three trust dimensions (H3a, H3b, H3c: $p < 0.05$). All three trust dimensions significantly affected user stickiness (H4, H5, H6: $p < 0.05$).

4.5. Predictive Relevance and Effect Size

The R^2 values were 0.595 for CT, 0.549 for IT, 0.413 for PT, and 0.622 for US, with corresponding adjusted R^2 values of 0.591, 0.544, 0.407, and 0.618, respectively, indicating moderate explanatory power of the theoretical model. Effect size analysis (f^2) showed that homophily had a medium effect on CT (0.202) and IT (0.183), and a small effect on PT (0.110). Physical attractiveness had a small effect on CT (0.167) and PT (0.107), and a negligible effect on IT (0.054). Social attractiveness had a negligible effect on CT (0.002), IT (0.038), and PT (0.005), consistent with the non-significant paths for H2b and H2c. Institution-based trust had a medium effect on US (0.196), while characteristics-based trust (0.084) and process-based trust (0.065) had small effects on US.

Out-of-sample predictive relevance was assessed using the PLSpredict procedure [103], with RMSE used as the prediction error metric. As shown in **Table 6**, all Q^2predict values exceeded zero (CT = 0.581, IT = 0.534, PT = 0.393, US = 0.351), indicating that the model outperforms the naive mean-based benchmark for all endogenous constructs. As an additional check, the blindfolding procedure (omission distance = 7) yielded Stone–Geisser Q^2 (construct cross-validated redundancy) values that were consistent in direction, with all four endogenous constructs again showing positive predictive relevance (CT = 0.382, IT = 0.293, PT = 0.233, US = 0.464), corroborating the PLSpredict results through a second, independent predictive-relevance criterion.

Table 6. PLSpredict Results and R^2

	R^2	Q^2 predict	RMSE	MAE
CT	0.595	0.581	0.655	0.476
IT	0.549	0.534	0.691	0.526
PT	0.413	0.393	0.787	0.591
US	0.622	0.351	0.815	0.594

Source: by authors

To formally test the mediating role of trust as the organism in the SOR framework, specific indirect effects were examined via bootstrapping. As shown in **Table 7**, seven of the nine indirect paths were statistically significant. Homophily and physical attractiveness showed significant indirect effects on user stickiness through all three trust dimensions (HP→CT→US: β = 0.125, p = 0.001; HP→IT→US: β = 0.166, p < 0.001; HP→PT→US: β = 0.091, p = 0.003; PA→CT→US: β = 0.105, p = 0.001; PA→IT→US: β = 0.083, p = 0.001; PA→PT→US: β = 0.083, p = 0.009), confirming significant indirect effects through the three dimensions of trust for these two constructs. Social attractiveness showed a significant indirect effect only through institution-based trust (SA→IT→US: β = 0.065, p = 0.002), while its indirect effects

through characteristics-based trust (SA→CT→US: β = 0.011, p = 0.512) and process-based trust (SA→PT→US: β = -0.017, p = 0.237) were non-significant. This pattern is consistent with the direct-effect results reported for H2a–H2c and provides formal statistical confirmation that trust mediates the relationship between virtual influencer characteristics and user stickiness, with social attractiveness operating through a narrower institutional pathway than homophily and physical attractiveness.

Table 7. Specific Indirect Effects

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
HP -> PT -> US	0.091	0.091	0.031	2.957	0.003
HP -> IT -> US	0.166	0.164	0.039	4.229	0.000
PA -> PT -> US	0.083	0.085	0.032	2.632	0.009
HP -> CT -> US	0.125	0.125	0.037	3.377	0.001
PA -> IT -> US	0.083	0.083	0.026	3.216	0.001
SA -> PT -> US	-0.017	-0.017	0.014	1.183	0.237
PA -> CT -> US	0.105	0.106	0.032	3.248	0.001
SA -> IT -> US	0.065	0.067	0.021	3.104	0.002
SA -> CT -> US	0.011	0.011	0.017	0.656	0.512

Source: by authors

5. Discussion

This study examines how virtual influencer characteristics influence user stickiness in the metaverse through multidimensional trust. The results show that physical attractiveness significantly affects all three dimensions of trust: institution-based trust (β = 0.210), characteristics-based trust (β = 0.369), and process-based trust (β = 0.345). These findings are consistent with previous research confirming that physical attractiveness is an important signal in quick social judgments, with trust being a primary outcome [78,79,80]. In the metaverse context, physically attractive virtual influencers may therefore find it easier to gain users' trust. The strongest effect was found for characteristics-based trust (β = 0.369), suggesting that attractive appearance may contribute to positive perceptions of benevolence, competence, and honesty. Social attractiveness only significantly affects institution-based trust (β = 0.174), without impacting characteristics-based or process-based trust. This finding suggests that social appeal builds trust in the institutional environment as a safe space for interaction [86], but is insufficient to build trust at the individual level. Previous studies have found the relationship between social attractiveness and general trust [83,84]. The present findings provide a more specific view by showing that this effect differs across trust dimensions. A plausible theoretical explanation for this divergence is that social attractiveness operates as a relatively distal, impression-based cue. It signals that a virtual influencer is generally well-regarded and socially competent, which is sufficient to build confidence in the institutional environment, but does not by itself supply the accumulated evidence of benevolence, competence, or integrity that characteristics-based trust requires, nor the track record of repeated interaction that process-based trust requires. This is consistent with the broader distinction in the trust

literature between institutional, swift forms of trust that can form from limited cues and interpersonal or process-based trust that typically accumulates through direct, repeated interaction [66,67,95]. Homophily and physical attractiveness, in contrast, are experienced more directly and continuously through the avatar itself, which may explain why they extend into the characteristics- and process-based dimensions in a way that social attractiveness does not. Homophily demonstrates the strongest and most comprehensive impact across all three trust dimensions: institution-based trust ($\beta = 0.451$), characteristics-based trust ($\beta = 0.444$), and process-based trust ($\beta = 0.401$). This aligns with research showing that homophily exerts a stronger influence on trust in virtual influencers than other attributes [109]. When users perceive consistency in attitudes, beliefs, and values with virtual influencers, trust is enhanced across all dimensions, creating strong and comprehensive relationships [90]. Regarding the trust–stickiness relationship, all three trust dimensions positively influence user stickiness: institution-based trust ($\beta = 0.376$), characteristics-based trust ($\beta = 0.284$), and process-based trust ($\beta = 0.234$). Institution-based trust, encompassing structural assurance and situational normality, plays the most crucial role, consistent with previous findings [95,110]. This finding is intuitive, as institutional trust in the platform underpins the development of sticky behavior. The findings reaffirm that trust serves as an antecedent and premise for building customer stickiness [71,111].

6. Implications

6.1. Theoretical Implications

This study makes several theoretical contributions. First, it contributes to the literature on metaverse marketing by constructing a theoretical framework using the SOR theory that identifies user stickiness behavior through virtual influencer characteristics, with multidimensional trust as the mediating organism. This framework establishes a novel theoretical relationship between virtual influencer characteristics, multidimensional trust, and user stickiness in the metaverse, a relationship not previously examined in the literature. The novelty of this contribution lies not merely in importing established constructs into a new setting, but in demonstrating that the metaverse's immersive, avatar-embodied, and persistently co-present nature changes how these constructs relate to one another; most notably, that social attractiveness decouples from the deeper, relationally accumulated trust dimensions in a way not consistently observed in conventional social media research, while homophily and physical attractiveness, which are continuously experienced through the avatar itself, extend their influence across all three trust dimensions. Second, the study extends research on virtual influencer characteristics by adapting and integrating findings from studies on virtual idols [47] and spoke-characters [56,112]. Third, it provides a deeper evaluation of trust through three dimensions: institution-based, characteristics-based, and process-based, rather than treating trust as a unidimensional construct, demonstrating that all three positively affect user stickiness when stimulated by virtual influencer characteristics.

6.2. Managerial Implications

The study offers several practical insights. First, because homophily showed the strongest and most comprehensive effect across all three trust dimensions, brands designing virtual influencers for the metaverse should prioritize attitude and value alignment with the target audience over generic appeal; concretely, this can be operationalized by scripting the virtual influencer's stated opinions, interests, and

communication style to mirror the values of the target segment (e.g., sustainability positions for eco-conscious segments, gaming or fandom references for younger users), and by allowing avatar customization or persona variants for different audience clusters rather than deploying a single, one-size-fits-all persona. Second, because physical attractiveness influenced characteristics-based trust most strongly, avatar designers should calibrate visual realism carefully: appearance cues (facial expressiveness, styling, movement fluidity) should be tuned to project competence and benevolence rather than aesthetic appeal alone, while staying short of hyper-realism that risks the uncanny valley effect. Third, because institution-based trust had the strongest effect on stickiness, platform operators and brands should invest in visible structural-assurance signals within the metaverse environment itself; for example, verified-influencer badges, transparent moderation policies, and clear data-handling notices; rather than relying on the virtual influencer's persona alone to carry the burden of building trust. Fourth, because social attractiveness affected only institution-based trust, marketers should not expect likeability-driven content (humor, popularity signals) to translate into deeper relational trust or stickiness on its own; it should be paired with sustained, interactive engagement (e.g., responsive interactions, participation in user-initiated activities) to build the characteristics- and process-based trust that more strongly predict continued platform use. Finally, virtual influencers should be built with engaging brand stories that meet the characteristic requirements identified in this research, and marketers should track trust-dimension-specific metrics (e.g., perceived competence, perceived value alignment) rather than a single aggregate trust score, since the drivers of each dimension differ. These managerial recommendations are, however, derived from a sample composed predominantly of younger student users; brands should therefore validate them against their own broader target demographics before large-scale deployment, as older or non-student metaverse users may respond differently to avatar design, trust cues, and engagement strategies.

7. Limitations and Conclusion

This study has several limitations. First, it was conducted only in Ho Chi Minh City, potentially limiting the generalizability of findings to other regions. Future studies should investigate various regional and cultural contexts. Second, the majority of respondents were students, and different demographic groups may yield different conclusions. Third, the questionnaire did not include a dedicated screening item confirming that respondents had interacted with virtual influencers on an immersive metaverse platform specifically, rather than on conventional social media where virtual influencers also appear; consequently, some responses may reflect experience with virtual influencers outside the metaverse context, and future studies should incorporate explicit platform-verification screening. Fourth, a formal pilot test and back-translation procedure were not conducted for the questionnaire, and future studies should incorporate these steps to further strengthen instrument validity. Fifth, the conceptual model focuses on immersion, avatar embodiment, and virtual presence as the metaverse-specific mechanisms most relevant to the stimulus constructs examined; interoperability across platforms was not incorporated into the model and represents a direction for future research. Sixth, the model's overall goodness-of-fit indices (SRMR = 0.109; NFI = 0.595) fell outside the thresholds conventionally applied in covariance-based structural equation modeling; although these indices are known to be conservative for complex reflective PLS-SEM models containing several

constructs and Likert-scale indicators, they suggest that the overall goodness-of-fit of the model should be interpreted with some caution. Seventh, the cross-sectional design captures only a snapshot of respondents' evaluations; future studies could apply longitudinal data collection to examine how these relationships evolve over time.

In conclusion, this study contributes to understanding how virtual influencer characteristics impact user trust and stickiness in the metaverse. Using the SOR theoretical framework, the results demonstrate that physical attractiveness and homophily affect all three dimensions of trust, while social attractiveness only impacts institution-based trust. All three trust dimensions: institution-based, characteristics-based, and process-based positively influence user stickiness. These findings provide both theoretical foundations for future research and practical guidance for marketers seeking to enhance user engagement through virtual influencers in the metaverse. At the same time, these findings should be interpreted with appropriate caution: because respondents were not explicitly verified as active users of immersive metaverse platforms, and because the sample was dominated by younger student users, the results are best understood as indicative of virtual-influencer engagement within metaverse-type environments broadly defined rather than as fully generalizable to all metaverse users; their managerial implications and external validity should therefore be confirmed across more demographically diverse and platform-verified populations in future research.

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