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Gamifying Human Behavior: How Gamification Drives Consumer Stickiness in E-Commerce

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ABSTRACT

Objective: Despite the growing integration of gamification in digital commerce, its impact on consumer stickiness remains underexplored, particularly in emerging markets. This study develops and empirically tests a framework examining how specific gamification elements in e-commerce platforms—badge upgrades, random rewards, and gamified design—affect consumer stickiness through perceived value (hedonic and utilitarian) and social interaction. The research aims to clarify the mechanisms through which gamification enhances customer loyalty and continued platform engagement in the Vietnamese context.

Methods: A questionnaire-based survey was conducted with 310 consumers who had participated in gamified activities on e-commerce platforms in Vietnam. The study integrates Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine linear relationships and Artificial Neural Networks (ANN) to capture nonlinear interactions within the proposed model. This dual-stage analytical approach enhances the robustness and predictive power of the findings.

Results: The findings show that gamified design and badge upgrades positively influence both perceived hedonic and utilitarian values, while random rewards significantly affect perceived hedonic value only. Social interaction is significantly influenced by gamified design but not by badge upgrades or random rewards. Perceived value and social interaction, in turn, contribute to consumer stickiness on e-commerce platforms.

Conclusion: The study confirms that different gamification elements generate distinct effects on consumer perceptions and stickiness. By highlighting the mediating roles of hedonic and utilitarian values as well as social interaction, the research contributes to the literature on smart e-commerce and gamification. The findings suggest that businesses should strategically design gamification features that simultaneously enhance functional benefits and experiential enjoyment to strengthen long-term customer retention on digital platforms.

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1. Introduction

Technological innovations throughout the 4.0 Industrial Revolution have enhanced efficiency and convenience (Mariano et al., 2022; T. Zhang et al., 2019). Customers generally like shopping via applications on mobile smartphones since technology enhances accessibility (Murdiana, 2020). E-commerce is notably one of the industrial sectors most affected by the emergence of digital platforms (Ballerini et al., 2024). According to Statista, Vietnam's e-commerce market is growing tremendously, with around 60 million users and producing over 20.5 billion dollars in revenue in 2023 (Anh, 2023). Vietnam's weekly online shopping penetration rate surpasses 60%, contrasting with the global average of 57.6% (Huong, 2023). The flourishing e-commerce business has increased rivalry in the online retail sector (Mariano et al., 2022). Competitors in the realm of e-commerce are merely a few mice clicks distant (Aparicio et al., 2021). This digital shift drives intense competition: customers can easily switch between platforms, compare bargains, and enjoy frequent promotions. As a result, e-commerce firms must continually innovate to attract attention and sales in a crowded marketplace.

Despite booming sales, e-commerce firms face a persistent retention problem: users visit and buy but often fail to become sticky or loyal customers. “Stickiness” (frequent repeat visits and prolonged engagement) is crucial because sticky customers contribute more to the bottom line (Friedrich et al., 2019). In Southeast Asia, for example, the average e-commerce platform retains far less than one in four customers (Dey, 2023). Consumers cannot enhance sales despite the plethora of products on e-commerce platforms (Mu & Zhang, 2021), suggesting many shoppers remain disengaged and unloyal. This gap between high adoption and low stickiness creates a central problem: how to turn casual visitors into regularly returning buyers in e-commerce platforms. Research shows that customer stickiness drives loyalty, favorable word-of-mouth, and higher sales, but maintaining it is difficult amid constant new offerings and “one-click” alternatives.

E-commerce platforms continue to strive for increased customer engagement through innovative features, such as quizzes and games, known as gamification (Lacap et al., 2023). The effectiveness of gamified marketing strategies in enhancing sales, as evidenced by Bauer et al., (2020), has firmly established gamification as a powerful marketing tool (Zhang et al., 2025). The rapid advancement of gamification in e-commerce is evident, as it increases user stickiness on platforms, draws active participants, and facilitates social interaction via games and redeemable purchasing vouchers (Yu & Huang, 2022). Implemented gamification tactics can serve as a potent instrument for e-commerce enterprises to augment customer stickiness, bolster loyalty and stickiness, and cultivate more fun and rewarding buying experiences (Lopes et al., 2023). By enhancing the shopping experience with gamification, managers, and retailers can promote greater engagement, elevate transaction value, and cultivate a more favorable brand association.

Despite the growing popularity of gamification, its adoption is often constrained by high development costs and underestimated resource needs. Implementing gamification requires substantial investment in design, development, and integration, which are frequently undervalued, leading to cost overruns (Herzig et al., 2015; Karimi & Nickpayam, 2017). Maintenance and sustained user engagement also demand continuous funding, often overlooked during planning (Koivisto & Hamari, 2019). The absence of adequate infrastructure and data architecture further delays implementation. Industry reports estimate that developing a basic gamified e-commerce app costs $35,000–$40,000, while advanced multi-platform solutions can reach $80,000, excluding creative design and multimedia integration (Capermint, 2023). These factors highlight the need for strategic resource allocation before deployment.

Beyond financial barriers, gamification carries psychological and ethical risks. Variable reward systems resembling gambling can trigger addictive behaviors through dopamine-driven feedback loops (Denis Hure, 2024). Excessive reliance on external rewards may undermine intrinsic motivation—the over justification effect—reducing genuine engagement (Eszter et al., 2024). Competitive features like leaderboards can foster stress and low self-esteem among weaker users (Rajanen & Rajanen, 2017). Moreover, manipulative feedback mechanisms may lead to overexertion or ethical issues, including workplace strain (Srivastava et al., 2023). Poorly designed gamification can also cause boredom, fatigue, and disengagement (Eszter et al., 2024). Finally, accessibility and inclusivity challenges arise when designs neglect neurodiverse or disabled users. In e-commerce, repetitive incentives have been shown to reduce long-term engagement, requiring continual innovation to sustain user interest (Manisha, 2025).

Over the years, research pertaining to gamification in marketing has bloomedat an exponential pace (Gupta et al., 2024). Gamification has gained research attention in workplace and social media contexts (Alcivar & Abad, 2016; Landers et al., 2017), yet its application in e-commerce remains underexplored. A systematic review by Koivisto & Hamari (2019) found that only 2.9% of gamification studies focus on e-commerce. Most existing research emphasizes purchasing behavior (Tai & Tu, 2023), neglecting broader aspects like customer stickiness—an essential factor linked to website quality, perceived value, and long-term loyalty (Malmiri et al., 2022; M. Chen et al., 2019). Few studies examine how specific gamified elements (e.g., badges, rewards) influence sustained engagement through psychological mechanisms. Additionally, Prior research on e-shopping has shown that both hedonic and utilitarian values strongly affect satisfaction and repurchase intention (Cuong, 2025), but it remains unclear how gamification shifts those values in practice. Similarly, social interaction via games is known to matter in online communities (Zhang et al., 2025), but its role in an e-commerce app's stickiness is underexplored. This gap is especially critical in emerging markets like Vietnam, where e-commerce rapidly expands but research lags. By 2024, e-commerce makes up nearly two-thirds of Vietnam's digital economy, driven by tech-savvy Gen Z users—who represent over 43% of online shoppers and are highly engaged with mobile and social media (Vu, 2024). Gaming is deeply ingrained in local culture, marked by competitive, collectivist play styles that align well with gamified strategies. Additionally, Vietnamese youth use digital platforms not just for shopping but also for social connection and status-building, accelerating the adoption of gamified features through peer influence (McCauley et al., 2020).

This study in Vietnam aims to fill existing gaps by providing a comprehensive understanding of how gamification influences various aspects of customer behavior beyond purchasing. While linear relationships can be captured through SEM, such models are insufficient for predicting complex decision-making. To overcome this, the study employs a hybrid SEM-ANN approach, combining the strengths of both linear (SEM) and nonlinear (ANN) analyses to model compensatory and non-compensatory interactions (Al-Emran et al., 2021).Grounded in the Stimulus–Organism–Response (S-O-R) framework, this study investigates how gamification elements—badge upgrades, random rewards, and gamified design—affect customer stickiness in e-commerce, mediated by perceived hedonic value, utilitarian value, and social interaction. It examines the interrelationships among these perceptions and their contributions to stickiness, providing deeper insight into user cognition and affect when engaging with gamified platforms.

Theoretically, this research advances gamification knowledge by clarifying how functional, emotional, and social motivations drive long-term attachment to e-commerce platforms. Methodologically, it demonstrates the utility of integrating SEM and ANN for capturing both linear and nonlinear dynamics. Practically, the findings offer actionable guidance for marketers and managers, emphasizing that enhancing customer stickiness through gamification can improve brand connection, transaction value, and long-term profitability. Understanding the link between gamification and loyalty enables e-commerce firms to design more effective marketing and engagement strategies, thereby fostering stronger customer relationships and sustainable competitive advantage.

2. Literature Review and Hypotheses Development

2.1. Stimulus – Organism - Response (SOR) theory

In 1974, psychologists Mehrabian and Russell proposed the SOR theory, representing the "stimulus - organism - response" framework, as an innovative theoretical model for customer behavior (Mehrabian & Russell, 1974). The paradigm posits that external circumstances provoke distinct cognitive or emotional responses, leading to subsequent changes in consumer behavior (Jacoby, 2002). "Stimuli" refers to environmental signals or social contexts that might provoke psychological and behavioral responses or alterations in persons (Eroglu et al., 2003). This study regarded gamification features, including badge upgrades and random prizes, as stimuli in the gamification design. Prior studies have thoroughly examined the application of these elements as stimuli (Doğan-Südaş et al., 2023; C.-L. Hsu, 2022; Rakhmanita et al., 2023; Tai & Tu, 2023). "Organism" is an internal decision-making process that mediates a stimulus and a reaction. In this study, perceived utilitarian value, perceived hedonic value, and social interaction were considered as organisms. Previous research has extensively examined the utilization of these elements in organisms (Guo & Li, 2022; Shang et al., 2023; Shao et al., 2019; Shiu et al., 2023; Song et al., 2022). In the Stimulus-Organism-Response (SOR) theory, "Response" denotes the behavioral reaction or action executed by an individual because of stimuli and the internal emotional or cognitive processes elicited by those stimuli (T. K. Leong et al., 2022; Mishra et al., 2022; C. C. Tan, 2020). The Stimulus-Organism-Response model, a leading theory for analyzing consumer behavior, has been utilized in research on both commercial retail and internet shopping (Chiles & McMackin, 1996; Guo et al., 2021; Lin & Shen, 2023).

The Stimulus-Organism-Response (S-O-R) model posits that external cues trigger internal psychological states, which in turn drive behavior (Hochreiter et al., 2023). In the context of this study, gamification elements serve as stimuli that shape users' perceptions and emotions, whereas perceived utilitarian value, hedonic value, and social interaction capture the organism stage (internal response). Empirical studies confirm that these values strongly influence outcomes like satisfaction, engagement and loyalty (Evelina et al., 2020; Yusnara & Soepatini, 2023). For example, utilitarian value reflects consumers' rational assessment of practical benefits (leading to objective decision-making), while hedonic value captures enjoyment or pleasure from the experience (G. Zhang et al., 2025). Social value (or interaction) represents the sense of community and recognition users gain, satisfying desires for social connectedness or pride (Evelina et al., 2020; G. Zhang et al., 2025). Thus, these constructs logically map onto the S-O-R "organism" stage as the mediating cognitive/affective states between gamified stimuli and user responses.

In contrast, alternative theories emphasize different user motivations and processes. Uses and Gratifications (U&G) theory holds that consumers actively select media and content to fulfill needs like information, entertainment or social integration (Gogan et al., 2018; Gupta et al., 2024). TAM (Technology Acceptance Model) focuses on perceptions of usefulness and ease of use as determinants of technology adoption (Afiq & Junaini, 2025). Flow Theory, introduced by Csikszentmihalyi in 1975, describes an optimal state of full immersion and intrinsic enjoyment in an activity (Gogan et al., 2018), or a gratifying state of deep involvement and absorption that individuals experience when engaging in a challenging task and perceive themselves as capable of handling it (Peifer et al., 2022). Each lens highlights distinct aspects: U&G emphasizes goal-driven motivations, TAM highlights cognitive beliefs about technology, and Flow emphasizes immersive enjoyment. By comparison, the S-O-R framework uniquely underscores emotional and cognitive reactions to the environment as key mediators of behavior (Sugiarto et al., 2022). In gamified e-commerce, S-O-R is especially apt because it explicitly links specific game features (stimuli) to internal values (organism) and then to outcomes (response). By comparison, the S-O-R framework uniquely underscores emotional and cognitive reactions to the environment as key mediators of behavior. In gamified e-commerce, S-O-R is especially apt because it explicitly links specific game features (stimuli) to internal values (organism) and then to outcomes (response). For example, recent studies find that exposing users to gamification significantly raises perceived social and utilitarian values, which in turn boost attitudes and continued use (Evelina et al., 2020; Yusnara & Soepatini, 2023b). This chain of effect is naturally captured by S-O-R; other models like TAM or U&G could be adapted, but they would not focus as directly on the emotional "organism" processes that mediate stimulus-to-response links in interactive, gamified settings.

2.2. Gamification in the e-commerce industry

E-commerce businesses strive to create a memorable online buying experience (CustomerGlu, 2023). One emerging approach to achieve this is gamification—a popular marketing technique that captivates users, incentivizes actions, and addresses various challenges by deliberately integrating game elements into non-gaming contexts (Deterding et al., 2011; Wrona, 2012; Hewapathirana & Caldera, 2023). The term "gamification" was first introduced in academic literature in 2010 and is defined as "the use of game mechanics and dynamics in computer systems to alter user behavior" (Gupta et al., 2024). These mechanics—such as incentives, levels, challenges, and rewards—are applied in real-world environments to enhance user engagement, influence purchasing behavior, and solve marketing or operational issues (AlSaad & Durugbo, 2021).

As a result, gamification has seen rapid adoption across the e-commerce landscape. Leading platforms such as Shopee, Lazada, Taobao and Pinduoduo have successfully embedded gamified features throughout the customer journey, thereby reshaping how users interact with digital marketplaces (Bulu, 2024). In this context, one of gamification's most notable benefits is its ability to stimulate customer participation (Meylina, 2025). By transforming routine transactions into interactive experiences, gamification not only drives higher transaction volumes (Prihastomo et al., 2018) but also boosts customer engagement, retention, and acquisition (Salim & Kim, 2023).

2.3. Customer stickiness

In a business setting, customer stickiness denotes the extent of loyalty and attachment clients exhibit towards a specific platform or brand, affecting their propensity to remain engaged and make repeat purchases (M. Chen et al., 2019; He et al., 2020). It denotes the probability that a consumer will persist in selecting a particular product or service over alternatives (Friedlander, 2022; Rana, 2024; Riserbato, 2023). Zhou et al. (2024) characterized "stickiness" as a website or online platform's capacity to attract and retain clients by promoting prolonged engagement and encouraging visitors to remain on the site for extended durations. In e-commerce, stickiness denotes consumers' recurrent visits, extended browsing durations, and ease of use on a platform, propelled by contentment and trust, which affect their propensity to return and interact (Bahtar et al., 2022). Comprehending and enhancing consumer stickiness can result in improved retention, heightened sales, and sustained business expansion within the competitive e-commerce sector.

2.4. Hypotheses development

2.4.1 Gamification elements and perceived values

Gamification services can provoke psychological responses, resulting in favorable behavioral outcomes such as positive views, purchasing or repurchasing behavior, and heightened engagement with the brand experience (Balakrishnan & Griffiths, 2018; Helmefalk & Marcusson, 2019). Nonetheless, customers may lack adequate motivation from gamification unless it produces perceived value. Consequently, to effectively enhance consumer engagement and involvement, gamified mobile applications must generate perceived value (i.e., utilitarian or hedonic elements) (Doğan-Südaş et al., 2023).

Badges are among gamification research's most often examined components (Hamari et al., 2014). Obtaining badge upgrades is a gameplay feature that enhances players' feelings of achievement and rivalry (L. Zhang et al., 2021). Aparicio et al. (2021) assert that when clients attain a certain level of achievement, they experience a rise in status and receive an upgraded badge as a reward. The enhancement of badges in gamification has consistently demonstrated a favorable effect on perceived value across diverse contexts, including e-learning (Dicheva et al., 2020; Sitra et al., 2017), healthcare (Ahmed Nagaty, 2023), retail (Basaran, 2022), e-commerce (H. Chen et al., 2023; Tai & Tu, 2023), and gamified mobile applications (Doğan-Südaş et al., 2023).

Furthermore, these badges can substantially affect individuals' utilitarian judgments in a gamified online buying environment (Tai & Tu, 2023; Wu & Santana, 2022). Moreover, gamification badges can be linked to incentives such as discounts, which directly encourage users to purchase (Ptolemay LLC, 2023). Badge upgrading, which allows users to elevate their badges, can augment the perceived utilitarian value of the platform for consumers (C. L. Hsu & Chen, 2018a). When badges are linked to concrete incentives such as discounts or special offers, they significantly enhance their efficacy in influencing user behavior. Customers recognize enhanced utilitarian value in acquiring badges that confer tangible advantages, such as discounts on subsequent purchases (Kinga, 2023; Teslenko, 2019). The ability to earn and exchange badges for monetary value creates a definitive objective for users, increasing their engagement with the network. As a result, the study hypothesizes that:

H1a: Badges upgrade positively impacts perceived hedonic values

H1b: Badges upgrade positively impact perceived utilitarian values

Random rewards are a key gamification mechanism that enhances consumers' perceived enjoyment in online shopping (Hassan et al., 2019; Hwang & Choi, 2020). Typically offered through game cards or similar systems with uncertain outcomes, these rewards increase users' sense of fun and engagement (H. H. Nguyen et al., 2023; Pradhana et al., 2022). They also sustain players' long-term interest and enjoyment (Easley & Ghosh, 2016). In e-commerce contexts, random rewards significantly enhance perceived enjoyment and immersion, improving users' overall evaluation of marketing activities (P. Yang et al., 2018).

Gamified e-commerce platforms often provide coins, vouchers, discounts, or free shipping, serving as financial incentives that enrich the shopping experience (Hwang & Choi, 2020). Such rewards elevate perceived utilitarian value and encourage continued platform use (Yue & Cho, 2022). Prior studies confirm that gamification rewards boost user engagement (Kartevoll, 2017; Putra Rahmadhan et al., 2023) and foster positive emotional responses when paired with incentives like virtual currency (Jones et al., 2014; L. Zhang et al., 2021). Therefore, the following hypothesis is proposed:

H2a: Random reward positively impacts perceived hedonic values

H2b: Random reward positively impacts perceived utilitarian values

The elements of gamified design, such as visually appealing graphics, sound effects, and interactive storytelling, can elicit specific emotions in players, which can then be leveraged to motivate desired behavioral responses (Mullins & Sabherwal, 2018). A significant component of the gamified design that can elicit the consumer's hedonic value has been identified as fun (Petkus, 2004; Smilansky, 2017). According to (Fiore et al., 2005), (Kaur et al., 2023) and (Kaur et al., 2023), incorporating entertaining and immersive elements like interactive storytelling, engaging gameplay mechanics, and audiovisual effects enhances the player's enjoyment and emotional experience, providing hedonic value beyond just functional value

The utilitarian value of gamified platforms lies in their ability to enhance the user experience. Gamification influences consumer behavior by incorporating game-design elements to motivate users toward specific goals (Huseynov, 2020). Gamified elements can make the e-commerce platform more intuitive and user-friendly, improving customer utilitarian value (Aparicio et al., 2019). Well-designed gamification enhances the usability of the platform. Besides that, gamified design elements can increase the perceived usefulness of the e-commerce platform by making the shopping experience more engaging and rewarding for customers. This utilitarian benefit keeps customers returning to the site (Aparicio et al., 2019). Thus, in line with these arguments and extant literature, we hypothesize the following:

H3a: Gamified design positively impacts perceived hedonic values

H3b: Gamified design positively impacts perceived utilitarian values

2.4.2 Gamification elements and social interaction

Humans have been playing games for thousands of years. Games are among the oldest forms of social interaction (Huseynov, 2020). Prior research suggest that gamification can effectively motivate individuals to engage in more social interactions (Robinson et al., 2019; Simões-Silva et al., 2021; Valantiejienė & Girdauskienė, 2021; Xu et al., 2023). By incorporating gamification elements, such as reward systems and game-like elements, consumers can be encouraged to participate in social behaviors and increase their engagement (Hamari & Koivisto, 2013; Rodrigues et al., 2016).

Badge upgrade in gamification refers to digital badges as virtual rewards for completing tasks (Dyer et al., 2023). Consequently, community members who utilize gamification increase their social interaction to attain superior results (Hamari & Koivisto, 2015b, 2015a; Sailer et al., 2017). In gamification, badge upgrades can foster competition, provide feedback, and guide users in understanding their energy consumption patterns, leading to behavior change and increased energy literacy (Cravinho et al., 2022). The positive relationships between badge upgrading and social reactions are empirically tested (Hamari et al., 2014; Hamari & Koivisto, 2013). Additionally, badge upgrading and rewards are key elements that motivate individuals to actively participate in social interactions on e-commerce platforms (Shao et al., 2019; Tien Minh et al., 2023).

H1c: Badges upgrade positively impacts social interaction

By offering rewards, gamification encourages consumer engagement and facilitates collaboration among online users, fostering the exchange of ideas (Rodrigues et al., 2016; Simões et al., 2013). The new gamification system enhances the expectation of rewards, which in turn enhances social interaction and positively impacts the psychological emotions of the consumer (Johnson et al., 2017; Suh et al., 2017). Consequently, this fosters a sense of community within the gaming environment, leading to increased participation (Mamedov & Korkiya, 2023). The implementation of random rewards in gamification has a profound impact on social interactions among users, as observed in studies conducted by (Alves et al., 2020; Yin & Xiao, 2022). Such rewards contribute to developing a strong community spirit and encourage sustained participation. Furthermore, Hamari and Koivisto (2013) indicate that incorporating game-like features, including reward-giving, can stimulate social behaviors.

H2c: Random reward positively impacts social interaction

The gamified design has been shown to enhance social interaction within gamification contexts (Kaur et al., 2023; Liu & Tanaka, 2020b; Lugmayr et al., 2017; Lundqvist et al., 2013). They foster feelings of social relatedness and shared goals among players (Gaonkar et al., 2022). The impact of gamified design on social interaction is twofold, as it focuses on competitive and non-competitive user interactions within a gamified system, enhancing user engagement and overall experience (Liu & Tanaka, 2020a). Through the games, users want to maintain a social connection and engage with the members of their game association. Implementing appropriate gamified design is crucial in shaping social interactions within e-commerce platforms (A. Chen et al., 2016; Kaur et al., 2023; Lundqvist et al., 2013). In sum, the present study stipulates that:

H3c: Gamified design positively impacts social interaction

2.4.3 Perceived values and customer stickiness to e-commerce platforms

What accounts for the prominence of gamification in e-commerce application development? The solution resides in the intriguing psychology of gamification. Gamification leverages the intrinsic human need for competition, accomplishment, and reward. Users are more inclined to return when they see a sense of achievement (Ptolemay LLC, 2023). Gamification is a novel approach to shaping user behavior, as it merges hedonic and utilitarian values inside a gaming-like experience that fosters a sense of flow, mastery, and autonomy (Hamari & Koivisto, 2015a). The hedonic elements derive from the audiovisual material that offers pleasure, while the utilitarian value stems from the gamified loyalty program's economic incentives and productivity-boosting attributes (Kusumawardani et al., 2023). Users who perceive elevated levels of both utilitarian and hedonic value experience increased satisfaction and a heightened intention to purchase via social commerce platforms (Gan & Wang, 2017).

Ryan and Deci (2000) established a connection between gaming experience and hedonic shopping incentives. For instance, when systems produce hedonic value via user delight, the motivation to engage with them arises directly from the engagement with the system (van der Heijden, 2004). Consequently, while hedonic value is inherently motivating, it will influence the intention to participate in similar future activities (Högberg et al., 2019). Previous research indicates that utilitarian values substantially affect customer behavior in e-commerce (Avcilar & Ozsoy, 2015; Evelina et al., 2020; Gan & Wang, 2017; Purwianti & Jeslyn, 2021; Zainurrafiqi et al., 2021). The higher the utilitarian value consumers derive from the enjoyment and enjoyable experience of e-commerce, the greater their satisfaction will be (Gan & Wang, 2017). The results indicate that the practical advantages and capabilities provided by e-commerce platforms significantly influence client loyalty. From this logic, the present study stipulates that:

H4: Perceived hedonic values positively impact stickiness to an e-commerce platform

H5: Perceived utilitarian values positively impact stickiness to an e-commerce platform

2.4.4 Social interaction and customer stickiness to e-commerce platforms

Within gamification, several functionalities—such as chat, voice communication, emotes, gestures, avatars, teams, guilds, friendships, leaderboards, ratings, reviews, and communal spaces—can enhance social interaction and collaboration among players. These features accommodate various participants, promoting cooperation, learning, and community, enhancing engagement, enjoyment, and loyalty.

Social connection is acknowledged as a crucial element that enhances customers' decision-making processes and creates an engaging experience (Shiu et al., 2023; Valerio et al., 2019). In the field of online commerce, social contact serves as a vital prelude to shaping consumers' behavioral intentions (S. Hu & Zhu, 2022; Wang & Yu, 2017b; Q. Yang et al., 2023). Furthermore, the study by Sailer and Homner (2020) demonstrated that the integration of competition and collaboration in gamification positively influences motivational outcomes, underscoring the importance of social dynamics in gamified settings. Social interactions in e-commerce enhance customer engagement through gamification (Banerjee & Bhattacharya, 2022). The following hypothesis is proposed:

H6: Social interaction positively impacts stickiness to an e-commerce platform

The research model based on the above-discussed hypotheses is presented in Figure 1.

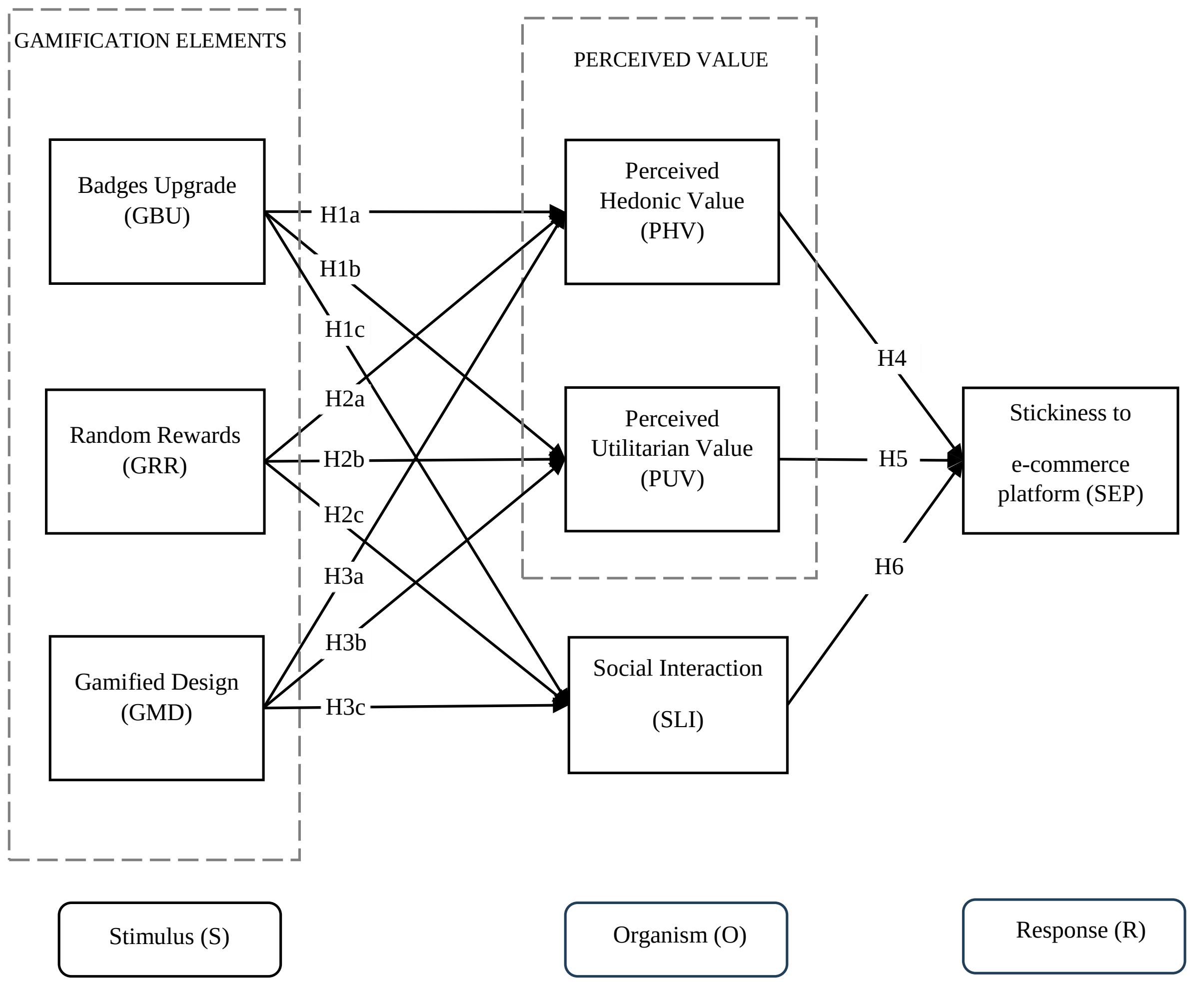

Figure 1. Conceptual model (by authors)

3. Methodology

3.1 Sampling method and sample size

A non-probability judgmental sampling method was applied to recruit participants with relevant experience using gamified e-commerce platforms, consistent with B. H. T. Nguyen et al. (2023) and Nguyen et al. (2023). This approach was chosen because such specific experiential knowledge is difficult to capture through random sampling. As noted by Etikan et al. (2016), judgmental sampling is appropriate when researchers seek insights from informed populations. The study acknowledges the limitation of restricted generalizability. Ethical standards were strictly followed. The study received approval from the Scientific Group, Faculty of Business Administration, HUFLIT (Approval No. 04/2025-ESG). Informed consent was obtained through a mobile-based survey, with participants assured of voluntary participation, confidentiality, and anonymity.

This study focuses on Vietnamese Gen Z because they represent the largest and most digitally active consumer segment driving the rapid expansion of e-commerce and gamification in emerging markets. According to Vu (2024), Gen Z accounts for more than 43% of Vietnam's online shoppers, exhibiting strong mobile dependence and a preference for interactive and reward-based applications. Moreover, Gen Z consumers are highly responsive to social and hedonic stimuli, aligning with gamified systems that integrate play, competition, and peer interaction (Przybylski et al., 2010; Hwang & Choi, 2020). From a cultural psychology perspective, Vietnamese Gen Z combines collectivist orientations—typical of high-context Asian societies—with rising individualist digital lifestyles (Hofstede Insights, 2023; Triandis, 1995). Such duality makes them particularly sensitive to both community-based and achievement-oriented gamification elements. Therefore, they offer an ideal context to explore how gamified e-commerce platforms stimulate enjoyment, social connection, and utilitarian motivation. Although the findings may not be directly generalizable to other cultural settings, they provide an important empirical foundation for cross-cultural comparisons, particularly between collectivist (e.g., Vietnam, China) and individualist (e.g., the United States, United Kingdom) markets. Besides, Eligible respondents were Vietnamese Gen Z citizens aged 18 or above who had prior experience shopping on gamified e-commerce platforms. Recruitment was conducted via online forums, social media groups (e.g., Shopee, Lazada, Tiki), and university networks. A screening question verified participants' previous exposure to gamified e-commerce environments.

In terms of minimum sample size, Sloper, the ten-time rule, and G*Power version 4 statistical software were used for this investigation. The PLS literature's "10-time rule" states that the minimum sample size should be ten times the research model's most complex relationship (Hair et al., 2017). The study required 80 replies to meet this condition. The researchers calculated the required sample size using G-Power version 4 with 12 predictors, 0.9 statistical power, 0.05 margin of error, and 0.15 effect sizes. The data suggest that 157 is a sufficient sample size. Last, the Sloper calculation approach recommends a minimum sample size of 89 for the following conditions: predicted effect size = 0.15, desired statistical power level = 0.8, 6 latent variables, 29 observable variables, and 0.05 probability level. After surveying, this study collected 310 samples that match the criteria for further analysis, exceeding the minimum sample size

3.2 Questionnaire design and method

The sample accurately reflected the target population. A mobile-based survey was used to examine factors influencing customer stickiness to gamified e-commerce platforms. Measurement items were adapted from prior studies and rated on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree), consistent with previous consumer behavior research (A.-H. D. Nguyen et al., 2024; L.-T. Nguyen et al., 2024). A hybrid PLS-ANN approach was applied to capture both linear and nonlinear relationships. While PLS-SEM effectively tests hypotheses with small samples, its capacity for nonlinear modeling is limited (Nguyen et al., 2022). ANN compensates for this by identifying complex nonlinear patterns (Sahrom et al., 2018). Combining both methods improves analytical robustness and prediction accuracy (Kulal et al., 2022; Lim et al., 2022). ANN also offers fault tolerance, adaptive learning, and real-time predictive capabilities, allowing valid estimation even without predefined hypotheses (Leong et al., 2020).

3.3 Common method bias (CMB)

Collecting data for both exogenous and endogenous variables from a single source may increase the risk of common method bias (CMB). To address this concern, the authors employed both procedural and statistical remedies (L. Y. Leong et al., 2018) within a cross-sectional design (Foo et al., 2018; N.-T. T. Nguyen et al., 2024). Participants were informed in advance about the study's confidentiality and anonymity policies, and the survey contained no right or wrong answers, encouraging honest and unbiased responses (Lai & Hitchcock, 2017). Statistically, Harman's single-factor test indicated that the Kaiser-Meyer-Olkin value of 0.945 exceeded the 0.5 threshold, while a single factor explained 27.503% of total variance, below the 50% cut-off (L.-Y. Leong et al., 2019; L.-T. Nguyen et al., 2025; Dang, L.-T. Nguyen, et al., 2025). Hence, CMB was not a significant issue in this dataset.

4. Results

4.1 Respondent profile

Table 1 shows an equal gender distribution, with females accounting for 50.32% and males 49.68% of respondents. Most participants were aged 18–25 (40%), followed by 26–35 (31.94%) and 35–45 (28.06%). Over half (52.9%) had used e-commerce platforms for 1–4 years, while 40% had more than 4 years of experience. Daily usage varied, with 44.3% spending under 1 hour, 48.71% spending 1–3 hours, and 9.68% over 3 hours. Monthly spending ranged from below VND 1,000,000 (28.06%) to VND 1,000,000–3,000,000 (36.13%) and above VND 7,000,000 (9.68%). Shopee was the most popular platform (92.58%), followed by Lazada (45.16%), Tiki (26.45%), and others (13.22%). Regarding game types, all-day games were most favored (77.10%), followed by time-sensitive (68.71%) and seasonal games (36.45%).

Table 1. Demographic profile

Demographic characteristic		**Frequency**	**Percentage**
Gender	Female	156	50.32%
	Male	154	49.68%
Age	18 – 25 years old	124	40.00%
	26 – 35 years old	99	31.94%
	35 – 45 years old	87	28.06%
Experiences with e-commerce platforms	Less than 1 year	22	7.10%
	1 - 4 years	164	52.90%
	More than 4 years	124	40.00%
Daily usage frequency in e-commerce platforms	Less than 1 hour per day	151	44.30%
	1-3 hours per day	129	48.71%
	More than 3 hours per day	30	9.68%
Spending per month to shop on e-commerce platforms	Less than VND 1,000,000	87	28.06%
	VND 1,000,000 - VND 3,000,000	112	36.13%
	VND 3,000,001 - VND 7,000,000	81	26.12%
	Over VND 7,000,000	30	9.68%
Favorite e-commerce platforms for playing games	Shopee	287	92.58%
	Lazada	140	45.16%
	Tiki	82	26.45%
	Others (Sendo, Taobao, etc.)	41	13.22%
Favorite types of games on e-commerce platforms	All-day Games	239	77.10%
	Time-sensitive game	213	68.71%
	Seasonal games	113	36.45%

4.2 Assessing the outer measurement model

During the outer measurement model analysis, it is essential to evaluate construct reliability and validity, as indicated by J. F. Hair et al. (2017). The author utilized Cronbach's Alpha (CA), composite reliability (CR), and Dijkstra-Henseler's rho (pA) to evaluate construct reliability in this work (Chuan et al., 2015; Teo et al., 2015). The minimal values for Cronbach's Alpha, Composite Reliability, and Dijkstra Henseler rho_A are 0.851, 0.900, and 0.853, respectively, as indicated in Table 2. The results of this study demonstrate that Cronbach’s Alpha, Composite

Reliability, and Dijkstra Henseler rho_A have been validated, with all three constructs exhibiting significant reliability, as each value above the essential threshold of 0.7 (Dang, T.-M. Nguyen, et al., 2025; Phan et al., 2025).

Convergent validity refers to the extent to which various measuring items evaluate the same construct (Kim et al., 2013). This research evaluated convergent validity by factor loadings (FL) and average variance extracted (AVE) (Hair et al., 2016). Convergent validity is recognized when the values of AVE and FL are above the recommended thresholds of 0.5 and 0.7, respectively, as per established guidelines (Nguyen et al., 2023; Ooi & Tan, 2016). Table 2 reveals that the minimum average variance extracted value of 0.684 surpasses the threshold of 0.5. Following the elimination of two items (GBU3 and PUV2) that failed to satisfy the minimal factor loading (FL) criterion of 0.7, the remaining items exhibited factor loadings between 0.763 and 0.938, all surpassing the 0.7 barrier (Hair et al., 2021). The convergent validity of this study has been confirmed.

Table 2. Convergent Validity and Construct Reliability

Constructs	**Items**	**Factor Loadings (FL)**	**Cronbach's Alpha (CA)**	**Dijkstra Henseler rho_A (pA)**	**Composite Reliability (CR)**	**Average Variance Extracted (AVE)**	**VIF**
GBU	GBU1	0.822	0.891	0.892	0.925	0.754	2.583
	GBU2	0.875					2.478
	GBU4	0.810					2.201
	GBU5	0.834					2.383
GRR	GRR1	0.843	0.863	0.863	0.907	0.709	2.038
	GRR2	0.862					1.969
	GRR3	0.892					2.075
	GRR4	0.910					2.049
GMD	GMD1	0.893	0.891	0.893	0.924	0.753	2.753
	GMD2	0.856					2.318
	GMD3	0.861					2.325
	GMD4	0.861					2.393
PHV	PHV1	0.871	0.895	0.895	0.927	0.760	2.481
	PHV2	0.865					2.391
	PHV3	0.869					2.478
	PHV4	0.883					2.693
PUV	PUV1	0.852	0.852	0.853	0.900	0.694	2.098
	PUV3	0.858					2.185
	PUV4	0.808					1.804
	PUV5	0.812					1.781
SEP	SEP1	0.816	0.884	0.884	0.915	0.684	2.056
	SEP2	0.851					2.372
	SEP3	0.816					2.040
	SEP4	0.821					2.060
	SEP5	0.830					2.138
SLI	SLI1	0.875	0.889	0.895	0.923	0.750	2.514
	SLI2	0.885					2.577
	SLI3	0.843					2.299
	SLI4	0.861					2.437

The discriminant validity of the instrument was assessed in this research using two criteria: Fornell-Larcker's criterion (Fornell & Larcker, 1981) and cross-loadings (Henseler et al., 2015). As demonstrated by (Henseler et al., 2015), the square roots of AVE all have values greater than their corresponding correlation coefficients, as shown in Table 3. Concurrently, the cross-loading outcomes presented in Table 4 indicate that each loading imposes a substantial burden on the corresponding constructs while placing a negligible burden on the irrelevant constructs. Thus, the discriminant validity of this study has been confirmed.

Table 3. Fornell and Larcker

	GBU	GMD	GRR	PHV	PUV	SEP	SLI
GBU	**0.868**						
GMD	0.829	**0.868**					
GRR	0.863	0.825	**0.842**				
PHV	0.831	0.857	0.788	**0.872**			
PUV	0.843	0.828	0.829	0.835	**0.833**		
SEP	0.769	0.745	0.767	0.804	0.814	**0.827**	
SLI	0.646	0.719	0.621	0.755	0.698	0.736	**0.866**

Table 4. Cross-Loadings

Latent Construct	GBU	GMD	GRR	PHV	PUV	SEP	SLI
GBU1	**0.879**	0.706	0.747	0.718	0.721	0.669	0.548
GBU2	**0.871**	0.738	0.767	0.714	0.725	0.662	0.550
GBU4	**0.851**	0.690	0.735	0.712	0.732	0.655	0.539
GBU5	**0.871**	0.743	0.748	0.741	0.747	0.685	0.605
GMD1	0.765	**0.893**	0.769	0.799	0.748	0.684	0.677
GMD2	0.690	**0.856**	0.710	0.708	0.710	0.625	0.577
GMD3	0.699	**0.861**	0.688	0.713	0.716	0.627	0.631
GMD4	0.720	**0.861**	0.695	0.751	0.700	0.648	0.606
GRR1	0.712	0.703	**0.843**	0.672	0.698	0.645	0.511
GRR2	0.721	0.700	**0.833**	0.642	0.694	0.622	0.519
GRR3	0.731	0.693	**0.845**	0.642	0.701	0.622	0.511
GRR4	0.742	0.684	**0.847**	0.695	0.699	0.691	0.550
PHV1	0.749	0.748	0.722	**0.871**	0.746	0.713	0.655
PHV2	0.724	0.731	0.687	**0.865**	0.729	0.688	0.655
PHV3	0.715	0.763	0.672	**0.869**	0.708	0.696	0.656
PHV4	0.710	0.745	0.665	**0.883**	0.729	0.707	0.670
PUV1	0.738	0.706	0.749	0.684	**0.852**	0.668	0.590
PUV3	0.712	0.716	0.689	0.688	**0.858**	0.676	0.586
PUV4	0.657	0.671	0.628	0.697	**0.808**	0.667	0.583
PUV5	0.696	0.665	0.691	0.715	**0.812**	0.700	0.566
SEP1	0.620	0.611	0.642	0.651	0.645	**0.816**	0.607
SEP2	0.621	0.616	0.654	0.651	0.689	**0.851**	0.640
SEP3	0.626	0.594	0.610	0.691	0.656	**0.816**	0.668
SEP4	0.638	0.636	0.591	0.668	0.663	**0.821**	0.573
SEP5	0.675	0.623	0.673	0.661	0.710	**0.830**	0.551
SLI1	0.621	0.671	0.601	0.719	0.625	0.637	**0.875**
SLI2	0.628	0.717	0.619	0.721	0.667	0.671	**0.885**
SLI3	0.456	0.513	0.427	0.549	0.554	0.612	**0.843**
SLI4	0.514	0.566	0.482	0.608	0.561	0.627	**0.861**

4.3 Inspecting the inner structural model

The author used a collinearity test to reduce multicollinearity before testing the hypotheses (J. F. Hair, 2019). Table 2 shows that variation inflation factors (VIF) range from 1.781 to 2.693, below the 5.0 threshold (G. W.-H. Tan & Ooi, 2018; Nguyen et al. 2024; Vo et al., 2024). Thus, this study can ignore multicollinearity.

Bootstrapping with 5,000 subsamples, no sign change, and 95 percent bias-corrected confidence intervals were used to collect inferential statistics for this investigation. Table 5 shows that nine of twelve hypotheses were validated. Both GBU and GMD significantly affect PHV (p_value < 0.05), supporting hypotheses H1a and H3a. The connection between GRR and PHV was not statistically significant (p_value = 0.442), exceeding 0.05. Therefore, the evidence did not support hypothesis H2a.

From the Table 5, as expected, GBU, GRR, and GMD significantly impact PUV ($p < 0.05$), validating hypotheses H1b, H2b, and H3b. This research also showed strong correlations between other model variables. Research indicates that GMD strongly impacts SLI, which in turn impacts SEP (p_value < 0.05 for both). These results support H3c and H6. The hypotheses about GBU and SLI (H1c) and GRR and SLI (H2c) were not supported because the p-values of 0.123 and 0.973 surpassed the 0.05 significance threshold. As shown by their p-values below 0.01 for PHV, PUV, and SLI, they significantly affect SEP. This confirms the link between H4, H5, and H6. Moreover, Table 6 demonstrates that GBU influences SEP via PUV ($p<0.05$) and PHV ($p<0.05$), indicating the mediating roles of PUV and PHV; however, SLI does not support a mediating function between GBU and SEP. PUV ($p<0.05$), PHV ($p<0.05$), and SLI ($p<0.05$) serve as mediators between GMD and SEP. Conversely, only PUV mediates the relationship between GRR and SEP.

Table 5. Structural Model

	PLS Path	Original sample (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Remarks
H1a	GBU → PHV*	0.348	0.081	4.284	0.000	Supported
H1b	GBU → PUV*	0.346	0.072	4.810	0.000	Supported
H1c	GBU → SLI^{NS}	0.165	0.107	1.543	0.123	Unsupported
H2a	GRR → PHV^{NS}	0.066	0.068	0.974	0.330	Unsupported
H2b	GRR → PUV*	0.266	0.071	3.722	0.000	Supported
H2c	GRR → SLI^{NS}	-0.007	0.106	0.062	0.950	Unsupported
H3a	GMD → PHV*	0.515	0.078	6.571	0.000	Supported
H3b	GMD → PUV*	0.321	0.085	3.798	0.000	Supported
H3c	GMD → SLI*	0.588	0.097	6.049	0.000	Supported
H4	PHV → SEP*	0.277	0.088	3.139	0.002	Supported
H5	PUV → SEP*	0.420	0.080	5.250	0.000	Supported
H6	SLI → SEP*	0.233	0.081	2.880	0.004	Supported

Table 6. Indirect effect

	Original sample (O)	Standard deviation	T statistics (|O/STDEV|)	P values	Remark
GBU -> PUV -> SEP	0.175	0.049	3.603	0.000	Supported
GBU -> PHV -> SEP	0.094	0.040	2.319	0.020	Supported
GBU -> SLI -> SEP^{NS}	0.026	0.029	0.912	0.362	Unsupported
GMD -> PUV -> SEP	0.149	0.048	3.124	0.002	Supported
GMD -> PHV -> SEP	0.127	0.042	2.999	0.003	Supported
GMD -> SLI -> SEP	0.129	0.049	2.614	0.009	Supported
GRR -> PUV -> SEP	0.110	0.038	2.855	0.004	Supported
GRR -> PHV -> SEP^{NS}	0.009	0.019	0.468	0.640	Unsupported
GRR -> SLI -> SEP^{NS}	0.004	0.027	0.159	0.874	Unsupported

Significant at p_value < 0.05 level

NS Not supported at p_value > 0.05 level.

Finally, the model's predictive capabilities are confirmed by the fact that all observed Q2 predictive values are positive and greater than zero, as shown in Table 7 for the PLS prediction assessment (Hair et al., 2017). In contrast, most PLS-SEM analysis indicators generate greater prediction error rates than the Linear Model Benchmark. Subsequently, the model's predictive capability is diminished (Shmueli et al., 2019). Blindfolded testing assessed the structural model's predictive accuracy and Q2 value. J. Hair et al. (2017) state that a model is predictively relevant when Q2 values exceed zero. The results in Table 8, particularly the Q^2 column (=1-SSE/SSO), support the predictive relevance of the model. R2 for SEP is 0.736. These results show PHV, PUV, and SEP is highly predictive. The three exogenous variables explain much of the endogenous variable's variance, proving the theoretical model's explanatory power. Table 9 shows that GMD had a medium effect on PHV and PUV, with f2 values of 0.325 and 0.193. This suggests that GMD predicts PHV and PUV. GBU has a small effect on PHV and PUV because its f2 value is 0.118 and 0.114, higher than 0.02. GRR has a small effect on PUV because its f2 value is 0.068, higher than 0.02. Finally, PHV, PUV, and SLI affect SEP with f2 values of 0.071, 0.195, and 0.085.

Table 7. PLS Predict

	PLS-SEM			Linear Model Benchmark	
	Q²_ predict	**RMSE**	**MAE**	**RMSE**	**MAE**
PHV	0.774	0.483	0.312	0.874	0.617
PUV	0.768	0.489	0.326	0.878	0.608
SEP	0.628	0.618	0.387	0.859	0.595
SLI	0.502	0.713	0.421	0.834	0.576

Table 8. Predictive Relevance (Q^2) and R^2

Endogenous variable	Q² (=1-SSE/SSO)	Predictive Relevant	R^2
PHV	0.560	Q²>0	0.781
PUV	0.542	Q²>0	0.778
SEP	0.573	Q²>0	0.736
SLI	0.642	Q²>0	0.525

Table 9. Effect Size (f^2)

Predictor Construct/ Dependent Construct	PHV	PUV	SEP	SLI
GBU	0.118	0.114		0.012
GMD	0.325	0.123		0.193
GRR	0.004	0.068		0.000
PHV			0.071	
PUV			0.195	
SLI			0.085	

4.4 Artificial Neural Network (ANN) Analysis

ANNs resemble the biological structure of the human brain, comprising hundreds of artificial neurons, synapses, and axons (Dang Quan et al., 2024). An ANN is capable of generating predictions even in the absence of hypotheses. This is owing to its advantageous features, such as enhanced knowledge acquisition via the learning process and real-time performance (Dang Quan et al., 2024; Leong, Hew, Ooi, & Tan, 2019). According to Lim et al., (2022), making use of ANN provides the benefit of examining nonlinear relationships, such as U-shaped and S-shaped distributions, resulting in a more precise prediction. The authors of this study solely rely on the research paper by Leong, Hew, Ooi, and Tan (2019) on the combination of SEM-ANN. The authors would like to confirm an established theory, they should use a hybrid SEM-ANN approach, which aims to maximise model fits and identify and rank nonlinear non-compensatory relationships (Leong, Hew, Ooi, & Tan, 2019). All steps of ANN is desrcive in Figure 2 belows.

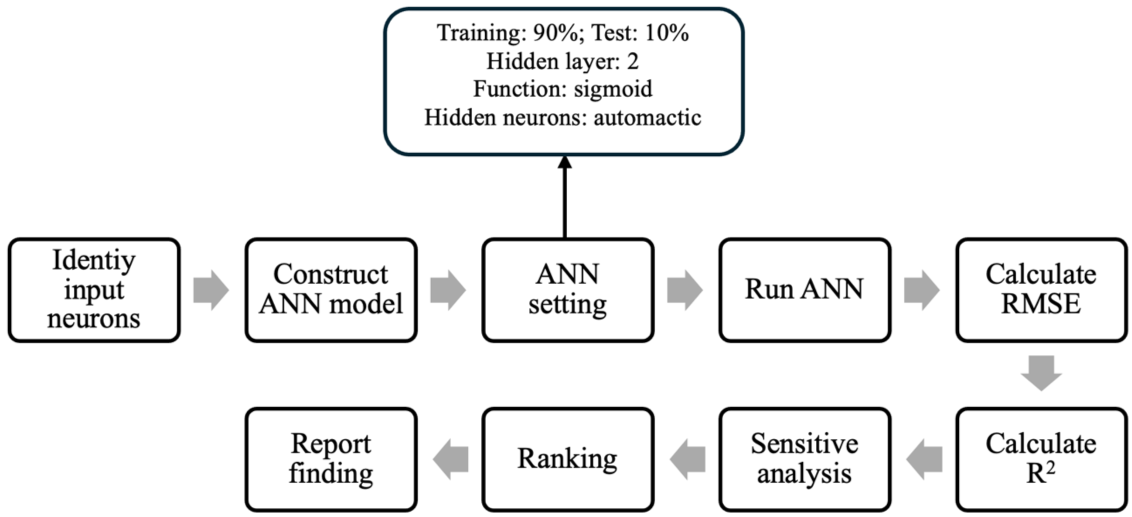

Figure 2. Process of Calculate ANN (Leong, Hew, Ooi, and Tan (2019))

To ensure methodological rigor and replicability in artificial neural network (ANN) analysis, the model should follow standardized settings consistent with prior empirical research (Dang Quan et al., 2024; Leong, Hew, Ooi, & Tan, 2019) . First, the input neurons should be derived from the significant predictors identified in the preceding PLS-SEM analysis. This hybrid approach leverages the advantages of both linear and nonlinear modeling, enhancing the predictive validity of the model (Leong et al., 2019; Sharma et al., 2023). The multilayer perceptron (MLP) architecture is recommended, as it has been the most commonly used ANN type (76% of prior studies) and supports deep learning by incorporating multiple hidden layers (Leong, Hew, Ooi, & Tan, 2019). Specifically, employing two hidden layers enables the network to capture complex nonlinear patterns more effectively than a single-layer structure (Hew et al., 2019).

For the activation function, the sigmoid function should be applied to both hidden and output layers. This function converts real-valued inputs into a bounded interval between 0 and 1, ensuring model comparability and computational stability (Hew et al., 2019). The number of hidden neurons should be automatically optimized by the software to minimize user bias and improve generalization. The feed-forward backpropagation (FFBP) algorithm is recommended for training, as it effectively minimizes prediction errors and remains the dominant approach in prior ANN-based business studies (Tan et al., 2021). To ensure generalizability, data should be divided into 90% for training and 10% for testing, aligning with common practice in existing literature (Leong et al., 2019). Additionally, a ten-fold cross-validation procedure is advised to control for overfitting and enhance model robustness (Hew et al., 2019; Sharma et al., 2023).

The study examined four different artificial neural network (ANN) models, labeled as Models A, B, C, and D. Figure 2,3,4,5 illustrate these four ANN models. The key difference between the four models was the complexity of their hidden neuron layers. From the Figures 3, and 4 show that Models A and B were the simplest, each with only a hidden neuron. In contrast, Model C (Figure 5) had a more complex hidden layer with 2 neurons, while Model D (Figure 6) was the most complex, with 4 neurons in its hidden layer.

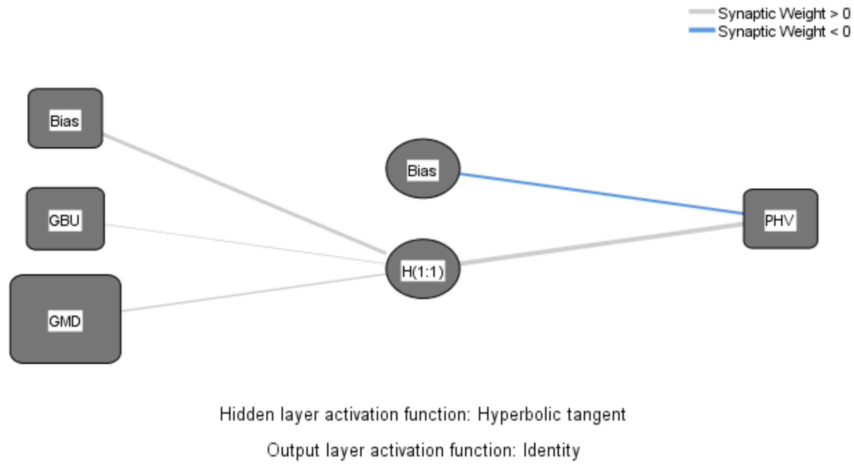

Figure 3. ANN Model A

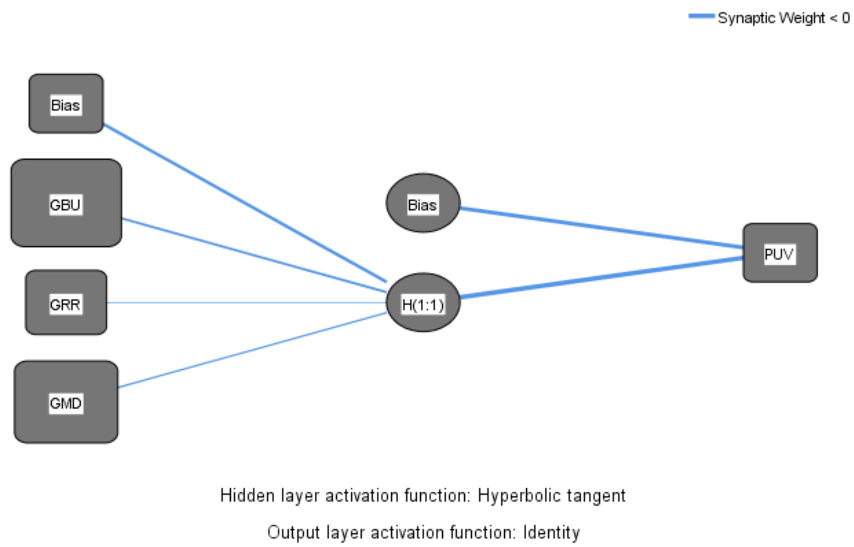

Figure 4. ANN Model B

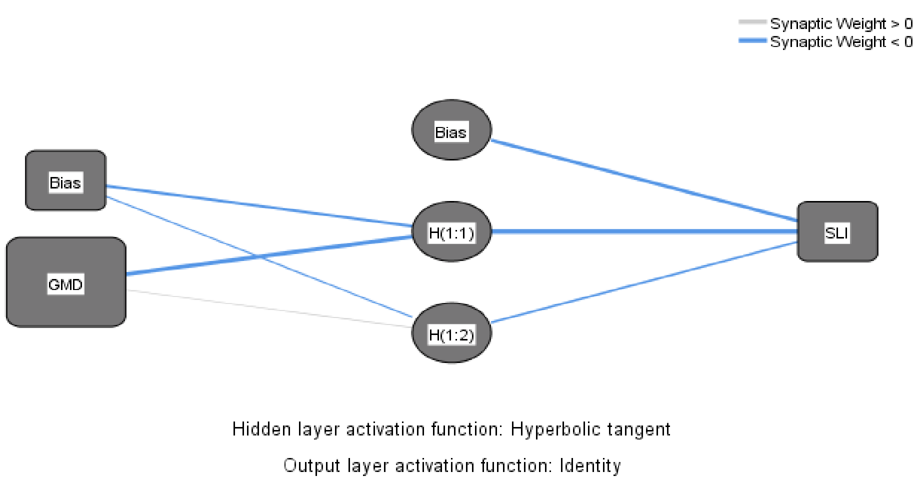

Figure 5. ANN Model C

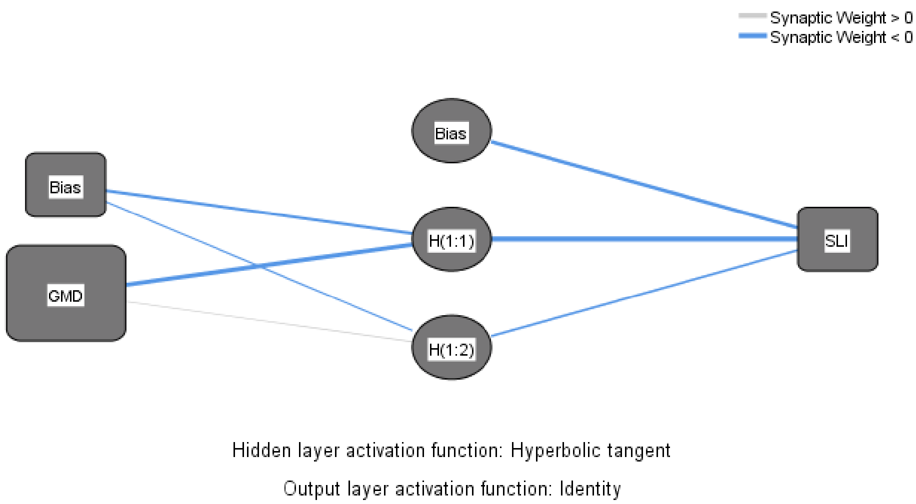

Figure 6. ANN Model D

To mitigate overfitting, the investigation implemented tenfold cross-validation. The network training process utilized 90% of the data, while the remaining 10% was allocated to testing, which involved assessing the precision of the trained network's predictions (Bocean Vărzaru & Bocean, 2021; Chong, 2012; Wong et al., 2018). The mean values of the Root Mean Squared Error (RMSE) for all ANN Models A, B, C, and D, as shown in Table 10, are small, with a range of 0.634 to 0.770. This finding suggests that all four models exhibit a high level of fit (Yang & Zeng, 2018). In addition, Models A, B, C, and D can accurately predict PHV, PUV, SLI, and SEP with RMSE values to calculate R2 at 98.95%, 98.95%, 98.67%, and 99.02%, respectively.

Table 10. RMSE Values for OT, BOL, ALO, CVC

	Model A		**Model B**		**Model C**		**Model D**	
	Input: GBU, GMD		**Input: GBU, GRR, GMD**		**Input: GMD**		**Input: PHV, PUV, SLI**	
	Output: PHV		**Output: PUV**		**Output: SLI**		**Output: SEP**	
	Training	**Testing**	**Training**	**Testing**	**Training**	**Testing**	**Training**	**Testing**
Neutral network	RMSE	RMSE	RMSE	RMSE	RMSE	RMSE	RMSE	RMSE
ANN1	0.649	0.679	0.780	0.613	0.796	0.655	0.707	0.647
ANN2	0.677	0.679	0.719	0.698	0.749	0.913	0.827	0.818
ANN3	0.645	0.588	0.663	0.536	0.753	0.857	0.702	0.786
ANN4	0.681	0.590	0.658	0.714	0.756	0.667	0.715	0.692
ANN5	0.639	0.643	0.716	0.615	0.741	0.833	0.784	0.808
ANN6	0.631	0.553	0.706	0.542	0.744	0.655	0.721	0.763
ANN7	0.681	0.645	0.729	0.622	0.727	0.762	0.833	0.931
ANN8	0.673	0.543	0.736	0.735	0.730	0.690	0.687	0.750
ANN9	0.680	0.759	0.616	0.677	0.745	0.844	0.729	0.676
ANN10	0.633	0.656	0.735	0.806	0.797	0.636	0.757	0.833
Mean	**0.659**	**0.634**	**0.706**	**0.656**	**0.754**	**0.751**	**0.746**	**0.770**
SD	**0.021**	**0.066**	**0.047**	**0.086**	**0.024**	**0.103**	**0.052**	**0.085**

Additionally, the normalized importance (%) indicated in Table 11 was determined through sensitivity analysis to evaluate the significance of each predictor in the neural network (Leong, Hew, Ooi, & Lin, 2019). The findings show that for ANN Model A, GMD is the most significant predictor with a normalized importance of 100%, followed by GBU at 55.2%. For ANN Model B, GBU is the most significant predictor with a normalized importance of 100%, followed by GMD at 90.4% and GRR at 60%. In the case of ANN Models C, the normalized importance is 100% as these models include only one neuron.

The findings of comparing the ratings between PLS-SEM and ANN, shown in Table 12, suggest that all 7 out of 9 models are compatible with the results obtained from the PLS-SEM estimation. The PLS-SEM results indicate that perceived utilitarian value is the most significant variable influencing stickiness to e-commerce platforms. In contrast, the ANN analysis showed that perceived hedonic value is the most significant influence on e-commerce platform stickiness, reflecting the nonlinear and complex relationships between the variables.

Table 11. Sensitivity Analysis

	Model A (Output: PHV)		Model B (Output: PUV)			Model C (Output: SLI)	Model D (Output: SEP)		
Neutral network	**GBU**	**GMD**	**GBU**	**GRR**	**GMD**	**GMD**	**PHV**	**PUV**	**SEP**
ANN1	0.555	0.445	0.325	0.365	0.310	1.000	0.320	0.428	0.253
ANN2	0.467	0.533	0.322	0.360	0.318	1.000	0.363	0.327	0.309
ANN3	0.454	0.546	0.389	0.300	0.311	1.000	0.356	0.352	0.291
ANN4	0.418	0.582	0.368	0.324	0.307	1.000	0.332	0.359	0.309
ANN5	0.449	0.551	0.304	0.368	0.328	1.000	0.433	0.218	0.349
ANN6	0.780	0.522	0.340	0.326	0.334	1.000	0.366	0.255	0.379
ANN7	0.398	0.602	0.369	0.370	0.261	1.000	0.387	0.365	0.248
ANN8	0.467	0.533	0.305	0.349	0.345	1.000	0.361	0.299	0.340
ANN9	0.504	0.496	0.328	0.292	0.380	1.000	0.508	0.201	0.291
ANN10	0.489	0.511	0.366	0.304	0.330	1.000	0.422	0.292	0.287
Average relative importance	**0.498**	**0.532**	**0.342**	**0.336**	**0.322**	**1.000**	**0.385**	**0.310**	**0.306**
Normalized relative importance (%)	**55.200**	**100.000**	**100.000**	**60.000**	**90.400**	**100.000**	**100.000**	**51.400**	**38.000**

Table 12. Comparison Between PLS-SEM and ANN Results

PLS Path	**Original Sample (O)/ Path Coefficient**	**ANN Results: Normalized Relative Importance (%)**	**Ranking (PLS-SEM) [Based on Path Coefficient]**	**Ranking (ANN) [Based on Normalized Relative Importance]**	**Remark**
Model A (Output: PHV)					
GBU → PHV	0.348	55.200	1	1	Match
GMD → PHV	0.515	100.000	2	2	Match
Model B (Output: PUV)					
GBU → PUV	0.346	100.000	1	1	Match
GRR → PUV	0.266	60.000	3	3	Match
GMD → PUV	0.321	90.400	2	2	Match
Model C (Output: SLI)					
GMD → SLI	0.588	100.000	1	1	Match
Model D (Output: SEP)					
PHV → SEP	0.277	100.000	2	1	Not Match
PUV → SEP	0.420	51.400	1	2	Not Match
SLI → SEP	0.233	38.000	3	3	Match

5. Discussions

This study employed the Stimulus–Organism–Response (S–O–R) framework to examine how gamification elements (badge upgrade, gamified design, random rewards) influence perceived values, social interaction, and ultimately customer stickiness in e-commerce. The findings provide new insights into how gamification enhances engagement and behavioral loyalty on online retail platforms. Results show that gamified design (GMD) ($\beta = 0.515$, $p < 0.05$) and badge upgrade (GBU) ($\beta = 0.348$, $p < 0.05$) significantly affect perceived hedonic value (PHV), with GMD having the stronger effect. This indicates that immersive game-like interfaces and mechanics—through autonomy, competence, and relatedness—foster intrinsic enjoyment and engagement (Bitrián et al., 2021). By contrast, random rewards (GRR) had no significant effect on PHV, as unpredictable extrinsic incentives may undermine intrinsic motivation (Hamari et al., 2014).

All three gamification elements positively affect perceived utilitarian value (PUV) to different degrees. GBU ($\beta = 0.346$, $p < 0.001$) and GMD ($\beta = 0.321$, $p < 0.001$) exhibit stronger effects than GRR ($\beta = 0.266$, $p < 0.001$). Badges signal competence and achievement, serving as progress indicators that sustain engagement (Hamari & Eranti, 2011). Similarly, well-designed gamified systems enhance functional efficiency through structured challenges and feedback (Hsu & Chen, 2018b). In contrast, GRR's reliance on unpredictability yields weaker practical value, offering temporary engagement rather than sustained utility (Hamari et al., 2014). Regarding social interaction (SLI), only GMD shows a significant effect ($\beta = 0.588$, $p < 0.05$), whereas GBU ($\beta = 0.165$, $p > 0.05$) and GRR ($\beta = -0.007$, $p > 0.05$) do not. This suggests that cooperative gamified designs—such as team challenges and shared progress—enhance communication and belonging (Xu et al., 2023). Individualistic features like badges or random rewards, however, mainly stimulate personal achievement and may reduce collaboration (Sailer et al., 2017; Deci & Ryan, 2000). Overly competitive mechanisms can even fragment social ties and lower motivation (Almeida et al., 2023).

Furthermore, both PHV ($\beta = 0.277$, $p < 0.05$) and PUV ($\beta = 0.420$, $p < 0.001$) significantly enhance customer stickiness. PHV strengthens emotional engagement and enjoyment (Hamari & Koivisto, 2015), while PUV reinforces cognitive satisfaction and perceived efficiency (Yue & Cho, 2022; Chiu et al., 2014). Social interaction ($\beta = 0.233$, $p < 0.001$) also fosters loyalty by creating a sense of community and shared experience (Puig et al., 2023; Kusumawardani et al., 2023). In sum, GMD and GBU act as primary stimuli shaping users' internal evaluations—hedonic, utilitarian, and social—that, in turn, drive behavioral stickiness, consistent with the S–O–R framework (Hamari, 2017; Xu et al., 2017). GRR, as an extrinsic motivator, has limited influence due to its unpredictability and lack of sustained psychological value (Deci et al., 1999).

The nonlinear insights revealed through ANN analysis can be better understood through established psychological and behavioral theories. Specifically, Self-Determination Theory (SDT) (Deci & Ryan, 2000) helps explain why gamified design and badge upgrades exert a stronger influence on hedonic and utilitarian values. According to SDT, intrinsic motivation arises when individuals experience autonomy, competence, and relatedness—conditions inherently supported by gamification elements that reward achievement (badges) and social belonging (interactive design). This intrinsic satisfaction fosters sustained engagement, clarifying why ANN identified hedonic value as the dominant predictor of stickiness in nonlinear patterns

Last but not least, by using an artificial neural network (ANN) approach—which is often based on SEM—this study broadens the acceptance-based research on contemporary technology. When compared to PLS-SEM, the intriguing results show that PUV is more significant than PHV in ANN ranks. Because ANN models have a greater prediction accuracy and can capture nonlinear interactions, there are only slight differences between the PLS-SEM and ANN results (Kusviansyah & Ardi, 2024). This critical insight would have been obscured if only PLS-SEM had been employed (Kusviansyah & Ardi, 2024). Minor inconsistencies were observed between the results of the standard PLS-SEM technique and the ANN analysis, which might offer substantial value and pertinent information for the decision-maker, as well as serve as a foundation for corporate decision-making (Sternad Zabukovšek et al., 2022). Therefore, the integration of PLS-SEM and ANN methodologies in this research offers a comprehensive perspective, augmenting the reliability and accuracy of the findings.

Finally, gamification is particularly impactful for Vietnamese Gen Z, who enjoy showcasing achievements and participating in online communities. Vietnam's collectivist culture (Hofstede, 2001) and preference for social recognition make features like leaderboards, progress upgrades, and small gifts highly appealing (Dang et al., 2025). Consequently, gamified e-commerce designs resonate strongly with Gen Z consumers, sustaining both engagement and loyalty.

6. Implications

6.1 Theoretical implications

Drawing on the S-O-R framework, this study advances gamification literature by exploring customer stickiness toward e-commerce platforms.

First, while previous research mainly examined gamification's effects on consumer perceptions, satisfaction, and behavioral intentions (Foroughi et al., 2023; Nugroho, 2024; Yu & Huang, 2022; Aprilia & Alfansi, 2024; Tai & Tu, 2023; Tran The et al., 2024; Sitthipon et al., 2022), little is known about how gamification elements influence customer stickiness. This study bridges that gap by linking gamification dimensions to stickiness through perceived hedonic value, utilitarian value, and social interaction, enriching understanding of post-gaming user behavior on e-commerce platforms.

Second, perceived values were divided into hedonic and utilitarian categories to clarify their effects on stickiness. This distinction provides insights into how pleasure- and functionality-driven motivations shape customer behavior.

Third, by examining GBU, GRR, and GMD effects on SEP via PHV, PUV, and SLI, the study offers a multifaceted view of gamification mechanisms. It reveals that consumer attachment to platforms is shaped by organism factors such as perceived values and social interaction.

Finally, adopting a dual PLS-SEM and ANN approach, this study contributes methodologically by integrating linear (PLS-SEM) and nonlinear (ANN) analyses (Dang et al., 2023). This hybrid method enhances understanding of complex gamification relationships and can be extended to education, healthcare, and marketing contexts to design more effective user engagement strategies.

6.2 Managerial implications

E-commerce expansion has heightened competition between large and small enterprises, impacting market share and revenue. The research indicates that integrating gamification into the shopping experience can alter consumer behavior on e-commerce platforms. This indicates that businesses can employ gamification to enhance shopping experiences. By comprehending its influence on consumer decision-making, businesses can formulate more efficacious marketing strategies, aligning their messaging and promotions with shifting consumer demands and preferences. The findings of this study suggest that to retain consumers on e-commerce platforms, businesses must account for utilitarian and hedonic values when integrating gamification into their operations. The study underscores the importance of a balanced strategy that considers both gamification's practical and experiential dimensions to effectively implement it and improve consumer loyalty on e-commerce platforms. Focusing exclusively on a single dimension may prove less effective. Conversely, these findings aid consumers in cultivating a more informed viewpoint concerning the selection and dependability of gamified e-commerce platforms for prolonged utilization.

Secondly, enhancing the utilitarian and hedonic value in gamification necessitates that the gamification elements directly reinforce the core service or product. To augment utilitarian and hedonic value in gamification, it is essential that gamification elements reinforce the core service without causing distraction. E-commerce platforms can enhance the shopping experience by providing pertinent rewards, such as discounts or exclusive access, thereby rendering gamification advantageous. Transparent progress monitoring and feedback on accomplishments, such as accrued points, can enhance customer engagement and foster a sense of achievement (Mazikov, 2024). Furthermore, establishing clear objectives that correspond with consumer preferences fosters a meaningful experience, enhancing engagement and satisfaction (Cerutti, 2017).

Ultimately, the study recommends that enterprises prioritize enhancing hedonic elements in gamification over social interaction to bolster customer retention and profitability. Companies can sustain a durable edge by securing a competitive advantage early in gamification development (Hanifa et al., 2023). This revelation bolsters the customer's confidence in their decisions as they persist in utilizing the e-commerce gamification despite its limited or negligible appeal to their social interaction concerns.

7. Conclusion, limitation and further research

This study emphasizes that businesses should integrate both utilitarian and hedonic values when adopting gamification to retain customers on e-commerce platforms. A balanced approach combining functional and experiential aspects enhances loyalty more effectively than focusing on a single dimension. These findings also help consumers make informed decisions about selecting reliable gamified platforms. To strengthen perceived value, gamification elements must support the platform’s core service rather than distract users. Relevant rewards such as discounts or exclusive access, along with transparent progress tracking, can enhance engagement and a sense of accomplishment (Mazikov, 2024).

However, several limitations must be acknowledged. The cross-sectional design restricts causal inference (Shadish et al., 2002), while self-reported data may introduce response bias. The single-country, single-platform setting limits generalizability (Kotp et al., 2025). Conceptually, key factors such as trust, satisfaction, habit formation, and behavioral outcomes (e.g., repurchase intention) were omitted (Xu et al., 2019; Liu et al., 2020). Additionally, some essential gamification elements, including points, leaderboards, and narratives, were excluded (Deterding et al., 2011). Methodologically, potential model specification errors may exist in both PLS-SEM and ANN analyses, as network configuration can affect results. Future research should employ longitudinal or experimental designs to test causal mechanisms (Maxwell & Cole, 2007), adopt multi-country samples for better generalizability (van de Vijver & Leung, 1997), and expand theoretical models to incorporate mediators and objective behavioral outcomes such as engagement and loyalty (Hamari, 2017; Xu et al., 2019).

Author Contributions

Nhan-Thanh Thi Nguyen: Conceptualization, Data curation, Validation, Writing – original draft. Tri-Quan Dang: Conceptualization, Methodology, Investigation, Writing – review & editing. Son-Hoang Dang: Software, Methodology, Investigation. Luan-Thanh Nguyen: Conceptualization, Writing – review & editing. Anh-Ly Quynh: Data curation, Investigation. Dang Thi Viet Duc: Resource, Writing – review & editing, Supervision, Project administration.

Data Availability Statement

Research data supporting this publication are available upon request.

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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