Jurnal Bisnis dan Manajemen
http://jurnal.unmer.ac.id/index.php/jbm

Volume 12 No 1
2025
Hlm. 38 - 51

Environmental Sustainability Gamification (ESG): Testing the Model

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Abstract:

This study aims to validate an environmental sustainability gamification (ESG) framework by examining six psychological dimensions; Autonomy, Competence, Relatedness, Enjoyment, Self-efficacy, and Self-presentation—among Grab users in Southeast Asia. Using confirmatory factor analysis (CFA) on data from 214 respondents, the results identify self-presentation (AVE = 0.623) as the dominant predictor of sustainable behaviour, reflecting the cultural emphasis on social recognition in collectivist markets. Competence (personalized rewards) and Relatedness (community features) significantly enhance long-term engagement, while Enjoyment drives initial adoption. The study provides actionable strategies for ride-hailing platforms, including reward personalization and social feature integration, to bridge the intention-action gap in sustainable behaviour. These findings not only advance the application of psychological theory in digital sustainability initiatives but also offer culturally sensitive insights for designing effective gamification strategies tailored to specific regional dynamics.

Keywords: Confirmatory Factor Analysis, Environmental Sustainability Gamification; Sustainable Behaviour, Psychological Needs.

1. Introduction

The rapid advancement of digital technology and increasing environmental awareness have spurred the adoption of Environmental Sustainability Gamification (ESG) as an innovative strategy to encourage sustainable behaviour. This study selects Grab as its case study due to its strategic relevance and empirical viability. As a platform that regularly publishes annual sustainability reports, Grab offers transparent data on its ESG initiatives, such as the GrabElectric program for electric vehicles and its plastic waste reduction efforts (ESG Report, 2023). (Putri et al., 2021), Nevertheless, it warns of greenwashing in which such sustainability claims are not followed through with action, which can also undermine consumer trust. Therefore, it is imperative to demonstrate that Grab's ESG attributes are not just words but embedded in tangible sustainability initiatives. From the gamification perspective, features like GrabRewards (points) and GrabChallenges (goal-based missions) offer a fertile area to explore the application of gamification to sustainability outcomes. (Aditya Nalendra et al., 2022) Second, it is stated that economic factors (e.g., fuel-dominating class methods, fuel price, and fuel tax prices) affect user satisfaction in online transportation. This is consistent with ESG-based motivations and incentives for green cars and punishment for polluting vehicles, which act as reward or barrier incentives and attitude stimuli.

This study is based on the ESGS (Hsu, 2025). ESGS is the first scale that measures the effectiveness of gamification on environmental sustainability by combining Self-Determination Theory (SDT) and game design principles. Its six facets- Autonomy, Competence, Relatedness, Enjoyment, Self-efficacy, and Self-presentation- offer a broad perspective of the motivational orientation of participants. The preliminary validation of the Zero2 Taiwan phishing app in ESGS presented good internal consistency (AVE>0.5) and reliability (CR>0.7), with Self-presentation presented as the most significant predictor (Hsu, 2025). This framework is suitable because it can also be applied for online transport use in the Indonesian collectivist context where social processes, namely self-identity (Self-presentation) and social structure (Relatedness), are important.

Gamification, defined as "the application of game-design elements in non-game contexts" (Deterding et al., 2011; Staller & Koerner, 2021), has demonstrated its effectiveness in enhancing motivations, engagement, and behavioural changes in education, technology, business, and so on (Dichev & Dicheva, 2017; Robson et al., 2015).

Contrastingly, environmental sustainability is a worldview that guarantees the satisfaction of contemporary demands without compromising the generation of tomorrow (Morelli, 2011; Silvius, 2017). Receives a fresh lease through the concept of gamification. ESG constitutes an integrated approach to galvanize public engagement with environmental issues, from carbon mitigation to sustainable consumption (Aguiar-Castillo et al., 2023; Lim et al., 2024; Ouariachi et al., 2020). The contribution of this study is threefold:(1) contributing to an extension of ESG implementation in online transportation platforms from a psychological lens by addressing Autonomy, Competence, Relatedness, Enjoyment, Self-efficacy, and Self-presentation needs;(2) analyzing the technical and contextual factors which influence the success of gamification in online transportation; and (3) suggesting personalized gamification of design recommendation to approve the long-term environmental impact. By examining ESG in online transportation services, this study contributes significantly to the existing literature by addressing critical gaps in the understanding of psychological motivators for sustainable behaviour within online platforms. While previous research has explored aspects of gamification, a comprehensive analysis of the psychological dimensions influencing sustainable behaviour in the specific context of online transportation services, particularly in collectivist markets, remains an under-researched area. Existing models have often been criticized for oversimplifying technical instantiation aspects and failing to account for users' attitudes towards non-materialistic incentives like environmental pride and green self-image (Jaiswal et al., 2018). Furthermore, the role of psychological dimensions such as Self-presentation and Relatedness in encouraging pro-sustainable behaviours in online transportation systems has not been thoroughly analyzed. This research fills these voids by providing a nuanced understanding of these motivators, offering insights that transcend the limitations of prior studies which often overlooked cultural factors and the long-term consequences of gamification on sustainability habits (Aguiar-Castillo et al., 2023; Xi & Hamari, 2020).

His work is inspired by the growing interest of researchers who want to understand the possible benefit of gamification as a behaviour change driver. As articulated by (Hsu, 2025), environmental sustainability gamification (ESG) is defined as "the integration of game elements in environmental sustainability initiatives to promote active participation." While (Felita & Hardjono, 2022) has confirmed the superiority of perceived Enjoyment in the field of e-commerce gamification, the role of other psychological dimensions - like Self-presentation and Relatedness – in encouraging pro-sustainable behaviours in on-line transportation systems has not yet been analyzed. The research questions guiding this investigation are designed to examine: (1) How do users respond to various ESG elements? (2) What factors determine the successful implementation of ESG in online transportation contexts? (3) What optimization strategies can maximize ESG's environmental impact? To fully comprehend ESG implementation complexities, it is essential to address contradictory findings in existing literature, including the transient effects of gamification due to insufficient intrinsic motivation (Aguiar-Castillo et al., 2023; Ryan & Deci, 2021), Design failures stemming from neglected cognitive-emotional aspects of users (Mullins & Sabherwal, 2020).

The primary objective of this study is to examine the factors influencing the effectiveness of ESG in online transportation services, with particular focus on (a) optimizing interface design to support Autonomy through easily accessible low-emission vehicle options, (b) personalizing reward systems to enhance Competence by aligning points with participant preferences, and (c) developing long-term engagement strategies through the integration of flow experience (Whittaker et al., 2021) and self-presentation mechanisms (Hsu, 2025). Within online transportation contexts, self-presentation reflects users' desire to project a sustainable lifestyle image, often manifested through features enabling social media sharing of achievements. Research by (Abou-Shouk & Soliman, 2021) identifies customer engagement as a crucial mediator in sustaining gamification impacts. (Lubaba & Masyhuri, 2022), Also, the above supports the idea that environmental attitude is mediating in determining customer innovation and sustainable product purchase intention. In sustainability gamification, the more positive the environmental attitude holder individuals possess, the more motivational power will push participants to engage in sustainability-based programs. As (Lubaba & Masyhuri, 2022) highlight, environmental attitude is an important mediator in linking consumer innovation with sustainable purchasing decisions, suggesting that ESG gamification designs provoke environmental awareness rather than just the reward system. The proposed results confirm the ESG construct in the context of the collectivist society of Indonesia and as deliverable suggestions to the platforms for improving long-term user participation in sustainability programs.

2. Literature Review

The paper is structured around a critical review of the literature that explores the development of the ESG behavioural perspective on environmental gamification and how it is manifested on digital platforms. New research opens doors for several questions that remain unanswered: (1) The influence of cultural factors in explaining the effectiveness of ESG (Xi & Hamari, 2020); (2) The long-term consequences of gamification on sustainability habits

(Aguiar-Castillo et al., 2023); (3) The role of digital literacy as a moderator factor of the ESG outcomes (Zafar et al., 2024). In contrast to the common understanding of the universality of gamification, (Xi & Hamari, 2020) have shown that the effectiveness of ESG depends greatly on cultural context and type of rewards (specifically for collectivist cultures with an emphasis on social recognition). Existing models in literature have been criticized for oversimplifying the technical instantiation aspects. For example, (Jaiswal et al., 2018) identified shortcomings of such gamification applications, as they do not account for users' attitudes towards non-materialistic incentives, such as environmental pride and green self-image. In contrast, (Liu et al., 2018) work on industrial environments highlighted the essential role of user-centered design in maintaining engagement in the long run. Although extant work often emphasizes the transformative potential of ESG, the current research contributes to these studies by examining concrete ride-hailing features such as low-emission vehicle rewards and social media achievement-sharing tools.

Expanding on knowledge gap identification, (Felita & Hardjono, 2022) found that perceived Enjoyment plays the leading role in enhancing user engagement experiencing gamification in Shopee – a finding of potential importance to Grab as, likewise, in its sustainability feature adoption. Enjoyment determines the willingness to adopt the initial feature. However, their study shows that perceived ease of use. Might not always lead to substantial effects, calling for ESG gamification designs to focus more on intrinsic motivations (e.g., environmental pride) than ease of use. This work, therefore, proposes explicitly an approach to (1) adapt the ESGS to the transportation context online and (2) integrate intrinsic (e.g., pride) and extrinsic (e.g., discounts) rewards in a way that influences the retention of sustainable behaviour; (3) optimize the ESG's environmental effect in whatever way possible. The research collects empirical evidence of the factor structure of ESG, using confirmatory factor analysis (CFA) on a sample of 214 Southeast Asian online transportation users, as well as provides culturally sensitive insights for the design of gamification, which reflects the local psychological needs and behavioural tendencies.

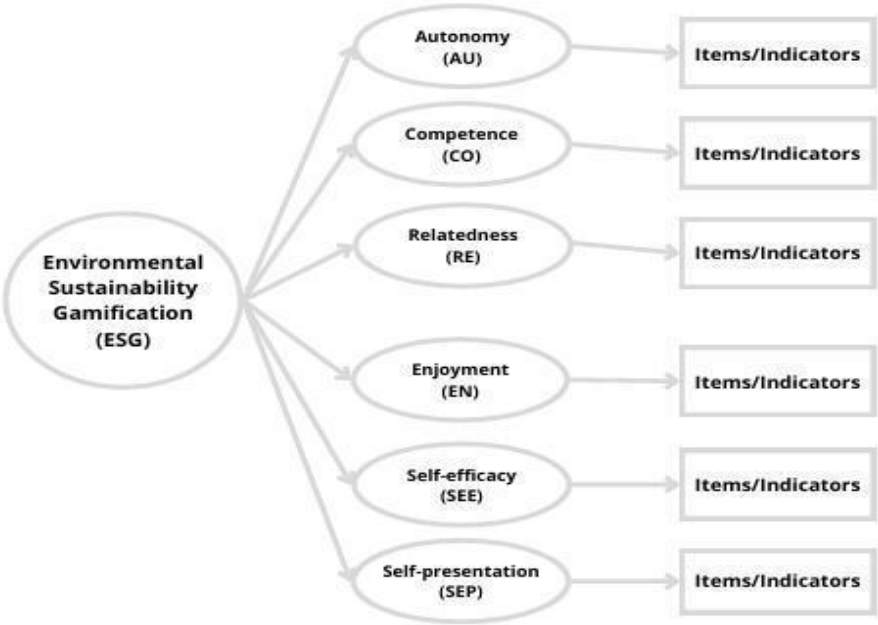
3. Method

From a quantitative perspective, we seek to understand the positive effect of ESG on users' behaviour and their environmentally friendly consciousness in the Grab app infrastructure. Below the stated research objectives, a descriptive quantitative research design was used, which was deemed best for achieving systematic and measurable data in regard to participants' attitudes and experiences towards gamification features designed based on sustainability. The theoretical justification for using CFA as the primary analysis method is based on the study to understand the degree to which well-documented variables reflect the ESG concept. As (Hair et al., 2013) pointed out, CFA tests construct validity and verify the measured variable's factor structure. To meet the research goals, an online questionnaire was used as the primary data collection tool, which was delivered through Google Forms and employed a 5-point Likert scale (1=Strongly Disagree, 5=Strongly Agree) to measure users' perceptions and experiences of sustainability-related gamification features in online transportation services. Following (Hair et al., 2013), The minimum sample size for Confirmatory Factor Analysis (CFA) analysis can be estimated using a 1:10 ratio, also referred to as use 10:1, where one indicator needs 10 participants. Nineteen indicators were employed in this research. The purpose of CFA in this study is to examine the structure of the ESG construct and ensure that the indicators employed can empirically represent the six psychological dimensions. CFA permits testing the association between observable indicators (observed variables) and unobserved constructs (latent variables), an important aspect in the measurement scale-building process such as ESGS. The CFA analysis is stepwise, from the first-order Measurement Model per dimension to the second-order Measurement Model for the ESG construct.

Core dimensions and constituent items were chosen based on theoretical support in Self-Determination Theory (Ryan & Deci, 2021) and previous research validating ESG in the on-demand application domain. We measured user experiences with 3 or 4 indicators for each dimension, reflecting the characteristics of user experiences in desires-based gamification of online transportation services. For instance, the dimension of self-presentation was assessed with items like the wish to appear pro-environmental and want to share contributions to social media. To guarantee the criterion validity and consistency indexes of the instrument, the process of CFA verification was supplemented by the review of AVE and CR scores and the test of the adequacy of the model through the presence of the signs of adequacy of GFI, RMSEA, and CFI indexes. Specifically, Composite Reliability (CR) values were required to exceed the 0.7 threshold, and Average Variance Extracted (AVE) values needed to

surpass the 0.5 benchmark, both in line with Hair et al. (2013). For model fit indices, RMSEA was required to be ≤ 0.05, CFI ≥ 0.9 (significantly exceeding the 0.90 benchmark recommended by Rufaidah, 2017), and GFI ≥ 0.90 (Hair et al., 2013, p. 579). This approach eliminates the interferential terms and highlights the concept of the presented model. With a total of 214 respondents in different SEA regions, both the design of data collection and the participant geographical representation and digital literacy level were taken into account to enhance the generalization of the research results. Figure 1: Conceptual Model 4 used an experimental design to test the conceptual framework (Figure 1).

Figure 1. Research Conceptual Framework



Source: Processed data (2025)

4. Findings and Discussion

The findings present data collection and analysis results using Confirmatory Factor Analysis (CFA) to demonstrate how measured variables represent unobservable latent constructs. An analysis of respondent demographic characteristics, summarized in Table 1 (n=214), reveals several notable patterns that offer initial insights into the study's context and potential implications. The sample is predominantly female (62.6% female vs. 37.4% male) and heavily skewed towards young adults, with 51.9% aged 21-24 years. This demographic profile suggests that the findings are particularly relevant to understanding the engagement of young, educated women with environmental sustainability gamification in online transportation. Given that 48.6% held bachelor's degrees and 24.3% held diplomas, the sample is also well-educated, which might influence their awareness and receptiveness to complex gamified features. The universal usage of online transportation services (100%) and high awareness of gamification features (95.2%) among respondents indicate a highly relevant and engaged user base for this study. Geographically, the sample is concentrated in Java, particularly West Java (26.6%), East Java (23.4%), and Central Java (20.1%), reflecting a focus on key urban and populous regions in Indonesia. This geographical concentration, combined with the observed demographic trends, suggests that the study's insights into the psychological motivators of sustainable behaviour are particularly salient for this specific segment of the Southeast Asian market, potentially highlighting culturally specific responses to ESG initiatives. While these demographics are descriptive, they lay the groundwork for understanding the context in which the ESG framework operates and how different user segments might interact with gamified sustainability initiatives.

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Table 1. Respondent Profile

Profile		Frequency	Percent
	Male	80	37.4 %
	Female	134	62.6 %
Age	< 16	5	2.3 %
	17 – 20	22	10.3 %
	21 – 24	111	51.9 %
	25 – 30	44	20.6 %
	30 – 40	24	11.2 %
	40 – 50	6	2.8 %
	> 50	2	0.9 %
Education	Elementary School	2	0.9 %
	Junior High School	3	1.4%
	Senior High School	45	21.0%
	Associate Degree	52	24.3%
	Bachelor's Degree	104	48.6%
	Master's Degree	5	2.3%
	Doctoral Degree	3	1.4%
Occupation	Students	7	3.3%
	College Students	69	32.2%
	Bachelors	28	13.1%
	Employees	48	22.4%
	Freelance	21	9.8%
	Entrepreneurs	26	12.1%
	Not Yet Working	15	7.0%
Residence	West Java	57	26.6%
	East Java	50	23.4%
	Central Java	43	20.1%
	DKI Jakarta	41	19.2%
	Outside Java	23	10.7%
Grab Users	Yes	214	100%
Understanding Gamification	Yes	210	95.2%
	No	4	4.8%

Source: Processed data (2025)

Confirmatory Factor Analysis

The CFA testing phase began by analyzing factor loadings and goodness-of-fit indices to assess the adequacy of the measurement model. Following the (Rufaidah, 2017) framework, we evaluated multiple fit indices: GFI, AGFI, RMSEA, NFI, CFI, PNFI, and PGFI. Table 2 presents the CFA measurement model results, demonstrating excellent model fit. The fit statistics indicate strong model acceptability: $\chi^2 = 204.05$ with df = 138 ($\alpha = 0.05$), RMSEA = 0.047 (≤ 0.05 threshold), RMR = 0.033 (< 0.1 threshold), CFI = 0.99 (≥ 0.9 threshold), NFI = 0.97 (≥ 0.90 threshold), and GFI = 0.90 (meeting the ≥ 0.90 benchmark) (Hair et al., 2013, p. 579). The exceptionally high CFI value (0.99) particularly suggests outstanding model-data correspondence. This robust fit provides strong evidence that the proposed ESG construct structure aligns well with the empirical data, confirming that all six psychological dimensions (including Autonomy and self-presentation) accurately reflect users' perceptions of sustainability features in ride-hailing applications. The combination of low RMSEA and high CFI values indicates that respondents consistently interpreted scale items uniformly. These findings strengthen the instrument's validity for assessing sustainability-oriented gamification effectiveness and support its potential application in cross-platform or cross-cultural research. The strong structural validity also justifies retaining all items for subsequent analyses without elimination.

Table 2. Results of Fit Indices

X2/df	GFI	AGFI	RMSEA	NFI	CFI	PNFI	PGFI
1.478	0.90	0.87	0.047	0.97	0.99	0.78	0.60

Source: Processed data (2025)

The hypothesis testing followed (Hair et al., 2013) criteria, where hypotheses are accepted if the t-value exceeds 1.96 and the factor loading surpasses 0.50. The analysis confirmed that all hypotheses were supported, with every indicator satisfying both statistical thresholds ($t > 1.96$ and $\lambda > 0.50$). Consequently, no items required elimination during the CFA process, demonstrating the robustness of the measurement model. This outcome validates the theoretical relationships between observed indicators and their respective latent constructs within the ESG framework while confirming the appropriateness of all scale items for operationalizing the six psychological dimensions.

Table 3. First Order of Confirmatory Factor Analysis

First-order Latent Dimension	Item (Likert 1-5)	t-value	Loading factor
Autonomy	AU1: Freedom to choose eco-actions in online transportation	11.36	0.71
CR: 0.762	AU2: Choices based on personal values	11.48	0.72
AVE: 0.517	AU3: Freedom to do eco-actions my way	10.98	0.69
Competence	CO1: Accepted by online transportation eco-community	10.84	0.68
CR: 0.777	CO2: Engaged eco-conscious peers gamification	12.05	0.74
AVE: 0.538	CO3: Formed bonds with environmental collabor	12.09	0.74
Relatedness	RE1: Able to contribute via online transportation	12.76	0.78
CR: 0.821	RE2: Competent in completing challenges	12.03	0.74
AVE: 0.605	RE3: Understands eco-practices better	13.06	0.79
Enjoyment	EN1: Interested in exploring features	10.76	0.68
CR: 0.787	EN2: Excited to complete missions	12.62	0.76
AVE: 0.553	EN3: Finds features enjoyable	12.83	0.77
Self-efficacy	SEE1: Confident in completing tasks	11.73	0.72
CR: 0.757	SEE2: Has needed skills	11.42	0.70

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AVE: 0.510	SEE3: Capable of finishing missions	11.45	0.70
Self-presentation	SEP1: Builds eco-conscious image	12.47	0.75
CR: 0.869	SEP2: Shows active contribution	13.20	0.78
AVE: 0.623	SEP3: Makes a positive impression.	13.94	0.81
	SEP4: Projects responsible for image	13.90	0.80

Source: Processed data (2025)

The 19-item scoring (presented in Table 3) was demonstrated to be capable of discriminating between the six theoretical dimensions of the scale (Autonomy (3 items), Competence (3 items), Relatedness (3 items), Enjoyment (3 items), Self-efficacy (3 items), and Self-presentation (4 items). The factor loadings for all items were significant (>0.50), indicating a high contribution to the respective factors. For instance, the Autonomy factor was adequately represented by items as “freedom to choose eco-actions,” highlighting the importance of voluntary participation to create intrinsic motivation help to create intrinsic motivation within the volunteers. For example, those items that captured the facet Autonomy were those items settings: Those decisions arbitrating items as “freedom to choose eco-actions”. Determining that items represented the factor Autonomy the reviewer is giving. The fact that the t-values for each item were uniformly high also confirmed their statistical relevance and measurement consistency. The construct was sound regarding psychometric properties and Composite Reliability (CR) and Average Variance Extracted (AVE) were above the suggested cutoff values. Especially the Self-presentation dimension (CR = 0.869, AVE = 0.623) was noteworthy, wanting users to show a positive environmental identity as a strong motivation rather than as a reflection of a focus on social recognition inherent in collectivist values. This indicates that lifestyle dimensions that are not only sensitive enough to distinguish high from low performance but also able to include achievements would motivate greater use of different features and help to achieve social productivity of fitness promotion on platforms.

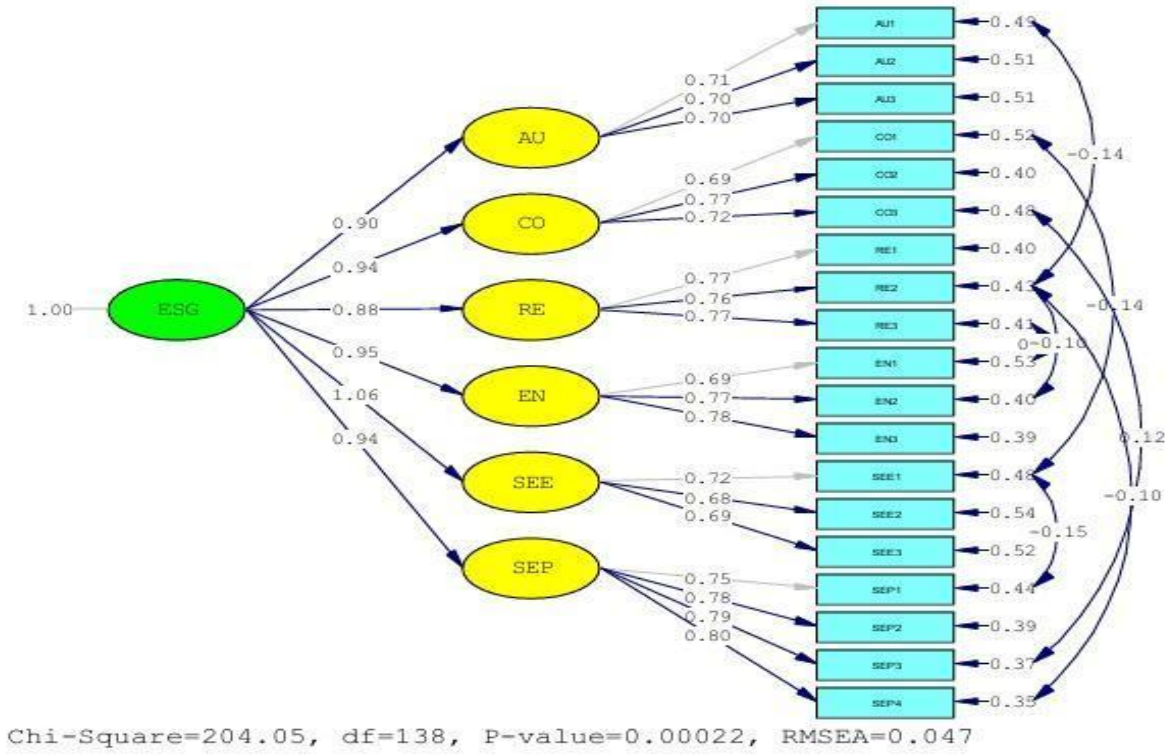
Table 4. Second Order of Confirmatory Factor Analysis

Second-order Latent Variables	First-order latent	t-value	Loading Factor
Environmental Sustainability Gamification (ESG)	Autonomy (AU)	11.05	0.90
	Competence (CO)	10.46	0.94
	Relatedness (RE)	10.92	0.88
	Enjoyment (EN)	10.68	0.95
	Self-efficacy (SEE)	11.83	1.06
	Self-presentation (SEP)	12.10	0.94

Source: Processed data (2025)

Table 4 demonstrates that all t-values for Autonomy, Competence, Relatedness, Enjoyment, Self-efficacy, and Self-presentation exceed 1.96, while all factor loadings (β) meet or surpass the 0.50 threshold (see Table 4). These results confirm that Environmental Sustainability Gamification (ESG) functions effectively as a second-order latent construct. Notably, the Enjoyment (β = 0.95) and Competence (β = 0.94) dimensions approach perfect loading values, indicating that user satisfaction during mission completion and perceived task mastery are powerful motivational drivers in gamification systems. This finding strongly supports implementing progressive reward structures and progress visualization features (e.g., leveling systems and ranking displays) to enhance long-term engagement. The Self-efficacy dimension demonstrates exceptional predictive power with a standardized loading of 1.06, revealing users' strong confidence in their capability to execute sustainable actions. This presents a critical opportunity to develop real-time visual feedback mechanisms, such as gamified carbon emission reduction reports, which foster user pride and cultivate sustainable self-identities through performance visualization.

Figure 2. Standardized Loading Factor



Source: Processed data (2025)

Convergent Validity and Reliability

Developing a robust measurement model requires verification of reliability and validity (Rufaidah, 2017). Construct reliability was evaluated using Composite Reliability (CR), with all values exceeding the 0.7 threshold (Hair et al., 2013). In Figure 2, the CR value is greater than 0.7, namely Autonomy CR: 0.762; Competence CR: 0.777; Relatedness CR: 0.821; Enjoyment CR: 0.787; Self-efficacy CR: 0.757; and Self-presentation CR: 0.869. Therefore, the construct is declared reliable. Convergent validity was assessed through Average Variance Extracted (AVE), with all constructs surpassing the 0.5 benchmark (Hair et al., 2013). Figure 1 demonstrates that all constructs exceeded the minimum Average Variance Extracted (AVE) threshold of 0.5, confirming convergent validity, with Autonomy (AVE = 0.517), Competence (AVE = 0.538), Relatedness (AVE = 0.605), Enjoyment (AVE = 0.553), Self-efficacy (AVE = 0.510), and Self-presentation (AVE = 0.623) all meet this criterion. The strong unidimensionality of the scale is further supported by a Comparative Fit Index (CFI) of 0.99 (Table II), significantly exceeding the 0.90 benchmark recommended by (Rufaidah, 2017), while the robust Composite Reliability (CR) and AVE values across all dimensions not only establish the measurement's reliability and validity but also confirm the psychological foundations of each construct within the online transportation context. These findings carry significant practical implications for ESG gamification design, suggesting that features aligned with the six validated dimensions - such as community challenges addressing Relatedness or visual reward systems catering to Self-presentation – will likely achieve high user acceptance. Platforms like Grab can leverage these psychometrically validated results to develop motivation-based behavioural segmentation strategies, where users scoring high on Enjoyment would respond best to interactive, narrative-driven features.

In contrast, Competence-oriented users would benefit more from tiered achievement systems. The successful CFA validation thus achieves dual objectives of strengthening the theoretical framework of ESG gamification while creating tangible opportunities for product design optimization and user experience enhancement in mobility platforms, with the robust metrics for Self-presentation (AVE = 0.623) specifically highlighting the importance of social recognition features in collectivist markets and suggesting high implementation potential for achievement-sharing functionalities. This validation provides an empirical basis for

gamification feature prioritization, enables data-driven user segmentation, and validates culture-specific design approaches for Southeast Asian markets, ultimately bridging the gap between psychometric validation and practical implementation in digital mobility platforms.

Discussion

The Confirmatory Factor Analysis (CFA) findings confirm that all indicators collectively form a valid and reliable structure for the Environmental Sustainability Gamification (ESG) construct. These findings further prove the importance of the six psychological components such as: Autonomy, Competence, Relatedness, Enjoyment, Self-efficacy, and Self-presentation in shaping sustainable behaviour intention among online transportation users. Interestingly, sellers were the strongest predictor, suggesting that the will to establish a pro-environmental self-image is the main driving force of behaviour in a collectivist society such as Indonesia. This is in line with previous research (Xi & Hamari, 2020), which showed that social rewards are a key factor affecting participatory decisions in the cases of digital sustainability interventions also in strong collectivist societies. The generalizability of these findings across cultural settings suggests that various gamification strategies that focus on social visibility and peer acknowledgment may effectively stimulate sustainable mode choice in the Southeast Asian context. These findings offer important implications for platform designers interested in customizing systems of engagement through culturally appropriate motivation strategies without the theoretical critique of the ESG model.

Examination of the loadings in the model showed that the dimensions of Competence and Relatedness had high weights, indicating that participants were experiencing satisfaction by accomplishing challenges (Competence) and feeling connected to other users (social Relatedness). These results demonstrate that gamification is more than just the fun of gaming. It is a form of a digital realm that promotes teamwork and social rewards for your effort. Ironically, this observation is consistent with the basic tenets of the Self-Determination Theory (Ryan & Deci, 2021). The results also emphasize the role of Enjoyment as the main positive driver of the early adoption of sustainability features. However, Enjoyment has relatively short-term effects, as demonstrated by (Aguiar-Castillo et al., 2023), who reported that the effects on gamification tend to vanish if Enjoyment modules are not coupled with intrinsic value. This means that future ESG designs must integrate Enjoyment aspects with more profound levels of meaning, that is, environmental purpose and sustainable self-identity.

Another two dimensions, including independence and self-efficacy, are also significant. The freedom to choose green actions fosters a sense of ownership and involvement, while self-efficacy in accomplishing challenges supports behavioural maintenance. In the context of gamification in online transportation, features such as selecting eco-friendly vehicles or personal mission options can strengthen both aspects. Interestingly, the CFA results also open discussions about the interaction between dimensions. For example, Competence and self-efficacy can mutually reinforce each other—users who feel confident in completing missions will perceive themselves as more competent, and vice versa. Therefore, successful gamification strategies should not target just one dimension but create psychological synergy across dimensions. Additionally, this study contributes to developing sustainable gamification literature by highlighting the Southeast Asian context, which remains relatively underexplored. Most previous research has focused on Europe or North America. Hence, findings from Indonesia provide new perspectives on how local cultural values, such as collectivism and respect for social norms, shape the effectiveness of ESG. In cultures where social recognition and community harmony are key behavioural drivers, features like community leaderboards, collective challenges, and digital symbols of environmental contributions become increasingly relevant and practical.

This study also expands on the findings of (Lubaba & Masyhuri, 2022), which showed that environmental attitude is an important mediator in the relationship between consumer innovation and the intention to purchase eco-friendly products. In the context of Grab's ESG, positive environmental attitudes can strengthen user engagement in sustainability missions, especially when accompanied by visual elements like emission contribution leaderboards. Previous research in the Journal of Business and Management found these findings are relevant to the study (Felita & Hardjono, 2022), emphasizing that perceived Enjoyment and brand attitude are dominant factors in building consumer engagement through gamification. However, this study expands the scope by showing that sustained engagement requires a holistic approach encompassing social, psychological, and environmental elements. The research also indicates that ESG success depends on feature design and effective communication of the environmental values associated with these features. Users may perceive the features as game elements without understanding that their digital actions have a positive environmental impact. Therefore, companies should incorporate data-based education, such as estimates of carbon savings, plastic waste prevented, or real-time

environmental impact information, to strengthen the connection between digital actions and sustainability values. These results confirm the importance of a multi-dimensional and locally-cultured approach in designing ESG. Gamification approaches cannot be generic but must be tailored to users' needs, preferences, and cultural values. In Indonesia, for example, social features like sharing achievements on social media or displaying environmental contribution badges on user profiles prove more effective than purely material incentives. These strategic implications show that ESG success requires synergy between feature design, psychological understanding of users, and explicit, consistent communication of sustainability values.

It should be noted that the relationships between various psychological dimensions in ESG are synergistic and mutually reinforcing. For example, people with high self-efficacy enjoy tasks more due to their confidence in their ability to succeed at challenging tasks. This is consistent with flow experience, where the optimal balance between challenge and skill induces deeper involvement. In the real world, ride-hailing apps could bake in tier challenges in a “daily or weekly mission” system that adjusts based on prior performance to keep users in the sweet spot of challenge performance. Local Indonesian cultural dimensions predominantly influence ESG success. Social recognition and community membership hold important values for users of a collectivist society. Hence, elements such as sharing completion stats via social media and competing with players from the same region can be helpful to social validation tools. In addition to the benefits of lower costs, letting people participate in local challenges also helps them feel they belong to a larger political (usually less formal) movement, such as the Green Movement in Indonesia, which Grab or the local government-sponsored.

Rapid advances in technology allow ESG to be more changeable. Based on user behaviour and machine learning, gamification systems can suggest rewards, challenges, or responses tailored to individual preferences. For instance, users who pick electric vehicles could learn special badges and mission recommendations, such as weekly carbon-saving challenges. This approach leverages personalized nudging that effectively shapes behaviour without compromising user liberality of action. Continued clicks can be further encouraged by incorporating real-time visual elements depicting impact. For example, inside the app, a 'useful' eco-dashboard feature could show users their estimated carbon saving, the number of green missions undertaken, and how much better they perform than their region's average. This would develop a sense of solidarity and favorable social comparison. Another interesting notion is that user motivation comprises tangible and psychological rewards. Many people are proud when their identity is connected to being green. As a result, in addition to discount or point motivations, platforms can include symbolic motivations such as digital badges (e.g., "Green hero of the month"), grateful messages, or even public endorsements of current users. Developing sustainability stories linking micro (user) actions with macro (environmental) outcomes is important for sustainable behaviour. This research paves the way for more narrative-driven approaches to ESG. Platforms can develop a strong community identity in sustainable practices by promoting user success stories or the collective effect of many network members inputs.

5. Conclusion

The primary results of the present research are that the ESG system measurement accurately constructs a latent factor from users’ six particular psychological factors: Autonomy driven by the capability of choice on involvement level in ESG, Competence established from the sense of reward system competency, Relatedness developed around the community aspect, Enjoyment stimulated by the visualization of the interface, self-efficacy created by feedback on users' contributions, and self-presentation supported by the presentation about the success and accomplishments of users. Unlike the CP, the ESG conceptual model provides a holistic assessment model for understanding why people adopt or do not adopt sustainable behaviours on digital platforms by capturing these psychological processes and whether various types of gamification elements effectively foster in fostering meaningful individual engagement. In today's sustainability-prioritized market, these parties adopt the Environmental Sustainability Gamification (ESG) approach to combat the problem space between user motivation and actual behaviour. A clear understanding of how users perceive motivated sustainability features is a prerequisite in designing more engaging strategies.

This research recognizes the limitations, such as the fast-changing technology development and the broad variance of local cultural preferences, which can impact on the adoption of gamification. Further studies could investigate how local cultural factors influence the acceptance and success of gamification in the digital context in more global and cross-cultural environments, for example, in the context of other culturally specific countries. Furthermore, it would be interesting for scholars to examine the possibility of incorporating multisensory content in ESG gamification initiatives to intensify consumer immersion. Challenges in the future will be adapting hardware to measurement scales and technological trends and further investigating multisensory integration to ensure that the individual feeling of presence reaches its maximum. However, these results lay a solid base for creating more

holistic, sustainable gamification design strategies with potential transferability to sustainability-oriented gamified digital services.

The practical implications of this research are substantial for online transportation services aiming to foster sustainable behaviour among their users. To maximize user engagement with Environmental Sustainability Gamification (ESG) features, platforms must move beyond simplistic external rewards and strategically balance them with fulfilling users' intrinsic psychological needs, as identified by the study's robust validation of the ESG framework. For instance, the finding that Self-presentation is the dominant predictor of sustainable behaviour (AVE = 0.623) in collectivist markets like Southeast Asia strongly suggests that platforms should prioritize features enabling users to visibly project a pro-environmental image. This could involve implementing 'eco-badge' features that visually display users' eco-friendly behavioural contributions on their profiles, allowing for social sharing of achievements, or integrating leaderboards that highlight top eco-contributors within communities. Such functionalities cater directly to the cultural emphasis on social recognition and can significantly amplify user motivation.

In line with recommendations to enhance Enjoyment, Grab could develop more interactive ESG missions (e.g., 'daily carbon reduction challenges'). However, our unique findings regarding self-presentation suggest the need for 'eco-badge' features that visually display users' eco-friendly behavioural contributions on their profiles, tailored to Indonesia's collectivist cultural characteristics. Furthermore, these research findings carry significant policy implications. Governments and regulators could encourage ESG adoption in the private sector by providing fiscal incentives or official recognition to digital platforms integrating gamification-based sustainability features. Public-private collaboration could accelerate digital transformation aligned with Sustainable Development Goals (SDGs). The ESG framework could extend to other sectors like education, healthcare, and waste management by adapting gamification designs to sector-specific contexts. Thus, gamification is a promotional or entertainment tool and a strategic instrument for broad social impact.

These findings provide critical theoretical contributions to understanding how gamification can be effectively integrated into sustainability-focused digital platforms, particularly when considering local cultural contexts. The study’s confirmation of ESG's six psychological dimensions in this study demonstrates that gamification strategies must be adapted technically, socially, and emotionally. From a practical perspective, effective ESG strategies must bridge intrinsic and extrinsic motivations. Enjoyable user experiences should be combined with meaningful purpose, social recognition, and authentic achievement. Grab and similar platforms have significant opportunities to pioneer green digital ecosystems through gamification innovations sensitive to user needs. Policy implications also become significant. Local governments and regulators can support ESG development through fiscal incentives, open environmental data integration, and official recognition for platforms demonstrating tangible sustainability contributions. The Public-private collaboration will be key to accelerating the widespread adoption of ESG.

This study's limitations primarily lie in its geographical context and methodological approach. Future research could develop longitudinal approaches to track changes in user motivation over time or explore qualitative methods to deepen understanding of emotional factors driving engagement. Additionally, further exploration could examine ESG integration in other digital service contexts, such as e-commerce, education, or healthcare. By tailoring gamification elements to sector characteristics and user needs, the ESG approach has the potential to become a strategic instrument in realizing more inclusive and impactful sustainable development agendas.

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