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Development and Validation of a *Sustainable Behavior* Scale for Generation Z in Indonesia

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Abstract : *Environmental sustainability challenges are intensifying alongside climate change, while Generation Z constitutes Indonesia's largest and most strategic demographic group, making their sustainable behavior vital for national development. This study aimed to develop and validate a contextually relevant Sustainable Behavior Scale for Indonesian Generation Z. Using a quantitative psychometric approach, data were collected from 486 respondents aged 16–28 years. Scale development was grounded in Corral Verdugo's multidimensional framework and examined using Exploratory Factor Analysis with minimum residual extraction and oblimin rotation. The analysis demonstrated adequate sampling adequacy (KMO = 0.781) and a significant Bartlett's Test of Sphericity ($p < .001$). A five-factor structure consisting of 19 items emerged, explaining 45.8% of the total variance. These factors represent behavioral dimensions of sustainable behavior in everyday life rather than causal determinants, including pro-ecological daily practices, resource conservation behavior, social responsibility and collective sustainability, fairness and intergenerational concern, and responsible consumption and lifestyle choices. The measurement model showed good fit (RMSEA = 0.049; TLI = 0.909) and acceptable internal consistency (α = 0.717). This study offers one of the first empirically validated multidimensional sustainable behavior scales tailored to Indonesian Generation Z, providing a robust instrument for future research.*

Keywords: Generation Z; Sustainable Behavior; Scale Development; Environmental Sustainability

INTRODUCTION

Environmental sustainability has become one of the most critical global challenges in recent decades, driven by accelerating climate change, ecosystem degradation, and excessive exploitation of natural resources (Choi, 2016 ; UNEP, 2021). Scientific evidence indicates that human activities have surpassed the Earth's ecological carrying capacity, resulting in a multidimensional crisis that threatens environmental integrity, public health, food security, and socio economic stability (IPCC, 2022; World Bank, 2023). These conditions highlight that environmental problems are not merely technological or policy related issues, but are fundamentally rooted in patterns of human behavior. Consequently, environmental psychology emphasizes the importance of understanding and measuring sustainable behavior as a key leverage point for addressing

environmental degradation (Steg & Vlek, 2009; Clayton et al., 2015; Ma'arif et al., 2023).

In Indonesia, environmental challenges are particularly evident in waste generation, unsustainable consumption, and inadequate waste management systems. National data show a persistent increase in solid and plastic waste, while recycling infrastructure and waste sorting practices remain limited, especially in urban areas (KLHK, 2023; World Bank, 2023). These structural constraints interact with lifestyle changes driven by urbanization and digital consumer culture, intensifying environmental pressure among younger populations (OECD, 2021; Steg et al., 2014 ; Quoquab et al., 2019). Previous studies suggest that sustainable behavior is shaped by a complex interplay of psychological, social, and contextual factors, including values, norms, habits, and situational barriers (Kollmuss & Agyeman, 2002; Gifford & Nilsson, 2014; Haryono, 2021). Therefore, understanding sustainable behavior requires a multidimensional perspective that goes beyond isolated actions or environmental awareness alone.

Generation Z occupies a strategically important position in this context. Representing approximately 27.94% of Indonesia's population (BPS, 2020), this generation will significantly influence the country's future environmental trajectory. As digital natives, Generation Z is highly exposed to information about climate change and sustainability through online media and social networks (Prensky, 2001 ; Twenge, 2017; Vukeli, 2021). International surveys consistently report high levels of environmental concern and climate-related anxiety among this cohort (Dimock, 2019; Pew Research Center, 2021; UNICEF, 2024).

However, empirical research repeatedly documents an attitude behavior gap, where strong pro environmental attitudes do not consistently translate into daily sustainable practices (Kollmuss & Agyeman, 2002; Barrera Hernández et al., 2020; Adishesa et al., 2024). This paradox is often explained by the presence of structural barriers (e.g., limited waste sorting facilities), habitual consumption patterns, and the dominance of low-effort behaviors over high effort ones (Haryono, 2021; Svendsen et al., 2020; Liu et al., 2024) . These findings imply that measuring sustainability solely through intentions or attitudes is insufficient; instead, instruments must capture reported behavioral practices across varying levels of effort and contextual constraints.

Theoretically, this study adopts the framework proposed by Corral Verdugo, which conceptualizes sustainable behavior as a multidimensional pattern of actions encompassing pro ecological behavior, resource conservation, altruism, and fairness (Corral Verdugo et al., 2006; 2011; 2021). This model is particularly relevant because it emphasizes positive psychological requirements for sustainability, such as self-regulation, social responsibility, and concern for intergenerational equity. Unlike dominant models such as the *Theory of Planned Behavior* (TPB), which primarily focuses on intention formation through attitudes, subjective norms, and perceived control, or the *Value Belief Norm* (VBN) theory, which centers on moral obligation (Palupi & Sawitri, 2017; Wicaksono et al., 2020; Khoiruman & Harsono, 2023; Magwegwe & Shaik, 2024), Corral Verdugo's framework explicitly conceptualizes sustainability as an integrated set of actual

behaviors embedded in everyday life This multidimensional and behavior focused orientation makes the framework especially suitable for addressing the attitude behavior gap and for developing measurement tools that move beyond cost benefit reasoning or moral intent alone.

Despite its conceptual strength, the application of this framework in Indonesia remains limited, particularly for Generation Z. Existing Indonesian studies on sustainable or pro environmental behavior predominantly rely on adapted or partial instruments that focus narrowly on specific domains, such as waste management or energy conservation (Adishesa et al., 2024; Jansen et al., 2024). These instruments often neglect key dimensions emphasized by Corral Verdugo, such as altruistic behavior, fairness, and broader social responsibility. Moreover, they rarely incorporate behaviors that reflect contemporary lifestyle characteristics of Indonesian Generation Z, including digital based advocacy, online consumption choices, or such as collective actions rooted in *gotong royong* (community based mutual cooperation). As a result, current measurement tools fail to fully capture the multidimensional and socioculturally embedded nature of sustainable behavior in the Indonesian context.

Contextualization is particularly important because sustainable behavior in Indonesia may differ substantially from Western settings where many existing scales were developed. For example, sustainable waste behavior in Indonesia is often constrained by limited access to waste sorting facilities, making communal initiatives or informal recycling practices more salient than individual household sorting. Similarly, collective actions grounded in *gotong royong*, such as community clean ups or shared resource management, represent culturally specific expressions of sustainability that are rarely reflected in Western centric instruments (Ma'arif et al., 2023; Ribeiro et al., 2023; Wei et al., 2024). Without incorporating these contextual realities, measurement tools risk misrepresenting actual sustainable practices among Indonesian youth.

Addressing these gaps, the present study aims to develop and validate a Sustainable Behavior measurement instrument specifically designed for Generation Z in Indonesia. Grounded in Corral Verdugo's multidimensional framework, this study employs a psychometric approach using *Exploratory Factor Analysis* (EFA) to identify the underlying behavioral dimensions and evaluate construct validity at the initial stage of scale development (Fabrigar et al., 1999; Hair et al., 2019). The novelty of this research lies in its explicit integration of a holistic theoretical model with the sociocultural and lifestyle characteristics of Indonesian Generation Z, ensuring that the instrument measures reported behavioral practices rather than attitudes or intentions alone. By providing a valid and reliable measurement tool, this study contributes to environmental psychology literature and offers a practical foundation for evidence-based interventions and policies aimed at promoting sustainable behavior in Indonesia.

RESEARCH METHODS

This study employed a quantitative approach using psychometric methods to develop and examine a Sustainable Behavior Scale for Generation Z in Indonesia. Sustainable behavior was conceptualized as a multidimensional construct encompassing pro ecological behavior, resource conserving behavior, altruistic behavior, and equitable behavior, based on the theoretical framework proposed by (Corral Verdugo et al., 2006; 2011). The study involved 486 Generation Z participants aged 16–28 years, recruited through purposive sampling via an online survey. Although the sample size met the minimum requirements for *Exploratory Factor Analysis* (EFA), this sampling technique may introduce self-selection bias, as participation was limited to respondents with adequate internet access and digital literacy. Therefore, the findings are not intended to represent the entire Generation Z population in Indonesia but rather to support the psychometric evaluation of the instrument at the initial stage of scale development.

Data were collected using a 48-item self-report questionnaire measured on a five point Likert scale ranging from Strongly Disagree (STS), Disagree (TS), Somewhat Agree (AS), Agree (S), to Strongly Agree (SS). Item development involved a literature review, blueprint construction based on theoretical dimensions, expert judgment to assess content validity, and a preliminary readability test. Construct validity was examined using *Exploratory Factor Analysis* (EFA) with JAMOVI version 2.3.28. Prior to factor extraction, data suitability was assessed using the *Kaiser Meyer Olkin* (KMO) *Measure of Sampling Adequacy* and *Bartlett's Test of Sphericity*. Factor extraction was conducted using the *minimum residual* (minres) method with *oblimin rotation*. Decisions regarding factor retention were based on eigenvalues, scree plot inspection, and theoretical coherence to obtain a stable and interpretable factor structure. Item purification was carried out iteratively by evaluating factor loadings, cross loadings, negative loadings, and uniqueness values. Internal consistency reliability was assessed using Cronbach's alpha coefficients for the overall scale and each extracted factor.

RESEARCH RESULTS and DISCUSSION

Data Adequacy and Assumption Testing for Factor Analysis

The adequacy of the data for factor analysis was examined using the *Kaiser Meyer Olkin* (KMO) *Measure of Sampling Adequacy* and *Bartlett's Test of Sphericity*. The results indicated a KMO value of 0.781, which falls within the good category, suggesting that the sample size was adequate for conducting factor analysis. In addition, *Bartlett's Test of Sphericity* yielded a statistically significant result (χ^2 = 2313; df = 171; $p < .001$), indicating that the correlation matrix was not an identity matrix. These findings confirm that the data met the statistical assumptions required for *Exploratory Factor Analysis* (EFA). These results demonstrate that the dataset met the necessary assumptions for conducting *Exploratory Factor Analysis* (EFA), providing a strong empirical foundation for identifying latent dimensions of sustainable behavior among Indonesian Generation Z.

Table 1 Assumption Checks (Barlett's Test of Sphericity)

χ^2	df	p
2313	171	< .001

The adequacy of the dataset for factor analytic procedures was systematically evaluated prior to conducting Exploratory Factor Analysis (EFA) to ensure that the statistical assumptions underlying factor extraction were sufficiently met. Two widely accepted diagnostic tests were employed for this purpose: the Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. These preliminary analyses are essential in psychometric research, as they assess whether the observed correlation matrix is suitable for identifying latent constructs and whether the sample size and inter-item correlations are adequate for factor analysis.

The Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy evaluates the proportion of variance among variables that might be common variance, that is, variance potentially attributable to underlying latent factors. KMO values range from 0 to 1, with higher values indicating a greater degree of shared variance among variables and, consequently, a stronger justification for applying factor analysis. According to established benchmarks, KMO values above 0.60 are considered acceptable, values between 0.70 and 0.79 are regarded as good, values between 0.80 and 0.89 as very good, and values of 0.90 or above as excellent. In the present study, the KMO value obtained was 0.781, which falls within the "good" category. This result indicates that the pattern of correlations among the items was sufficiently compact and that the shared variance was adequate to support reliable factor extraction.

The KMO value of 0.781 also suggests that the sample size of 486 respondents was appropriate for the number of items included in the initial scale development process. In psychometric research, particularly in exploratory factor analysis, an adequate ratio of participants to items is critical to ensure stable and interpretable factor solutions. While recommendations vary, many scholars suggest a minimum ratio of 5–10 participants per item, with larger samples preferred when the construct is multidimensional or when item communalities are expected to vary. Given the sample size and the resulting KMO value, the data in this study met these methodological expectations, thereby reducing the risk of unstable factor loadings or spurious factor structures.

In addition to the KMO measure, Bartlett's Test of Sphericity was conducted to examine whether the correlation matrix significantly differed from an identity matrix. An identity matrix indicates that variables are uncorrelated, which would render factor analysis inappropriate, as factor analysis relies on the presence of meaningful correlations among variables. Bartlett's Test evaluates the null hypothesis that the observed correlation matrix is an identity matrix. A statistically significant result indicates that the variables are sufficiently interrelated to justify factor analysis.

The results of Bartlett's Test of Sphericity in this study were statistically significant, with a chi-square value of $\chi^2 = 2313$, degrees of freedom (df) = 171, and a significance level of $p < .001$. This finding provides strong evidence to reject the null hypothesis that the correlation matrix is an identity matrix. In other words, the observed correlations among the scale items were significantly different from zero, indicating that the items shared meaningful relationships and were likely influenced by underlying latent dimensions. The magnitude of the chi-square value further suggests that the correlations were substantial enough to warrant factor extraction.

Taken together, the results of the KMO Measure of Sampling Adequacy and Bartlett's Test of Sphericity provide converging evidence that the dataset was well suited for Exploratory Factor Analysis. The KMO value demonstrated that the sample size and inter-item correlations were adequate, while Bartlett's Test confirmed that the correlation structure contained sufficient shared variance to allow for the identification of latent factors. These preliminary findings are particularly important in the context of scale development, as they establish the statistical legitimacy of proceeding with factor extraction and interpretation.

Beyond their technical significance, these results also have substantive implications for the study's objective of developing a Sustainable Behavior Scale tailored to Indonesian Generation Z. Sustainable behavior is inherently multidimensional, encompassing a range of practices, attitudes, and social considerations that manifest in daily life. The presence of adequate inter-item correlations suggests that the items designed to capture different aspects of sustainable behavior were not functioning in isolation, but rather reflected interconnected behavioral patterns. This interconnectedness is theoretically consistent with contemporary models of sustainable behavior, which emphasize the integration of ecological practices, social responsibility, resource conservation, and ethical considerations.

Moreover, the confirmation of factorability supports the use of Exploratory Factor Analysis as an appropriate methodological approach for uncovering the latent structure of sustainable behavior within this specific cultural and generational context. Given that most existing sustainable behavior scales have been developed in Western contexts, it is particularly important to empirically verify that newly developed items function coherently within an Indonesian Generation Z sample. The satisfactory KMO and Bartlett's Test results indicate that the items were interpreted in a sufficiently consistent manner by respondents, allowing underlying dimensions to emerge from the data rather than being imposed a priori.

These findings also contribute to the methodological rigor of the study by minimizing potential threats to construct validity. Conducting factor analysis without first establishing data adequacy can lead to misleading factor solutions, overextraction or underextraction of factors, and unstable loading patterns. By demonstrating that the data met the necessary statistical assumptions, the present study strengthens the credibility of subsequent EFA results, including factor structure, item retention decisions, and interpretation of latent dimensions.

At the item level, all retained items demonstrated *Measure of Sampling Adequacy* (MSA) values above the minimum threshold of 0.50, ranging from 0.581 to 0.846. This indicates that each item contributed sufficiently to the shared variance among variables. Items with higher MSA values showed stronger associations with the underlying latent constructs, while items with lower values remained within acceptable limits. These results support the suitability of the dataset for further factor analysis and provide evidence for the construct validity of the developed scale. This finding supports the construct validity of the scale and indicates that sustainable behavior among Generation Z can be meaningfully represented through underlying latent factors rather than isolated actions.

Table 2 KMO Measure of Sampling Adequacy

	MSA
Overall	0.718
SB 1	0.774
SB 3	0.829
SB 5	0.643
SB 6	0.728
SB 8	0.764
SB 9	0.653
SB 10	0.706
SB 13	0.846
SB 14	0.696
SB 15	0.740
SB 19	0.704
SB 20	0.784
SB 24	0.658
SB 26	0.581
SB 28	0.597
SB 29	0.678
SB 37	0.788
SB 42	0.669
SB 47	0.728

Following the evaluation of overall data suitability for Exploratory Factor Analysis (EFA), a more granular assessment was conducted at the item level using the Measure of Sampling Adequacy (MSA). Item-level MSA values provide critical information regarding the extent to which each observed variable contributes to the shared variance structure required for reliable factor extraction. This step is particularly important in scale development studies, as it allows researchers to identify problematic items that may not align well with the latent constructs or that may introduce noise into the factor solution.

The Measure of Sampling Adequacy assesses the proportion of variance in an item that can be explained by correlations with other items relative to the variance that is unique or error-related. Conceptually, higher MSA values indicate that an item shares substantial common variance with other variables and is therefore well suited for inclusion in factor analysis. Conversely, items with low MSA values suggest weak associations with the overall correlation structure and may undermine the stability and interpretability of the extracted factors. Methodologically, an MSA value of 0.50 is widely accepted as the minimum threshold for retaining an item, with values between 0.50 and 0.59 considered acceptable, values between 0.60 and 0.69 regarded as adequate, values between 0.70 and 0.79 as good, and values of 0.80 or higher as very good.

In the present study, all retained items demonstrated MSA values exceeding the minimum criterion of 0.50, with values ranging from 0.581 to 0.846. This finding indicates that each item made a sufficient contribution to the shared variance among variables and was appropriate for inclusion in the factor analytic procedure. The absence of items with subthreshold MSA values suggests that the initial item development process was theoretically coherent and empirically sound, minimizing the need for item elimination at this stage due to poor sampling adequacy.

The overall MSA value for the retained set of items was 0.718, which falls within the "good" category. This result indicates that, collectively, the items demonstrated a strong degree of common variance and were well integrated within the underlying correlation matrix. An overall MSA above 0.70 is generally interpreted as evidence that the dataset is well suited for factor analysis and that the resulting factor solution is likely to be stable and replicable. In the context of this study, the overall MSA further reinforces the conclusion that sustainable behavior among Indonesian Generation Z can be meaningfully conceptualized as a multidimensional construct composed of interrelated behavioral dimensions.

At the individual item level, several items demonstrated particularly strong sampling adequacy. For example, item SB13 yielded the highest MSA value (0.846), placing it in the very good category. This indicates that SB13 shared a substantial proportion of variance with other items and was strongly embedded within the latent structure of sustainable behavior. Items with such high MSA values typically function as robust indicators of the underlying construct and often exhibit strong factor loadings in subsequent EFA results. The high MSA value of SB13 suggests that this item captures a core aspect of sustainable behavior that resonates consistently with respondents and aligns well with the broader conceptual

framework of the scale.

Similarly, items SB3 (MSA = 0.829), SB37 (MSA = 0.788), SB20 (MSA = 0.784), SB1 (MSA = 0.774), and SB8 (MSA = 0.764) also demonstrated high levels of sampling adequacy. These items fall within the good to very good range, indicating strong inter-item correlations and meaningful contributions to the shared variance structure. The consistency of relatively high MSA values across multiple items suggests that the scale does not rely disproportionately on a small subset of indicators but instead reflects a well-distributed representation of sustainable behavior across different behavioral domains.

Items with moderate MSA values, such as SB6 (0.728), SB10 (0.706), SB19 (0.704), SB15 (0.740), and SB47 (0.728), also met acceptable to good criteria. These values indicate that while the items may not be the strongest indicators in terms of shared variance, they nevertheless contribute meaningfully to the factor structure. In scale development, the inclusion of such items is often theoretically justified, particularly when they capture unique or context-specific aspects of the construct that may not be fully represented by higher-loading items. In this study, retaining items with moderate MSA values supports a more comprehensive and culturally grounded representation of sustainable behavior among Generation Z.

A smaller subset of items demonstrated MSA values closer to the lower acceptable boundary, including SB26 (0.581), SB28 (0.597), SB5 (0.643), SB9 (0.653), SB24 (0.658), and SB42 (0.669). Although these items exhibited weaker associations with the overall correlation structure compared to higher-MSA items, they remained above the minimum threshold and therefore did not warrant exclusion. Importantly, MSA values in this range do not imply that the items are problematic; rather, they suggest that these behaviors may represent more specific, situational, or context-dependent aspects of sustainable behavior that are less uniformly practiced across respondents.

From a substantive perspective, the presence of items with varying MSA values may reflect the heterogeneity of sustainable behavior itself. Sustainable behavior among Generation Z is unlikely to manifest uniformly across all domains, as individuals may engage strongly in certain practices (e.g., daily pro-ecological actions or social responsibility behaviors) while engaging less consistently in others (e.g., specific consumption choices or intergenerational considerations). The retention of items with lower—but still acceptable—MSA values allows the scale to capture this variability, thereby enhancing its ecological validity and relevance to real-world behavioral patterns.

The item-level MSA results also provide important evidence supporting the construct validity of the developed Sustainable Behavior Scale. Construct validity refers to the extent to which an instrument accurately measures the theoretical construct it is intended to assess. One key aspect of construct validity is factorial validity, which involves demonstrating that items cluster together in a manner consistent with the underlying conceptual framework. The fact that all retained items demonstrated adequate MSA values indicates that they are not functioning as isolated indicators but are instead meaningfully connected to latent dimensions of sustainable behavior.

This finding is theoretically significant, as it supports the notion that sustainable behavior among Generation Z is best understood as a set of interrelated behavioral patterns rather than as a collection of independent actions. The adequate inter-item correlations implied by the MSA results suggest that behaviors such as resource conservation, pro-ecological daily practices, social responsibility, fairness, and responsible consumption are psychologically and behaviorally linked. This interconnectedness aligns with contemporary models of sustainability, which emphasize the integration of environmental, social, and ethical dimensions in shaping individual behavior.

Furthermore, the satisfactory item-level MSA values strengthen the empirical foundation for subsequent factor extraction and interpretation. Items with poor sampling adequacy can distort factor solutions by introducing excessive unique variance or measurement error, leading to unstable or uninterpretable factors. By confirming that all retained items met acceptable MSA criteria, the present study minimizes such risks and enhances confidence in the robustness of the extracted factor structure. This is particularly important given the study's aim to develop a multidimensional scale that can be used reliably in future research and applied settings.

In addition, the item-level MSA findings have practical implications for the potential use of the scale in program evaluation and policy-related research. Items that demonstrate adequate to strong sampling adequacy are more likely to perform consistently across different samples and contexts, increasing the generalizability of the instrument. For policymakers and practitioners seeking to assess sustainable behavior among Indonesian Generation Z, a scale composed of items with demonstrated sampling adequacy provides a more reliable basis for identifying behavioral strengths, gaps, and intervention targets.

The results presented in Table 2 further illustrate the balanced contribution of individual items to the overall measurement model. The distribution of MSA values across items suggests that the scale does not suffer from redundancy, as excessively high inter-item correlations can inflate MSA values while reducing content diversity. Instead, the observed range of MSA values reflects a healthy balance between shared variance and item specificity, which is desirable in multidimensional scale development.

Item Purification and Factor Structure of the *Sustainable Behavior* Scale

Item purification was conducted in a gradual and systematic manner to obtain a clear and stable factor structure. Items were eliminated based on several criteria, including cross loadings, negative factor loadings, low loading values, and high uniqueness scores. This process aimed to ensure that each item consistently represented a single factor and contributed meaningfully to the measurement of the construct. Item purification was conducted through a rigorous and transparent process, resulting in the reduction of items from 48 to 19. Items were removed due to cross loadings, negative loadings, low factor loadings, or high uniqueness values. The final EFA solution revealed a five-factor structure that collectively

explained 45.8% of the total variance, which is considered acceptable in behavioral and psychological scale development. More importantly, this structure reflects the multidimensional nature of sustainable behavior, consistent with Corral Verdugo's theoretical framework. However, moving beyond statistical adequacy, each factor represents a distinct psychological and behavioral dimension of sustainable behavior as experienced by Indonesian Generation Z. These dimensions are interpreted as follows.

Table 3 Item Purification Selection Results

Elimination Criteria	*Items* Eliminated
Items not *loading* onto factors	-
Cross-loading items	SB7, SB11, SB12, SB16, SB17, SB18, SB22, SB23, SB25, SB30, SB31, SB32, SB34, SB35, SB36, SB39, SB40, SB41, SB44, SB45, SB46.
Items loading negatively	SB25, SB27, SB30, SB32, SB33, SB38, SB41, SB43, SB48.
Items with high *uniqueness* (>0.70)	SB2, SB4, SB5, SB24.
Items with low *loading* (<0.30)	SB2, SB4, SB5, SB16.

Following the initial extraction of factors in the Exploratory Factor Analysis (EFA), a systematic item refinement process was undertaken to ensure the psychometric quality, interpretability, and theoretical coherence of the Sustainable Behavior Scale. Item elimination was guided by a set of well-established statistical and conceptual criteria commonly applied in scale development research, including factor loadings, cross-loadings, loading directionality, item uniqueness, and minimum loading thresholds. This multistep refinement process was essential to achieving a parsimonious factor structure that accurately reflects the latent dimensions of sustainable behavior among Indonesian Generation Z.

First, items were examined for their ability to load meaningfully onto at least one factor. Items that fail to load onto any factor typically indicate weak associations with the underlying latent constructs or poor conceptual alignment with the scale framework. In the present analysis, no items were eliminated due to a complete lack of factor loadings. This result suggests that all items demonstrated some degree of association with the factor solution, reflecting the overall coherence of the initial item pool and the theoretical grounding of the scale development process.

Second, cross-loading items were identified and evaluated. Cross-loading occurs when an item loads substantially on more than one factor, which can compromise the discriminant validity of the factor structure by blurring conceptual boundaries between dimensions. To maintain factorial clarity, items were flagged for removal when they exhibited similar or substantial loadings across multiple factors without a clear theoretical justification for multidimensionality. Based on this criterion, a substantial number of items were eliminated, including SB7, SB11, SB12, SB16, SB17, SB18, SB22, SB23, SB25, SB30, SB31, SB32, SB34, SB35, SB36, SB39, SB40, SB41, SB44, SB45, and SB46. The removal of these cross-loading items contributed to clearer factor separation and enhanced

the interpretability of each retained factor as a distinct behavioral dimension.

Third, items displaying negative factor loadings were examined. Negative loadings indicate that an item is inversely related to the latent construct represented by the factor, which may reflect reverse wording, conceptual inconsistency, or respondent misunderstanding. In the absence of a clear theoretical rationale for reverse-coded indicators, such items can introduce interpretive ambiguity and reduce internal consistency. Items identified with negative loadings included SB25, SB27, SB30, SB32, SB33, SB38, SB41, SB43, and SB48. Given the aim of developing a scale with straightforward interpretability and consistent directional meaning, these items were excluded from the final model.

Fourth, item uniqueness was assessed to evaluate the proportion of variance in each item not explained by the extracted factors. High uniqueness values indicate that an item is largely influenced by measurement error or idiosyncratic variance rather than by the common factors. Consistent with psychometric guidelines, items with uniqueness values greater than 0.70 were considered problematic and candidates for elimination. Based on this criterion, items SB2, SB4, SB5, and SB24 were removed, as they contributed limited shared variance to the factor solution and weakened the overall explanatory power of the model.

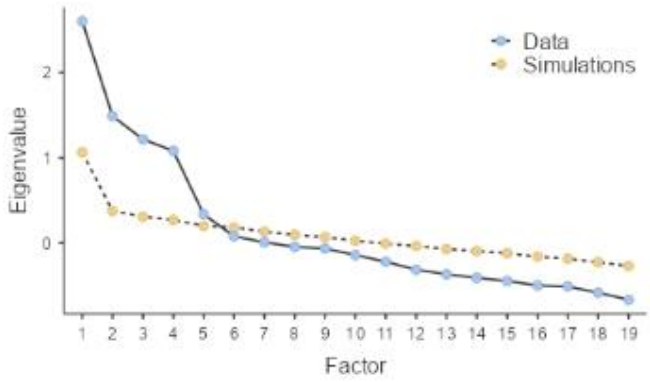
Finally, items were evaluated based on their absolute factor loading magnitude. Factor loadings represent the strength of the relationship between an item and its corresponding latent factor. Loadings below 0.30 are generally considered weak and suggest that an item does not function as a meaningful indicator of the construct. Items SB2, SB4, SB5, and SB16 exhibited low factor loadings below this threshold and were therefore eliminated. Notably, some of these items overlapped with those identified through the high uniqueness criterion, reinforcing the decision to remove them.

The application of multiple, overlapping elimination criteria reflects a conservative and rigorous approach to item refinement. Rather than relying on a single statistical indicator, decisions to remove items were informed by a combination of empirical evidence and theoretical considerations. This approach reduces the risk of overfitting the data and enhances the generalizability of the resulting factor structure.

Based on the item purification results, out of the initial 48 items, 19 items remained that met the psychometric criteria and were deemed acceptable. These items are SB1, SB3, SB5, SB6, SB8, SB9, SB10, SB13, SB14, SB15, SB19, SB20, SB24, SB26, SB28, SB29, SB37, SB42, and SB47, which show adequate *factor loadings*, do not experience *cross-loading* or negative *loadings*, and have acceptable *uniqueness* values.

Table 4 Factor Loadings

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Uniqueness
SB 1	0.533					0.68617
SB 3	0.558					0.66397
SB 5					0.583	0.56696
SB 6	0.735					0.42724
SB 8	0.696					0.47697
SB 9				0.486		0.70355
SB 10					0.619	0.58247
SB 13	0.635					0.47193
SB 14				0.588		0.62041
SB 15					0.603	0.58292
SB 19				0.713		0.48296
SB 20					0.501	0.65361
SB 24				0.556		0.69717
SB 26			0.999			0.00500
SB 28			0.612			0.60574
SB 29			0.413			0.81796
SB 37		0.592				0.55065
SB 42		0.892				0.22639
SB 47		0.717				0.48621



Grafik 1 Data

The EFA results, using the minimum residual extraction method with oblimin rotation, revealed a five factor solution. The factors were retained based on *eigenvalues* greater than one, *scree plot* examination, and theoretical considerations. Collectively, the five factors explained 45.8% of the total variance, indicating that the extracted factor structure adequately represents the *Sustainable Behavior* construct. Each factor demonstrated a clear loading pattern without *cross loading* issues, supporting the multidimensional nature of *sustainable behavior* among Generation Z.

Table 5 Factor Statistics

Factor	SS Loadings	% of Variance	Cumulative %
1	2.24	11.81	11.8
2	1.75	9.23	21.0
3	1.61	8.46	29.5
4	1.54	8.11	37.6
5	1.55	8.16	45.8

Model Fit, Reliability, and Implications of the Findings

The goodness of fit indices indicated that the measurement model exhibited satisfactory fit. The RMSEA value of 0.049 suggested good *model fit*, while the *Tucker Lewis Index* (TLI) value of 0.909 exceeded the recommended cutoff value. These results demonstrate that the five factor model is empirically supported and consistent with the theoretical framework of sustainable behavior.

Table 6 Model Fit

RMSEA	Lower	Upper	TLI	BIC	χ^2	df	p
0.0493	0.0394	0.0593	0.909	-345	183	86	< .001

Table 7 Scale Reliability

Scale	Number of Items	Cronbach's Alpha
Overall Scale	19	0.717
Factor 1	5	0.769
Factor 2	3	0.786
Factor 3	4	0.686
Factor 4	3	0.686
Factor 5	4	0.661

Reliability analysis showed that the overall scale achieved acceptable internal consistency, with a *Cronbach's alpha* coefficient of 0.717. At the factor level, several factors demonstrated good reliability, while others showed moderate yet acceptable reliability. These findings indicate that the scale is sufficiently reliable for research purposes, although certain factors may benefit from further refinement in future studies.The results confirm that the *Sustainable Behavior* Scale developed in this study possesses adequate construct validity and reliability and is appropriate for use within the Indonesian Generation Z context. This study contributes empirically to the development of a contextually relevant and psychometrically sound instrument for measuring sustainable behavior, thereby reinforcing the novelty of the present research in the field of environmental psychology.

Factor Interpretation and Theoretical Integration

The results of the *Exploratory Factor Analysis* revealed the emergence of five empirical factors representing the structure of sustainable behavior among Generation Z in Indonesia. These factors are not interpreted as causal determinants, but rather as behavioral dimensions that describe how sustainable behavior is expressed and experienced in everyday life. Although Corral Verdugo's theoretical framework conceptualizes sustainable behavior into four main dimensions pro ecological behavior, resource conservation, altruism, and fairness the five factor structure identified in this study reflects a contextual differentiation of these theoretical dimensions when operationalized within the Indonesian Generation Z context.

Specifically, one theoretical dimension was differentiated into two more behaviorally specific empirical factors. This differentiation indicates that respondents perceive and practice certain forms of sustainability related behavior as distinct, even though they remain conceptually within the same theoretical domain. This finding suggests that sustainable behavior is shaped not only by abstract value structures but also by sociocultural contexts, lifestyle patterns, and structural opportunities that influence how Generation Z enacts sustainability, particularly in urban and digitally mediated environments.

The five empirical factors represent: (1) pro ecological practices in daily activities, (2) resource conservation behavior, (3) social responsibility and collective sustainability, (4) fairness and intergenerational concern, and (5) responsible consumption and lifestyle choices. The first and fifth factors can be understood as empirical differentiations of the pro ecological behavior dimension, whereby Generation Z distinguishes between routine environmentally friendly habits and consumption related decisions that involve economic and lifestyle considerations. Meanwhile, the second factor directly represents resource conservation, the third reflects the altruistic dimension within a social and communal context, and the fourth corresponds to the fairness dimension as proposed in Corral Verdugo's framework.

Theoretically, these findings support the validity of Corral Verdugo's multidimensional model in a developing country and collectivist cultural context, while also extending the framework by demonstrating that expressions of sustainable behavior may become empirically fragmented according to sociocultural conditions and generational characteristics. Thus, the five-factor structure identified in this study does not indicate a deviation from the theoretical model, but rather illustrates how theoretical dimensions of sustainable behavior are manifested more specifically in the everyday practices of Indonesian Generation Z.

CONCLUSION

This study aimed to develop and evaluate a valid and reliable Sustainable Behavior measurement instrument for Generation Z in Indonesia using a psychometric approach. The results of the *Exploratory Factor Analysis* (EFA)

indicate that sustainable behavior among Generation Z is a multidimensional construct consisting of several interrelated factors, confirming the theoretical framework proposed by Corral Verdugo. The extracted factor structure demonstrates that sustainable behavior extends beyond pro environmental actions to include resource conservation, social concern, and fairness related behaviors. The retained items showed adequate *factor loadings* and acceptable internal consistency, indicating that the developed instrument has satisfactory construct validity and reliability. These findings suggest that *sustainable behavior* among *Generation Z* should be understood as an integrated pattern of daily actions rather than a single behavioral tendency.

One of the main strengths of this study is the development of a contextually relevant measurement tool that reflects the behavioral characteristics of Generation Z in Indonesia, thereby addressing the lack of empirically validated instruments in this context. Nevertheless, several limitations should be noted. The use of convenience sampling may limit the generalizability of the findings, and some factors demonstrated moderate reliability, indicating the need for further refinement of the scale. In addition, the reliance on self report data may introduce response bias. Despite these limitations, the instrument developed in this study has practical and theoretical potential. It can be used in future research, program evaluation, and policy development related to sustainability behavior. Future studies are encouraged to conduct *confirmatory factor analysis* (CFA), apply the instrument to more diverse samples, and explore its relationship with other psychological and contextual variables to strengthen its validity and applicability.

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