



An Extended Theory of Planned Behavior with Environmental Spirituality in Indonesia: Study Circular Economy Behavior in Urban Households

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Abstract: This study examines the determinants of household circular economy behavior (CEB) by extending the Theory of Planned Behavior (TPB) with environmental spirituality (ES). A quantitative approach was employed, with the research design based on an extended TPB model. The subjects of this study were households in Semarang City, selected through random sampling. The final sample comprised 270 families. The questionnaire consisted of nine sections: demographic or respondent characteristics and eight research variables. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), followed by multi-group analysis (MGA) to compare individuals with secondary and higher education levels. The results of this study indicate that ES significantly strengthens subjective norm (SN) and perceived behavioral control (PBC), but does not directly influence CEB. This finding suggests that spirituality exerts its impact primarily through psychological mechanisms rather than via immediate behavioral actions. The intention to engage in circular economy practices (circular economy intention, CEI) is the strongest predictor of CEB in urban households. MGA further reveals differences by education level: PBC has a stronger effect in the secondary-education group, whereas SN and situational factors (SFs) exert stronger effects among the higher-education group. Theoretically, this study highlights the urgency of integrating spiritual values into extended TPB models. It suggests that ES can serve as a predictor of culturally grounded pro-environmental cognition in highly religious societies. The findings offer novel insights relevant to the field of sustainability psychology, particularly in cultural contexts similar to those in Malaysia, Brunei Darussalam, and the Middle East.

Keywords: Circular economy behavior; Circular economy intention; Environmental spirituality; Extended Theory of Planned Behavior; Multi-group analysis

1 Introduction

Environmental degradation, such as climate change and pollution, represents a crucial public concern and has become a global issue across all regions [1–4]. Another equally pressing environmental issue is waste management, which has drawn significant attention globally, particularly in urban areas of developing countries, including Indonesia [5–9]. Population growth and rapid industrialization are primary contributors to the increase in waste in developing countries that experience rapid demographic expansion and urbanization [10–13].

Households are among the primary sources of municipal solid waste [14–16]. Waste generated from household activities poses severe environmental challenges, contributing not only to pollution but also to risks to human health and the biotic environment [17–20]. These challenges highlight the urgency of behavioral change in household waste management practices. Building a balanced and harmonious relationship between human populations and the natural environment requires behavioral transformation, as human actions are a fundamental driver of environmental

challenges [21]. This has led scholars to argue that the most effective way to mitigate adverse anthropogenic impacts on the environment is by fostering pro-environmental behavior [22].

A central example of pro-environmental behavior is the practice of reducing, reusing, and recycling (3R), which also constitutes a key component of the circular economy. The circular economy represents a paradigm shift intended to reduce waste and promote sustainable resource use through practices such as recycling, reuse, and sustainable production [23]. It reflects a transformation from a linear economy, characterized by extract–produce–dispose patterns, toward a restorative and regenerative system that emphasizes resource reduction, reuse, and recycling [24]. The circular economy fosters industrial symbiosis by reintroducing industrial byproducts and consumer waste into the supply chain as raw materials [25].

The potential of 3R and broader circular economy behavior (CEB) underscores the need for attitudinal and behavioral shifts to ensure environmental sustainability and support the transition toward a green economy. However, attitudinal change is gradual and requires consistent, long-term processes to foster positive orientations [26]. Many individuals still fail to take meaningful actions to mitigate their environmental impact [27].

Accordingly, studying human behavior related to 3R and circular economy practices is essential. This aligns with Kates [28], who emphasized 3R behavior as a means to counter the damage caused by consumerist cultures. Similarly, Ottman [29] highlighted green consumption as a potential cornerstone of a global green revolution, underscoring the significant role of consumers in environmental protection. This behavioral inquiry is also consistent with Gifford [30], who argued that understanding behavior at the psychological level is crucial, as the cumulative effects of individual choices remain key drivers of climate change.

The Theory of Planned Behavior (TPB) provides a useful framework for analyzing such behavior, as it has been widely applied to examine human behavior, particularly pro-environmental practices and waste management. TPB posits that intentions are the most reliable predictors of behavior. In contrast, intentions themselves are influenced by psychological factors such as subjective norms (SNs), behavioral attitudes, and perceived behavioral control (PBC) [31]. Prior studies have applied TPB to explore various pro-environmental behaviors, including green purchasing [32, 33], employees' energy-saving behavior [34], waste-sorting [35–39], household waste management [40–42], and other sustainable behaviors [43, 44].

Despite enduring criticism and limitations [45], TPB has withstood the test of time. Nonetheless, given the complexity of human behavior, TPB alone is insufficient to fully explain the drivers of waste management behavior [46, 47]. Consequently, numerous efforts have sought to adapt, extend, and refine TPB to improve its predictive utility [48, 49]. Ajzen [50] also underscored that TPB is inherently open to the inclusion of additional predictors, allowing extended models to better account for individual behavior [51].

One of the most frequently added variables is moral norms [52]. Other extensions include knowledge [53–55], awareness of consequences [56–58], moral responsibility or obligation [41, 59–61], place attachment [62, 63], facility availability [64, 65], situational factors (SFs) [66–68], information publicity [69, 70], and self-identity [71].

A relatively underexplored extension involves religion, belief systems, religiosity, or spirituality. Several studies have attempted to integrate religiosity and spirituality within TPB [72–76]. Indeed, religiosity and spirituality have been shown to significantly influence individual pro-environmental behavior, as evidenced in studies [77–80]. Spirituality is an especially important variable, as religion prescribes rules, requirements, and sanctions that directly shape behavior [81], while also molding culture, values, and norms within societies [82]. Nearly all religions regard humans as stewards entrusted with safeguarding God's creation, including the natural environment [83].

In this context, this study aims to analyze 3R practices and broader CEB among urban households using an Extended Theory of Planned Behavior (ETPB) framework that incorporates environmental spirituality (ES). The novelty of this research lies in integrating ES into ETPB, a direction that remains underexplored in the existing literature. Similar studies are scarce in Indonesia, a country known for its high levels of spirituality and whose state philosophy, Pancasila, anchors its first principle on “Belief in the Almighty God”, requiring every citizen to adhere to a religion. Prior research has been more prevalent in contexts such as Malaysia, Iran, China, and India.

2 Methodology

2.1 Research Design

This study employed a quantitative approach. The research design was based on the ETPB, an extension of TPB [31], with the addition of a new variable, namely ES. The primary focus of this study was to analyze the variables influencing household behavior in adopting circular economy practices in urban areas. The variables investigated included attitudes toward the circular economy, SNs, PBC, intention toward the circular economy, CEB, circular economy knowledge (CEK), SFs, and ES.

The hypotheses formulated for this study were as follows:

H1: ES influences circular economy attitudes (CEA).

H2: ES influences SNs.

H3: ES influences PBC.

- H4: ES influences circular economy intention (CEI).
H5: ES influences CEB. H6: Attitudes toward the circular economy influence CEI.
H7: SNs influence CEI.
H8: PBC influences CEI.
H9: CEK influences CEI.
H10: SFs influence CEI.
H11: CEI influences CEB.

The conceptual design of this research is illustrated in Figure 1.

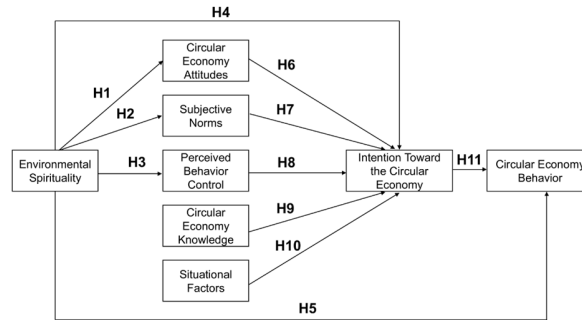


Figure 1. Theoretical framework

2.2 Research Location

This study was conducted in Semarang City, Central Java Province, which comprises 16 sub-districts with a total area of 373.78 km². Semarang was chosen as the research site because it is among the 10 largest metropolitan cities in Indonesia, with a large population and high population density, and significant waste production. In 2023, the population of Semarang reached 1,694,740, with a density of 4,534 people/km² [84]. Waste production in the city is exceptionally high; in September 2022, the volume of waste transported to the landfill (TPA) reached 1,110–1,150 tons per day [85]. Furthermore, reference [86] reported that throughout 2023, the total volume of collected waste reached 293,003 m³ per day. These conditions underscore why Semarang presents a compelling context for this study.

The sociocultural composition of Semarang further strengthens its significance as a research location. The city's residents are religiously diverse. According to study [84], out of 1,694,740 inhabitants, 87.55% identify as Muslims, 6.82% as Protestants, 4.95% as Catholics, 0.07% as Hindus, 0.59% as Buddhists, and 0.03% adhere to other religions. Moreover, the city is home to a variety of ethnic and cultural groups, creating a multicultural society that makes the study of household behavior in such a demographic context particularly relevant.

2.3 Participants

The subjects of this research were households in Semarang City, selected using random sampling, yielding a sample of 270 families. We consider this sample size sufficient, in line with Byrne [87], who stated that the minimum acceptable sample for Structural Equation Modelling (SEM) estimation is 100. Kline [88] also stated that the minimum sample size for SEM estimation is more than 200 for complex models, a criterion met in this study. Furthermore, the sample size satisfies the commonly applied “10-fold rule” in Partial Least Squares Structural Equation Modeling (PLS-SEM). Based on the largest number of structural paths directed to the endogenous construct CEI, which receives six arrows, the minimum required sample is $10 \times 6 = 60$ cases. Similarly, for the largest measurement block (ES with 8 indicators), the minimum required sample is $10 \times 8 = 80$ cases. Thus, the current sample ($N = 270$) exceeds all recommended thresholds for reliable PLS-SEM estimation. The ideal sample in this study comprised household heads aged 18 years or older, who possess the authority to make decisions concerning the three circular economy practices proposed for their households [89].

2.4 Data Collection Techniques and Instruments

Data collection in this research combined personal interviews and printed questionnaires. Conducting direct interviews allowed respondents to take the necessary time to reflect on their answers, while interviewers were available to clarify uncertainties, thereby minimizing incomplete responses [90]. Questionnaires were administered in two formats: paper-and-pencil and web-based, both in Indonesian. Both formats used a standardized set of instruments, including self-administered questionnaires (paper or digital), confidentiality agreements, explanatory sheets detailing the research objectives, target populations, and completion instructions.

The primary data collection instrument used in this study was a questionnaire. The research employed a combination of scales and questionnaires, carefully adapted and modified to accommodate the cross-cultural context

of the investigation. Adjustments to the questionnaire items were made to enhance respondents' comprehension, acknowledging that intrinsic meanings may be interpreted differently across various backgrounds. Furthermore, the questionnaire items had previously been validated for reliability and validity in earlier studies, ensuring methodological rigor and measurement integrity.

The primary instrument was a questionnaire comprising nine sections covering respondent demographics (gender, age, occupation, income, education level, and religion) and eight research variables. The attitude toward the circular economy construct contained four items. SNs were measured with six items; PBC with five items; CEK with five items; SFs with six items; CEI with four items; CEB with six items; and ES with eight items. In total, 45 items were employed to measure the eight variables. These items were adopted from prior studies [55, 56, 66, 91–95]. A five-point Likert scale was used to structure responses.

2.5 Data Analysis

As described in Section 2.4, data were collected through personal interviews and printed questionnaires, and subsequently prepared for analysis [96]. Questionnaires were administered in two formats: paper-and-pencil and web-based, both in Indonesian. Both formats used a standardized set of instruments, including self-administered questionnaires (paper or digital), confidentiality agreements, explanatory sheets detailing the research objectives, target populations, and completion instructions.

The data from surveys and observations were entered into Microsoft Excel for tabulation, coding, and grouping by variables and indicators, then saved in CSV format and exported to SmartPLS 4 for analysis. PLS-SEM with multi-group analysis (MGA) and bootstrapping was applied to maximize the R-square values and minimize predictive residuals or errors [97], as well as to evaluate the significance levels of each hypothesis for different education groups. The analysis involved two stages:

2.5.1 Full model analysis

At this stage, full model evaluation was conducted with each variable assessed using first-order confirmatory factor analysis (CFA). Model assessment comprised evaluating the outer and inner models. The outer model evaluation assessed measurement constructs separately to examine convergent validity, discriminant validity, and internal consistency reliability (composite reliability (CR) and Cronbach's alpha). The inner model evaluation considered three aspects: coefficient values and directionality, significance of parameter estimates, and determination coefficients (R^2) and effect sizes. Reciprocal relationships were evaluated concurrently with the inner model. If outer model testing identified invalid or unreliable constructs, the model was revised (re-specified) by eliminating invalid constructs. Furthermore, moderating variables were evaluated within the inner model by comparing p -values < 0.05 using bootstrapping.

2.5.2 Comparative model analysis between groups

At this stage, models were compared descriptively and using t-tests between groups based on the highest education level (based on the highest education level (secondary education/SMP-SMA versus higher education/Diploma-Bachelor). In addition to assessing p -values for each group, differences between the groups were systematically compared.

The specification of the construct model in this study is presented in Figure 2 and Table 1.

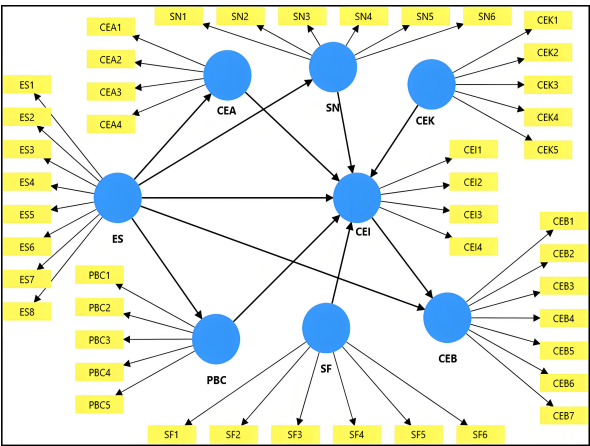


Figure 2. Initial research model

Note: ES, environmental spirituality; CEK, circular economy knowledge; SF, situational factor; CEA, circular economy attitude; SN, subjective norm; PBC, perceived behavior control; CEI, circular economy intention; CEB, circular economy behavior.

Table 1. Research model specification

Latent Variable		Indicator Item	Symbol
Exogenous latent	Environmental spirituality (ES)	1. There exists a spiritual connection between humans and the natural environment.	ES1
		2. The natural environment possesses a sense of sacredness.	ES2
		3. All entities in nature are spiritually interconnected.	ES3
		4. Nature is a source of spiritual resources.	ES4
		5. I experience a profound sense of awe toward nature.	ES5
		6. When immersed in nature, I feel a sense of wonder.	ES6
		7. At times, I am captivated by nature's beauty.	ES7
		8. There is nothing more pleasurable than being in nature.	ES8
	Circular economy knowledge (CEK)	1. I am more knowledgeable about waste management than the average person.	CEK1
		2. I am aware of the negative impacts resulting from excessive waste accumulation.	CEK2
		3. I believe I am knowledgeable regarding proper household waste management.	CEK3
		4. I recognize that thousands of species will face extinction in the coming years due to improper waste practices.	CEK4
		5. I understand that proper waste management can generate economic benefits.	CEK5
	Situational factors (SFs)	1. I do not have sufficient space or facilities for sorting and recycling household waste.	SF1
		2. Most vendors around me continue to use plastic packaging.	SF2
		3. I lack adequate tools for sorting and processing waste.	SF3
		4. I am aware of and can utilize the waste management facilities available in my vicinity.	SF4
		5. I perceive circular economy activities as labor-intensive and time-consuming.	SF5
		6. Most public facilities and merchandise near me still rely on single-use products.	SF6
Endogenous latent	Circular economy attitude (CEA)	1. I believe that practicing the circular economy is beneficial.	CEA1
		2. I perceive the circular economy as essential for environmental conservation.	CEA2
		3. I consider the circular economy critically important for addressing natural resource scarcity.	CEA3
		4. I find participation in the circular economy enjoyable.	CEA4
	Subjective norms (SNs)	1. Most people important to me (family, friends, etc.) believe we should practice the circular economy.	SN1
		2. Individuals in my organizations (school, university, workplace, etc.) wish to engage in circular economy practices.	SN2
		3. Most people important to me would approve if I practiced the circular economy.	SN3
		4. Most people important to me would criticize me if I did not practice the circular economy.	SN4
		5. My neighbors expect me to engage in circular economy practices.	SN5
		6. My religious leaders (imam, pastor, monk, etc.) influence me to practice the circular economy.	SN6
	Perceived behavior control (PBC)	1. Engaging in the circular economy demands considerable effort and does not fully solve waste issues.	PBC1
		2. I believe I possess the skills necessary to manage waste and practice the circular economy effectively.	PBC2
		3. I have ample opportunities and free time for recycling or repurposing waste and participating in the circular economy at home.	PBC3
		4. I feel uncomfortable and find it cumbersome to perform waste reduction, reuse, and recycling.	PBC4
		5. I have complete autonomy in deciding whether to reduce, reuse, and recycle household waste.	PBC5
	Circular economy intention (CEI)	1. I intend to practice the circular economy to support environmental sustainability.	CEI1
		2. I intend to allocate time and effort for recycling household waste.	CEI2
		3. I intend to participate in recycling and waste management programs organized by local authorities.	CEI3
		4. I intend to recommend and encourage others to participate in the circular economy.	CEI4
	Circular economy behavior (CEB)	1. I never recycle household waste.	CEB1
		2. I recycle cans, paper, cardboard, bottles, etc., at home.	CEB2
		3. I separate food waste, wet and dry waste, and organic from inorganic materials at home.	CEB3
		5. I repurpose unused items for other purposes at home.	CEB5
		7. I conserve the use of plastics, paper, tissues, and other single-use items at home.	CEB7

3 Results

The initial model analysis did not satisfy the criteria for validity and reliability, necessitating a model revision by excluding several indicators, specifically CEB4, CEB6, SF3, SF4, SF6, PBC1, and CEK5, from their respective constructs. This adjustment ensured all parameters met the minimum requirements for validity and reliability. The results of the revised SEM analysis are presented in Figure 3.

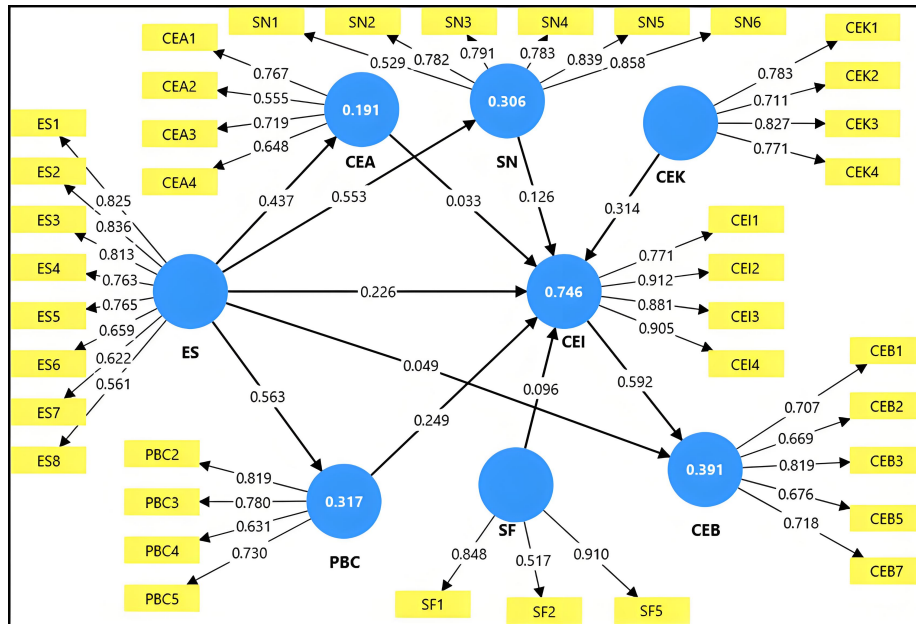


Figure 3. Full model modification

Note: ES, environmental spirituality; CEK, circular economy knowledge; SF, situational factor; CEA, circular economy attitude; SN, subjective norm; PBC, perceived behavior control; CEI, circular economy intention; CEB, circular economy behavior.

Model analysis was conducted in two stages: evaluation of the outer model (first-order CFA) and the inner model (hypothesis testing). Evaluation of the outer model applied four criteria: convergent validity, discriminant validity, CR, and Cronbach's alpha. Convergent validity was assessed using the factor loadings (outer loadings) for each indicator and the Average Variance Extracted (AVE), applying a threshold of $AVE \geq 0.5$. Discriminant validity analysis compared the cross-loadings of an indicator on its own construct to those on other constructs; cross-loadings that are lower on other constructs indicate satisfactory discriminant validity.

Convergent validity testing (Table 2) was performed solely on the full model. The MGA models were used to compare factor loadings between the secondary and higher education groups and to examine loading values in the full model further. The analysis found that all indicators in the full model had outer loadings above 0.5 (Table 2), with AVEs ≥ 0.5 , except for the CEA variable, which exhibited AVEs ranging from 0.4 to 0.5. However, AVE values between 0.4 and 0.5 remain acceptable if CR exceeds 0.6, thus confirming the construct's convergent validity.

The analysis also revealed that the lowest factor loading occurred for the SFs construct, specifically for the indicator "most vendors around me continue to use plastic packaging" (SF2). This low loading (0.266) likely reflects that participants in the secondary education group perceived SF2 as less representative of SFs. Similarly, a low loading was observed for the CEA item, "circular economy is vital for environmental sustainability" (CEA2), again attributable to the higher education group perceiving CEA2 as less representative, with a loading value of 0.325.

Conversely, the highest factor loadings were observed for the CEI construct, notably for "allocating time and effort for recycling" (CEI2) and "recommending and encouraging others to participate" (CEI4), which were consistently the strongest indicators across both educational groups.

For the revised model, the discriminant validity output demonstrated that each indicator exhibited higher cross-loadings on its respective variable than on any other variable, establishing robust discriminant validity.

As shown in Table 3, Cronbach's alpha values for all constructs were at least 0.6, and CR exceeded 0.6 for all latent variables, confirming adequate accuracy, consistency, and reliability. Analysis of the inner model, or the structural model, involved hypothesis testing of inter-variable relationships. The structural model was evaluated in three stages: verifying the the absence of multicollinearity through Inner Variance Inflated Factor (VIF), hypothesis testing using *t*-statistics or *p*-values, and *R*-square and *f*-square assessment of direct variable effects at the structural level, and comparative analysis of paths between the secondary and higher education groups.

Table 2. Loading factor score construct model

Variable	Indicator's	Full Model	MGA Model's	
			Junior/Senior High School	Diploma/Bachelor
CEA	CEA1	0.767	0.826	0.686
	CEA2	0.555	0.738	0.324
	CEA3	0.719	0.700	0.775
	CEA4	0.648	0.562	0.726
CEB	CEB1	0.707	0.633	0.765
	CEB2	0.669	0.644	0.692
	CEB3	0.819	0.761	0.874
	CEB5	0.676	0.686	0.683
CEI	CEB7	0.718	0.685	0.816
	CEI1	0.771	0.700	0.824
	CEI2	0.912	0.903	0.928
	CEI3	0.881	0.857	0.902
CEK	CEI4	0.905	0.870	0.938
	CEK1	0.783	0.738	0.829
	CEK2	0.711	0.723	0.707
	CEK3	0.827	0.803	0.854
ES	CEK4	0.771	0.769	0.785
	ES1	0.825	0.775	0.869
	ES2	0.836	0.768	0.879
	ES3	0.813	0.740	0.873
	ES4	0.763	0.711	0.802
	ES5	0.765	0.742	0.797
	ES6	0.659	0.784	0.548
	ES7	0.622	0.771	0.480
PBC	ES8	0.561	0.580	0.539
	PBC2	0.819	0.743	0.880
	PBC3	0.780	0.782	0.783
	PBC4	0.631	0.523	0.713
SF	PBC5	0.730	0.745	0.742
	SF1	0.848	0.880	0.820
	SF2	0.517	0.266	0.683
SN	SF5	0.910	0.915	0.887
	SN1	0.529	0.603	0.467
	SN2	0.782	0.698	0.854
	SN3	0.791	0.814	0.770
	SN4	0.783	0.726	0.851
	SN5	0.839	0.833	0.851
	SN6	0.858	0.857	0.857

Note: ES, environmental spirituality; CEK, circular economy knowledge; SF, situational factor; CEA, circular economy attitude; SN, subjective norm; PBC, perceived behavior control; CEI, circular economy intention; CEB, circular economy behavior. Loading factor > 0.5 is significant.

Source: Processed Results from Smart PLS 4.1, 2025.

Table 3. Construct reliability

Latent Variable	Cronbach's Alpha (CA)	Composite Reliability (CR)	Average Variance Extracted (AVE)
CEA	0.607	0.769	0.458
CEB	0.768	0.842	0.518
CEI	0.890	0.925	0.755
CEK	0.777	0.856	0.599
ES	0.877	0.903	0.543
PBC	0.729	0.830	0.553
SF	0.682	0.814	0.605
SN	0.860	0.896	0.595

Note: ES, environmental spirituality; CEK, circular economy knowledge; SF, situational factor; CEA, circular economy attitude; SN, subjective norm; PBC, perceived behavior control; CEI, circular economy intention; CEB, circular economy behavior. CA > 0.7 or 0.6 < CA < 0.7 still acceptable; CR > 0.6; AVE ≥ 0.5 or 0.4 < AVE < 0.5 with CR > 0.6 still acceptable. Source: Processed Results from Smart PLS 4.1.

Estimation results yielded Inner VIF values below 5, indicating negligible multicollinearity among latent variables. This supports the robustness and unbiased parameter estimation of SEM-PLS. Effect size (f -square) and coefficient of determination (R -square) values for inter-variable relationships are shown in Table 4.

Table 4. *f*-square and *R*-square

Path	<i>f</i> -Square	Category <i>f</i>	<i>R</i> -Square	Category <i>R</i>
ES → CEA	0.236	Moderate	0.191	Low
CEI → CEB	0.322	Moderate	0.391	Moderate
ES → CEB	0.002	No Effect		
PBC → CEI	0.073	Low	0.746	High
SF → CEI	0.021	Low		
SN → CEI	0.026	Low		
CEA → CEI	0.003	No Effect		
CEK → CEI	0.142	Low		
ES → CEI	0.117	Low		
ES → PBC	0.464	High	0.317	Low
ES → SN	0.440	High	0.306	Low

Note: ES, environmental spirituality; CEK, circular economy knowledge; SF, situational factor; CEA, circular economy attitude; SN, subjective norm; PBC, perceived behavior control; CEI, circular economy intention; CEB, circular economy behavior. Source: Processed Results from Smart PLS 4.1.

Table 4 shows substantial effect sizes for ES on PBC (0.464) and on SNs (0.440), although both relationships are associated with relatively low *R*-square values. This suggests PBC and SFs are likely influenced by additional external variables not captured in the current study, which may exert greater combined effects than ES alone. In contrast, the effect sizes for PBC, SF, SN, CEA, and CEK on CEI were low individually, yet the combined *R*-square for CEI was high (0.746). These findings indicate that, while the independent effects on CEI are modest, the proportion of CEI's variance explained by these five predictors is substantial.

Inner model analysis continued by assessing the significance of direct, indirect, and total effects across the full model and MGA models for secondary and higher education levels, using bootstrapping procedures. A *p*-value below 0.05 indicates a statistically significant effect, and the coefficient indicates the direction of the relationship. Direct effect results are provided in Table 5.

Table 5. Direct effect comparison

Path	Full Model		MGA Model (Junior/Senior High School)		MGA Model (Diploma/Bachelor)	
	Coef	<i>p</i> -Value	Coef	<i>p</i> -Value	Coef	<i>p</i> -Value
CEA → CEI	0.033	0.366	0.039	0.523	-0.007	0.895
CEI → CEB	0.592	0.000	0.599	0.000	0.567	0.000
CEK → CEI	0.314	0.000	0.370	0.000	0.251	0.001
ES → CEA	0.437	0.000	0.398	0.000	0.545	0.000
ES → CEB	0.049	0.547	-0.010	0.923	0.141	0.315
ES → CEI	0.226	0.000	0.169	0.023	0.307	0.000
ES → PBC	0.563	0.000	0.463	0.000	0.672	0.000
ES → SN	0.553	0.000	0.454	0.000	0.674	0.000
PBC → CEI	0.249	0.000	0.341	0.000	0.126	0.140
SF → CEI	0.096	0.025	0.044	0.488	0.164	0.005
SN → CEI	0.126	0.098	0.039	0.747	0.217	0.011

Note: ES, environmental spirituality; CEK, circular economy knowledge; SF, situational factor; CEA, circular economy attitude; SN, subjective norm; PBC, perceived behavior control; CEI, circular economy intention; CEB, circular economy behavior. *p*-values < 0.05 indicate a significant direct effect. Source: Processed Results from Smart PLS 4.1.

Direct effect testing revealed that all relationships among the constructs were positive and significant, except for the paths from CEA and SN to CEI and from ES to CEB, which were nonsignificant (*p* > 0.05) in the full model. The MGA results for the secondary education group mirrored those of the full model, indicating that SFs did not exert a significant effect on CEI in this group. Among higher education participants, PBC's impact on CEI was positive but not significant, suggesting that most respondents did not perceive PBC as a major determinant of their intention to participate in the circular economy.

Table 5 also highlights the highest coefficients for the relationships between CEI and CEB, ES and PBC, and ES and SNs across all three models. Direct effect values were largely consistent across educational groups, except for the association between ES and intention and PBC, suggesting that educational attainment modulates the influence of spiritual perspectives on intention and perceived control. Bootstrapped indirect effect results are presented in Table 6.

Table 6. Indirect effect comparison

Path	Full Model		MGA Model (Junior/Senior High School)		MGA Model (Diploma/Bachelor)	
	Coef	p-Value	Coef	p-Value	Coef	p-Value
Total Indirect Effect						
CEA → CEB	0.020	0.360	0.023	0.516	-0.004	0.897
CEK → CEB	0.186	0.000	0.222	0.002	0.142	0.006
ES → CEB	0.266	0.000	0.216	0.001	0.303	0.000
ES → CEI	0.224	0.000	0.191	0.003	0.228	0.001
PBC → CEB	0.148	0.001	0.204	0.004	0.072	0.191
SF → CEB	0.057	0.033	0.027	0.502	0.093	0.014
SN → CEB	0.074	0.110	0.023	0.753	0.123	0.016
Specific Indirect Effect						
ES → PBC → CEI	0.140	0.000	0.158	0.002	0.085	0.135
CEK → CEI → CEB	0.186	0.000	0.222	0.002	0.142	0.006
ES → CEI → CEB	0.134	0.000	0.101	0.026	0.174	0.007
ES → CEA → CEI → CEB	0.009	0.390	0.009	0.559	-0.002	0.900
ES → SN → CEI → CEB	0.041	0.120	0.011	0.767	0.083	0.027
PBC → CEI → CEB	0.148	0.001	0.204	0.004	0.072	0.191
SF → CEI → CEB	0.057	0.033	0.027	0.502	0.093	0.014
ES → CEA → CEI	0.015	0.397	0.015	0.571	-0.004	0.898
SN → CEI → CEB	0.074	0.110	0.023	0.753	0.123	0.016
CEA → CEI → CEB	0.020	0.360	0.023	0.516	-0.004	0.897
ES → PBC → CEI → CEB	0.083	0.001	0.095	0.008	0.048	0.189
ES → SN → CEI	0.069	0.108	0.018	0.763	0.146	0.020

Note: ES, environmental spirituality; CEK, circular economy knowledge; SF, situational factor; CEA, circular economy attitude; SN, subjective norm; PBC, perceived behavior control; CEI, circular economy intention; CEB, circular economy behavior. *p*-values < 0.05 indicate a significant indirect effect. Source: Processed Results from Smart PLS 4.0.

Indirect effect analysis revealed that CEI positively but non-significantly mediated the relationships from CEA and SN to CEB in both the full model and the secondary education group. In contrast, higher education respondents perceived CEI as a significant and positive mediator between SN and CEB. Interestingly, CEI did not mediate PBC and CEB among higher education respondents, whereas secondary education participants recognized CEI's vital role in mediating PBC's effect on CEB. Indirect effects of SFs on CEB via CEI were significant only in the higher education group.

Table 5 and Table 6 further indicate that, although the direct effects of ES on CEB were positive but not significant, the addition of mediators such as CEI and PBC converted the indirect effects to positive and statistically significant. Thus, CEI and PBC functioned as complete mediators of the ES–CEB relationship. A comparative assessment showed no significant differences in indirect effect values between educational groups, despite explicit mean differences.

Table 7. Comparison of total effect values

Path	Full Model		MGA Model (Junior/Senior High School)		MGA Model (Diploma/Bachelor)	
	Coef	p-Value	Coef	p-Value	Coef	p-Value
CEA → CEB	0.020	0.360	0.023	0.516	-0.004	0.897
CEA → CEI	0.033	0.366	0.039	0.523	-0.007	0.895
CEI → CEB	0.592	0.000	0.599	0.000	0.567	0.000
CEK → CEB	0.186	0.000	0.222	0.002	0.142	0.006
CEK → CEI	0.314	0.000	0.370	0.000	0.251	0.001
ES → CEA	0.437	0.000	0.398	0.000	0.545	0.000
ES → CEB	0.316	0.000	0.205	0.022	0.444	0.000
ES → CEI	0.450	0.000	0.360	0.000	0.534	0.000
ES → PBC	0.563	0.000	0.463	0.000	0.672	0.000
ES → SN	0.553	0.000	0.454	0.000	0.674	0.000
PBC → CEB	0.148	0.001	0.204	0.004	0.072	0.191
PBC → CEI	0.249	0.000	0.341	0.000	0.126	0.140
SF → CEB	0.057	0.033	0.027	0.502	0.093	0.014
SF → CEI	0.096	0.025	0.044	0.488	0.164	0.005
SN → CEB	0.074	0.110	0.023	0.753	0.123	0.016
SN → CEI	0.126	0.098	0.039	0.747	0.217	0.011

Note: ES, environmental spirituality; CEK, circular economy knowledge; SF, situational factor; CEA, circular economy attitude; SN, subjective norm; PBC, perceived behavior control; CEI, circular economy intention; CEB, circular economy behavior. *p*-value < 0.05 indicate a significant total effect. Source: Processed Results from Smart PLS 4.1.

Total effect computations summing direct and indirect coefficients are detailed in Table 7. Both the full model and the secondary education MGA showed all total effects to be positive and significant, except the relationships involving CEA and SN with CEI and CEB, which remained nonsignificant. The higher education group's MGA revealed significant total effects for SN on both CEI and CEB, but not for CEA. Furthermore, SFs showed nonsignificant total effects on CEI and CEB for the secondary education group; higher education participants exhibited nonsignificant total effects for PBC on both CEI and CEB. Comparative results indicated significant differences in total effects between educational groups, with ES's impact on PBC and SNs being stronger for higher education respondents than for secondary education respondents. Across other relationships, perceptions were largely similar between the two groups.

4 Discussion

4.1 General Discussion

This study used the ETPB to analyse CEB among urban residents in Semarang, introducing additional predictor variables—ES, CEK, and SFs—alongside the traditional constructs of attitude, SNs, and PBC. Notably, preliminary SEM analysis revealed that two principal predictors within the original TPB framework, the paths from CEA to CEI and from SNs to CEI, were not statistically significant (p -values of 0.366 and 0.098, respectively). Only PBC demonstrated a significant impact on intention ($p < 0.001$). In contrast, all newly integrated variables CEK, ES, and SFs significantly predicted CEI (p -values < 0.05).

Beyond statistical significance, the analysis identified several substantively strong influences within the ETPB framework. The predictor with the most substantial effect on CEB was CEI ($\beta = 0.592$), thereby confirming intention as a central determinant of environmentally responsible behavior. Among the predictors of CEI, PBC exhibited the strongest influence ($\beta = 0.249$). In contrast, the most substantial subsequent effects were found between ES and PBC ($\beta = 0.563$) and between ES and SNs ($\beta = 0.553$).

The incorporation of ES in this study, as part of the ETPB, introduces a distinctive perspective that has been largely absent from prior research. The findings demonstrate that including ES within the ETPB yields novel insights, specifically showing that ES has a direct and significant impact on the principal TPB predictor variables, namely CEA, PBC, and SNs. Direct effect analysis further indicates that ES significantly influences CEI (p -value = 0.000). While the impact of ES on TPB constructs, as outlined by Ajzen [31], is evident, its direct effect on CEB is not observed. However, indirect effect analysis reveals that ES can influence CEB indirectly through mediation by CEI and PBC.

The findings reveal that ES significantly strengthens SN and PBC but does not directly influence CEB, implying that spirituality primarily operates through internal psychological mechanisms. Psychologically, spiritual values tend to shape how individuals interpret social norms and self-efficacy, rather than acting directly on behavior. In other words, moral and spiritual values influence environmental actions through internal socio-cognitive constructions rather than direct external behaviors. This also suggests that one's spirituality can heighten sensitivity to social norms, which subsequently serves as a key motivational driver of the realisation of tangible circular economy practices.

However, internal motivation alone is not sufficient to trigger CEB immediately. On the other hand, such behavior is also shaped by practical constraints, such as an individual's access to recycling and waste sorting facilities, time availability, convenience, information accessibility, and perceived behavioral capability. Thus, spiritual motivation must first be translated into a stronger sense of self-efficacy to overcome these practical barriers inherent to circular economy practices. This study underscores the critical importance of integrating internal motivation development with the reduction of practical barriers to foster actual engagement in CEB.

This research makes a substantial contribution to TPB development by establishing ES as an upstream determinant capturing both psychological and cultural nuances. Whereas ES does not directly spur behavioral enactment, it meaningfully enhances PBC and SNs, shaping intentions and, ultimately, behavior. This mediation pattern demonstrates that spiritual values serve as an internal foundation for self-efficacy and social pressure, prerequisites for behavioral intention. In effect, nature-oriented spirituality catalyzes ecological action through cognitive and social pathways rather than direct motivational force, thereby expanding TPB's relevance to societies with a pronounced cultural and religious identity, like Indonesia. These findings affirm prior scholarship proposing spiritual values as potent agents of behavioral transformation [98, 99], and enrich classical rational models [31] with value-based dynamics.

The study's results resonate with several preceding works. For example, Ayten et al. [100] observed positive correlations between religiosity and waste management in Jordanian and Turkish samples. Eom et al. [101] discovered religiosity moderates pro-environmental behavior, while White and Billet [102] linked ES with gratitude towards nature and positive environmental attitudes. Similarly, Siagian et al. [103] identified spiritual norms as mediators of environmental behaviors, and Elgammal and Al-Modaf [104] found religiosity shapes sustainable consumer practices.

Additional support emerges from Sharma and Lal [105], who established spiritual orientation as a motivator for green purchasing, and Fang et al. [106], who showed Christian beliefs in Taiwan promote both environmental awareness and activism. Baran et al. [107] identified rising religiosity as associated with increased environmental

sensitivity manifested through waste reduction, eco-attitudes, activism, and strengthened social and SNs. These results cohere with studies [101, 108], reinforcing the study's innovative integration of spirituality into the TPB framework.

Another noteworthy finding from this study is that CEA does not have a significant effect on CEI (p -value = 0.366), even though CEA is a key predictor variable in the TPB framework according to study [31]. This result points to the existence of an attitude–intention gap, indicating that positive attitudes toward the circular economy do not necessarily translate into actual intention or behavior. These findings differ from most previous studies, which assert that attitude significantly influences intention and behaviour. For example, similar research [42, 109, 110] on waste reduction and sorting highlights a significant relationship, as do studies [111–113], which also found that attitude has a positive effect on pro-environmental intention and behavior.

Nevertheless, while the majority of studies report that attitude influences intention, several works have found that attitude does not significantly affect intention, consistent with the findings of this study. Research [114–119] all document the presence of an attitude-intention gap. Other studies suggest that this gap is partly due to pro-environmental attitudes being more closely connected to behavior when the opportunity cost (financial) of acting is low [120].

Furthermore, Wyss et al. [120] argued that individuals generally weigh the costs and benefits of their environmental choices; even with a strong desire to protect the environment, they may lack the self-control necessary to align attitudes with behaviors consistently. Supporting this, Farjam et al. [121] observed that although environmental attitudes positively influence behavior, their actual realization depends heavily on the financial cost required to carry out those behaviors.

As with attitude, SNs were also nonsignificant predictors of intention in the full model. However, in the MGA, SNs significantly influenced intention within the higher education group. This outcome diverges from most previous studies, as SN are typically regarded as a principal predictor in the TPB. Nevertheless, this is not the only study to report such findings; relevant works [122–128] have documented similar results.

Although SNs are a core element of the TPB, this study did not find evidence of their influence on intention in the full model. This may be because SNs reflect the prevailing values of the group, which do not entirely represent individual intentions but instead arise from social pressure [129]. Morren and Grinstein [130] contend that people in collectivist cultures experience stronger social pressure and tend to hold more positive attitudes toward green consumption, preferring group coherence and conformity over individualism. Although Indonesia is chiefly a collectivist society, the specific context of urban Semarang demonstrates a population leaning toward individualistic and materialistic orientations.

Of the three principal predictors in the TPB evaluated in this study, only PBC emerged as a significant influence on intention. Additionally, the extended theory variables, knowledge, and SFs were found to affect intention significantly. Previous research offers varied findings: Jia et al. [131] and Sun et al. [132] observed that all TPB predictor variables significantly affect intention, whereas others found PBC to be the most significant [133, 134], with weaker effects for SNs and attitude [135, 136].

4.2 Multi-Group Analysis

These findings have significant implications for designing effective behavior change strategies. The results indicate that intention is the strongest predictor of CEB, highlighting the need for interventions that focus on intention formation among individuals and communities, rather than merely altering attitudes. Behavioural interventions limited to attitude change, such as campaigns, outreach, or passive educational efforts, are insufficient for fostering genuine intention and tangible action. Instead, programs should be oriented towards enhancing behavioral control and leveraging social components.

This study distinguishes itself by employing MGA, interrogating contrasts by education level, a departure from prior work that typically treats education as an independent or moderating variable. The MGA revealed distinctive behavioural-determinant patterns by educational attainment level, suggesting that CEB is not universally constructed.

Previous studies report a range of findings regarding the impact of education level on respondents' waste management and pro-environmental behaviors. Some found that higher education attainment tends to correlate with more pronounced pro-environmental practices [137–142]. Conversely, other studies concluded that education level does not necessarily influence environmental behavior [55, 61, 140]. Furthermore, findings suggest that higher education can sometimes be associated with lower levels of pro-environmental behaviour [143–145].

Unlike previous studies, the MGA in this research does not examine education level as a general predictor of CEB. Instead, education is treated as an integral variable for understanding how other predictors function within different educational strata. Of the eleven hypotheses tested, three showed differences between higher- and lower-education groups: $PBC \rightarrow CEI$, $SN \rightarrow CEI$, and $SF \rightarrow CEI$.

Results show that among respondents with secondary education, PBC significantly affects CEI, suggesting that intention formation within this group is primarily shaped by self-efficacy and access to supporting resources. However, for those with higher education, PBC does not significantly impact CEI, which may be attributed to their greater

capabilities, information, and resource accessibility, making personal factors less dominant. This finding is consistent with the results of study [146], which found that individuals without higher education perceive waste sorting as challenging and are less likely to form intentions to engage in such behaviors.

Regarding SNs, this study found that they are not significant predictors of intention among secondary education respondents. In contrast, SNs have a significant influence on intention among higher-education respondents, indicating that educated individuals are more attuned to the expectations and evaluations of family, friends, colleagues, and neighbors, and that their engagement in the circular economy reflects heightened sensitivity to social norms and institutional pressures. Less educated groups tend to be more independent and influenced by daily practical constraints, showing less concern for external social opinions—a contrast to the findings of study [147], which showed that the views of friends and family often drive individuals with lower education.

Consistent with PBC, SFs significantly affect intention among higher-education groups, but not in secondary-education groups. This suggests that those with higher education are more critical of structural barriers and supports, such as the availability of 3R facilities, government regulations, or access to circular products. In contrast, those with less education remain more focused on personal control and are less sensitive to environmental context. This pattern is echoed by Jacob and Dwipayanti [40], who found that high-school graduates are more responsive to psychological predictors as described in the TPB framework.

5 Conclusion and Implications

5.1 Conclusion

This study examines CEB among urban households in Semarang by applying the TPB and integrating the variable of ES. The findings confirm that intention plays a crucial role in shaping CEB and that ES significantly influences the formation of PEA, SNs, and PBC. Furthermore, the multi-group analysis shows that the determinants of CEB vary by educational level. Among respondents with secondary education, PBC exerts a stronger influence on intention, whereas SNs and SFs are more influential among respondents with higher education. These findings underscore the importance of integrating cultural and spiritual dimensions into behavioral models and highlight the need for differentiated intervention strategies to promote CEB in urban communities.

5.2 Theoretical Implications

This study offers a theoretical contribution by expanding the TPB framework by integrating ES as an upstream determinant that indirectly influences CEB intentions. The findings introduce a new dimension to TPB, which was previously more rational and cognitively driven, by acknowledging the importance of transcendental and contextual values, an aspect particularly salient in societies with strong religious traditions and environmental affinities. For culturally grounded contexts such as Indonesia, where religiosity and spiritual connection to nature are pervasive, incorporating ES into TPB yields a model that is more relevant, contextualized, and culturally sensitive than approaches rooted solely in Western rational-psychological theory.

These results validate perspective which holds that cultural worldviews shape and reinforce the diverse reasons people appreciate nature. Sociocultural factors, including religion, serve as powerful forces shaping psychological processes associated with environmental behavior. Understanding how these sociocultural drivers interact with other key psychological variables, such as environmental beliefs and social norms, points to promising avenues for advancing theory in environmental, cultural, and social psychology.

Moreover, the TPB approach has often been criticized because it tends to emphasize rational and logical decision-making processes, thus potentially ignoring other motivational factors that also influence individual intentions and behavior. This study also enriches the ETPB by showing that its core constructs vary across demographic subgroups, especially by educational level. The differences observed in the MGA, namely, in the relationships between PBC, SN, and SF and CEI across groups, challenge the assumption of universality and position TPB within a more adaptive, context-driven behavioral framework. These findings emphasize that environmental behavior needs to be understood within a more adaptive and contextual framework, taking into account the influence of sociocultural factors and demographic characteristics of the community.

The findings of this study also signify a meaningful cross-cultural insight. In the Indonesian context, ES influences SNs and PBC but has no direct effect on CEB. This indicates that spiritual values shape pro-environmental cognition through psychological and cultural pathways. Such mechanisms are likely to manifest in other religious societies where spirituality, moral values, and social order play a central role in individual decision-making, for example, in Malaysia, Brunei Darussalam, Pakistan, and several Middle Eastern countries, where religious teachings often emphasize worship, moral responsibility, and trustworthy behavior for the collective good.

5.3 Practical Implications

These findings have significant implications for designing effective behavior change strategies. The results indicate that intention is the strongest predictor of CEB, highlighting the need for interventions that focus on intention

formation among individuals and communities, rather than merely altering attitudes. Behavioural interventions limited to attitude change, such as campaigns, outreach, or passive educational efforts, are insufficient for fostering genuine intention and tangible action. Instead, programs should be oriented towards enhancing behavioral control and leveraging social components.

More specifically, this study underscores the need to tailor intervention strategies to educational attainment. For communities with secondary education, CEIs are most heavily influenced by PBC; consequently, policies should focus on providing easily accessible infrastructure, such as widespread segregated waste collection points, mobile recycling services, and simple economic incentives for 3R practices. Additionally, practical, hands-on workshops in waste management can more effectively build community skills and self-efficacy, going beyond mere knowledge transfer.

For communities with higher education, CEIs are primarily shaped by SNs and SFs. Therefore, interventions should aim to build positive social norms and reinforce structural supports, including policies, infrastructure improvements (such as single-use plastic restrictions and subsidies for eco-friendly products), and the establishment of integrated recycling logistics systems.

MGA revealed no significant differences between secondary and higher education groups in ES. The consistent effects of ES across educational strata suggest that environmental spiritual values can serve as a universal foundation for cultivating CEB. Ecological spirituality presents a key paradigm for intervention programs such as faith-based campaigns, religious lectures, the integration of local wisdom, and moral narratives that harmonise relationships among humans, the divine, and the natural environment. These programs can be implemented across all social segments.

This study also highlights that religion, belief systems, and ethical frameworks are seen as important factors that can drive behavioral change toward a life more in harmony with nature. An integrated ethical approach becomes increasingly relevant amidst various global environmental crises, such as climate change, biodiversity loss, and increasing pollution levels. This perspective emphasizes that solutions to environmental problems require not only technological or policy innovation, but also a transformation of human values and awareness of nature. Furthermore, true sustainability demands spiritual transformation at the individual level. Without a deep awareness of the spiritual connection between humans and all living things, sustainability efforts risk remaining merely superficial and symbolic, without resulting in fundamental behavioral change.

5.4 Limitations of the Study and Future Research Directions

One notable limitation of this study is its restricted geographical and demographic context. The research focused solely on urban communities in Semarang, so the findings cannot be generalised to other contexts, such as rural communities, regions with different levels of environmental infrastructure, or areas characterised by stronger local cultural traditions. A further limitation stems from the explanatory variables included: several crucial factors, such as moral norms, habitual behaviours, environmental identity, policy awareness, and household economic considerations, were not addressed, leaving relevant aspects of pro-environmental behaviour unexplored. The relatively low R^2 values observed in some causal paths (e.g., $ES \rightarrow PBC$ and $ES \rightarrow SN$) suggest that additional factors may shape these variables.

Additionally, the scope of the MGA presents an important limitation: respondents were distinguished only by their most recent educational attainment, while other potentially influential demographic variables, such as age, gender, income, and prior participation in environmental communities, were not incorporated.

Future studies are encouraged to expand the research area, allowing analysis of how current variables function across different urban centres or within rural communities with varying infrastructural and cultural profiles. This would strengthen the generalizability of results and facilitate more detailed and complex comparative analyses. Incorporating new variables such as moral norms, environmental identity, policy awareness, and household economics, as well as additional demographic factors like age, gender, income, and environmental involvement, will also enhance the contextual clarity of future analyses and support the development of more precise intervention strategies for distinct population segments.

Author Contributions

Conceptualization, E.K. and M.S.; methodology, M.S. and A.T.; software, M.S., T.M., and N.A.W.; validation, E.K., E.S., and T.M.; formal analysis, M.S. and N.A.W.; writing—original draft preparation, M.S. and E.K.; writing—review and editing, E.S. and A.T.; critical review, H.M. and E.K.; supervision, E.S. and H.M.; project administration, E.K. and N.A.W.; final approval, E.K. and A.T. All authors have read and agreed to the published version of the manuscript.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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