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Validation of Energy Conservation Behaviour for Malaysia University Students Using Exploratory and Confirmatory Factor Analysis

Noor Asiah Hassan[1*], Dajvinder Singh [2], Rodiah Mohd Hassan[3]
Universiti Selangor, Jalan Timur Tambahan, 45600 Bestari Jaya, Selangor, Malaysia
*Email: noorasiah@unisel.edu.my

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ABSTRACT

Given the increasing urgency of addressing global environmental challenges, research on energy conservation in educational settings is critical. University students represent a significant demographic with the potential to drive behavioural change and promote sustainable practices. By understanding and influencing their energy conservation behaviours, this research contributes to the broader efforts to mitigate environmental impact and foster a culture of sustainability. This study aims to validate the Environment Conservation Behavioural Survey (ECOBS), an instrument designed to assess university students' behaviours and intentions regarding energy conservation, through the lens of the Theory of Planned Behaviour (TPB). The ECOBS model integrates five key variables: behaviour, intention, perceived behavioural control, environmental education, and attitude. Initially, a pilot study with 150 respondents was conducted, followed by Exploratory Factor Analysis (EFA) using SPSS. Subsequently, primary data were collected from 400 respondents and analysed using Confirmatory Factor Analysis (CFA) in AMOS. The findings confirm that the ECOBS instrument meets the stringent criteria for convergent, construct, and discriminant validity, as well as reliability, demonstrating its robustness in evaluating students' intentions and behaviours towards energy conservation. The validated ECOBS instrument not only identifies key predictors of energy conservation behaviours but also offers practical insights for stakeholders aiming to enhance such behaviours among students. The rigorous validation process underscores the ECOBS instrument's value as a reliable and valid tool for measuring and promoting energy conservation behaviours in educational settings. This instrument can serve as a foundation for future studies, contributing to the development of targeted interventions that foster sustainable behaviours among university students.

Keywords: Confirmatory factor analysis, Exploratory factor analysis, Intention, Theory of planned behaviour, Energy Conserving behaviour (ECB)

INTRODUCTION

Growing populations, increased urbanization, improved living standards, technological advancements in manufacturing, and heightened economic competitiveness all drive a rising demand for energy (Raihan & Tuspekova, 2022) and Malaysia is no exception to this trend. The present energy sector relies heavily on fossil fuels, which emit greenhouse gases into the atmosphere (Chu et al., 2023). Thus, environmental sustainability has emerged as a critical global concern, prompting increased interest in understanding and promoting energy conservation behaviour (ECB) across various demographics. Although, Malaysia has shown support for environmental sustainability through various policies, initiatives, and commitments at both the national and international levels. For example, the Twelfth Malaysia Plan (2021-2025) builds on the initiatives of the Eleventh Plan, placing a strong emphasis on sustainable development goals (SDGs) and environmental sustainability as fundamental principles for national development (12th Malaysian Plan, 2021). This comprehensive strategy aims to integrate economic growth with ecological preservation, ensuring a balanced and sustainable future for Malaysia. By prioritizing SDGs, the plan seeks to address various environmental challenges while promoting green technology, renewable energy, and resource efficiency across all sectors (Fallah Shayan et al., 2022).

But, still Malaysia faces several interrelated challenges in energy conservation, reflecting the complexities of balancing economic growth with sustainable practices. According to the International Energy Agency (IEA), the country's energy demand has been steadily increasing due to rapid economic growth and urbanization. This rising demand underscores the need for more effective energy conservation strategies. Although reports from the Sustainable Energy Development Authority (SEDA) Malaysia highlight growth in renewable energy capacity, this still constitutes only a small fraction of the total energy mix, indicating a slow transition towards more sustainable energy sources (Mansor et al., 2020).

Other than that, the energy efficiency challenges faced by buildings as highlighted by the Malaysia Green Building Confederation (MGBC), further compound the issue. Many buildings suffer from inefficient energy use, which could be mitigated through green building certifications and retrofitting, but progress in this area remains limited (Mustaffa & Kudus, 2022). Additionally, surveys and studies conducted by Wong et al., (2022) reveal varying levels of public awareness and engagement in energy conservation practices. Despite government and NGO campaigns aimed at raising awareness, achieving meaningful behavioural change remains challenging without continuous education and incentives. Results of the systematic review on shaping energy-saving behaviour in the education system confirm the need for further research on promoting energy-saving behaviour at both university and school levels (Irmak et al., 2023). This need is underscored by several interconnected issues: growing energy demand, limited renewable energy adoption, inefficient building practices, and insufficient public engagement. These challenges highlight the necessity for a comprehensive approach to energy conservation that addresses each issue in a coordinated manner.

In this context, the participation of university students becomes crucial. As future leaders and decision-makers, their active engagement in energy conservation efforts is vital (Murray, 2018). Encouraging university students to adopt and promote sustainable practices can significantly influence broader societal behaviours and contribute to achieving long-term environmental goals (Stein, 2024). However, the factors influencing students' energy conservation behaviour (ECB), particularly in the context of Malaysian universities, remain underexplored. Understanding these factors is essential not only for immediate conservation efforts but also for fostering a culture of sustainability that can inspire wider community action. By identifying and addressing the determinants of ECB among university students, educational institutions can play a pivotal role in shaping sustainable behaviours. This approach not only helps in reducing energy consumption in the short term but also contributes to cultivating environmentally conscious future generations. Further research is needed to explore these factors in depth, considering the unique cultural, social, and infrastructural contexts of Malaysian universities. This research should aim to identify effective strategies for engaging students in energy conservation, promoting the adoption of sustainable practices, and integrating these practices into the broader educational framework. Such efforts will not only enhance the immediate impact of energy conservation initiatives but also ensure their long-term success and sustainability.

To address this gap, our study aims to propose and validate a model grounded in Ajzen's Theory of Planned Behaviour (TPB), tailored to explain the energy conservation behaviour (ECB) of Malaysian university students. The TPB framework, renowned for its efficacy in predicting and understanding various human behaviours (Ajzen, 2020), integrates five key constructs: behaviour, intention, perceived behavioural control, environmental education, and attitude. By leveraging this theoretical foundation, we seek to uncover the underlying determinants that shape students' intentions and actions towards energy conservation.

The literature underscores ECB as an issue requiring further examination. Unsatisfactory ECB is perceived as unfavourable because effective ECB is essential for the younger generation to adopt environmental sustainability. Additionally, limited studies have examined the ECB of Malaysian higher education students and the determinants that influence their ECB. To produce future leaders committed to attaining environmental sustainability, it is essential to investigate the factors that contribute to ECB and how these affect students' energy conserving performance.

An appropriate framework for measuring students' intention to participate in energy-conserving behaviour is the Theory of Planned Behaviour (TPB). Developed by Ajzen (1991), the TPB is a revision of the Theory of Reasoned Action (TRA). The TPB proposes that intention is the core motivator for individuals to perform a specific behaviour (Ajzen, 1991). To examine the efficacy of the TPB, Yuriev et al. (2020) conducted a scoping review of 126 independent studies and found that the TPB is one of the most effective models for developing behavioural interventions. For example, Timm and Deal (2016) reported using TPB to implement several measures aimed at changing energy behaviours within college campuses in Illinois. They noted a significant energy saving of up to 50%, as well as a positive longitudinal effect of this intervention. This article could provide scholars with guidance on how to develop more environment-related interventions based on TPB studies. Additionally, TPB is known for its flexible structure, allowing for the integration of additional variables from other theories. Accordingly, in this research, TPB was used as the underpinning theory in the development of the Energy Conservation Behaviour Survey (ECOBS).

The Theory of Planned Behaviour (TPB) suggests that behaviour is influenced by four main predictors: attitude, subjective norms, perceived behavioural control, and intention. In this study, attitude is defined as the degree to which a student has a favourable or unfavourable evaluation of energy conservation. Perceived behavioural control is characterized as a student's belief about their ability to participate in energy conservation. Meanwhile, environmental education is referred to as a multifaceted learning process that enhances an individual's knowledge about energy conservation and environmental protection through diverse educational methods. It is essential to model the influence of these predictors on intention, as intention will directly contribute to more positive pro-environmental behaviour as shown in Figure 1.

Building on these theoretical foundations, the current study intends to develop and validate a survey questionnaire termed Environment Conservation Behavioural Survey (ECOBS). This instrument could be employed to identify the factors influencing students' energy conservation behaviour. ECOBS also provides an opportunity to advance our understanding of the barriers and enablers that affect students' intention to participate in energy-conserving behaviour.

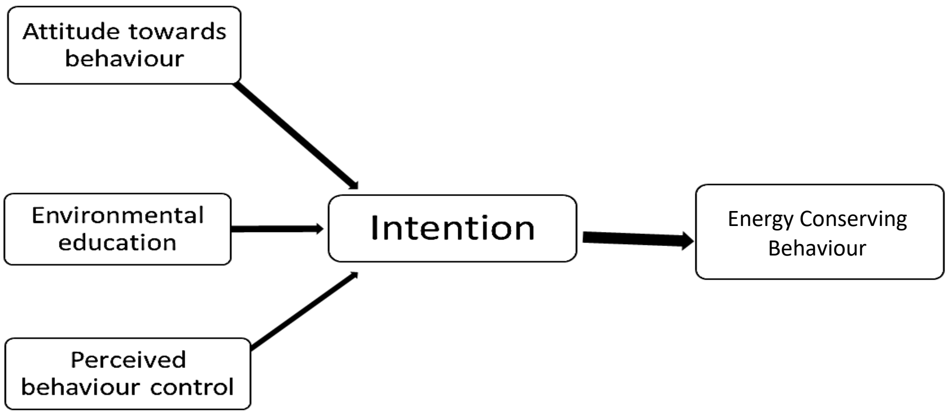

Figure 1 The Conceptual Framework of the Study

METHODOLOGY

This study utilized a cross-sectional research design, where data were gathered at a single point in time (Sekaran & Bougie, 2016). Data collection for both the pilot and main studies was conducted in public and private universities in Malaysia. Multistage sampling was employed to select university student as respondents. The survey items for attitude, environmental education, and perceived behavioral control were adapted from existing literature. To ensure the validity of the ECOBS for the main study, a pre-test was conducted. The content validity of the ECOBS was evaluated by five content experts who have been teaching environmental courses for over a decade. Additionally, a statistical expert assessed the criterion validity to confirm the appropriateness of the scale used.

After completing the validation procedure, the ECOBS was pre-tested on 30 randomly selected respondents to assess the consistency of their responses and to gather feedback on any unclear terms, the clarity of the questions, and the overall questionnaire design. Identified issues were addressed before conducting the pilot study and actual fieldwork (Zikmund & Babin, 2010). Following revisions based on the experts' feedback and the pre-test results, a pilot study was carried out, yielding 150 valid responses, thus meeting the minimum required sample size of 100 (Awang et al., 2018). The pilot study data underwent exploratory factor analysis (EFA) before the actual survey. The EFA results are detailed in Table 1 and Table 2.

The finalized ECOBS instrument comprised 28 items, excluding questions about the respondents' demographic profiles. A 10-point interval scale ranging from 1 (strongly disagree) to 10 (strongly agree) was used, as recommended by Awang (2018) and Coelho and Esteves (2007), to ensure the independence of the data obtained. The actual survey yielded 400 valid responses. The data were analyzed using the Statistical Package for Social Science (SPSS) version 26 and Analysis of Moment Structures (AMOS) version 24. SPSS was employed for data screening and conducting the exploratory factor analysis (EFA), while AMOS was used to validate the measurement model for unidimensionality, validity, and reliability through confirmatory factor analysis (CFA) (Awang et al., 2018).

RESULTS

Exploratory Factor Analysis

The objective of Exploratory Factor Analysis (EFA) is to identify and summarize the underlying dimensions by grouping together variables that are correlated (Zikmund & Babin, 2010). In this study, EFA was conducted using data from the pilot study to uncover the underlying factors related to attitude, ECB, environment education, perceived behavioural control, and intention to participate in conserving the energy. Several conditions were considered to ensure the appropriateness of EFA:

1. Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy (MSA): The KMO value should be greater than 0.50, with values closer to 1.0 indicating better sampling adequacy.
2. Bartlett's Test of Sphericity: This test evaluates whether the correlation matrix significantly differs from an identity matrix, and should be significant at $p < 0.001$, as recommended by Hair et al. (2014).

Table 1 outlines the results of the KMO and Bartlett's test of sphericity for attitude, perceived behavioural control, environment education, ECB and intention. The values of KMO for all constructs exceeded 0.5. The Bartlett's test of sphericity results for all constructs were significant ($p < 0.001$) as recommended.

Initially, there were 31 items across the five constructs before conducting Exploratory Factor Analysis (EFA). This comprehensive set of items was analysed to determine which best represented the underlying constructs. After EFA, the number of items retained varied among the constructs, reflecting the analysis's impact on refining the measurement tools. Constructs such as Attitude, Intention, and Perceived Behavioural Control (PBC) retained all their original items, suggesting that these items were well-aligned with their respective constructs and contributed effectively to the overall model. In contrast, Environmental Education and Energy Conserving Behaviour underwent some changes, with a reduction in the number of items. Specifically, 3 items were dropped, leading to a final total of 28 items retained for the study.

The reduction in the number of items for environmental education and environment conserving behaviour indicates that EFA helped in refining these constructs by eliminating less relevant items. This refinement likely improves the clarity and focus of the measures used, enhancing the overall quality of the study. Table 2 summarizes the items that were dropped and those retained during the EFA process, providing a clear overview of how the analysis contributed to the refinement of the measurement constructs. In addition, reliability was assessed using Cronbach's Alpha, and the result achieved a minimum satisfactory value above 0.7 (Nunnally, 1974).

Table 1 Results of KMO and Bartlett's Test of Sphericity

Construct	KMO (>0.50)	Bartlett's Test of Sphericity (p<0.001)
Attitude	0.691	0.00
Env. education	0.905	0.00
ECB	0.738	0.00
Intention	0.929	0.00
PBC	0.833	0.00

Table 2 Item Retention Result after EFA

Construct	Items before EFA	Number of Items Dropped	Number of Items Retained after EFA	Reliability (Cronbach Alpha)
Attitude	5	0	5	0.91
Env education	8	2	6	0.92
ECB	5	1	4	0.75
Intention	8	0	8	0.96
PBC	5	0	5	0.84

Confirmatory Factor Analysis (Pooled-CFA)

The study aimed to validate all measurement models of latent constructs through Confirmatory Factor Analysis (CFA) to ensure (1) unidimensionality, (2) validity, and (3) reliability (Hair et al., 2014; Awang, 2018). This process involved several key steps:

The measurement models of the latent constructs needed to pass three types of validity:

Convergent Validity: Evaluated by computing the Average Variance Extracted (AVE). This ensures that the items within a construct share a high proportion of variance.

Construct Validity: Assessed by determining the fitness indices of the measurement model. This checks how well the model fits the data.

Discriminant Validity: Established through the Discriminant Validity Index Summary, ensuring that constructs are distinct from one another.

Reliability Assessment: Composite Reliability (CR) was used to determine the reliability of ECOBS, offering a more robust alternative to the traditional Cronbach's Alpha (Hair et al., 2014; Yusof et al., 2017).

To streamline the validation process, all constructs were pooled for simultaneous validation using a Pooled Confirmatory Factor Analysis (Pooled-CFA), as illustrated in Figure 2. This method involved pooling constructs with double-headed arrows to execute the Pooled-CFA. According to Awang et al., (2018), model identification is not problematic with Pooled-CFA, even if some constructs have fewer than four items, because combining constructs increases the model's degrees of freedom. Therefore, Pooled-CFA was utilized in this study to enhance efficiency compared to conducting CFA for each measurement model separately.

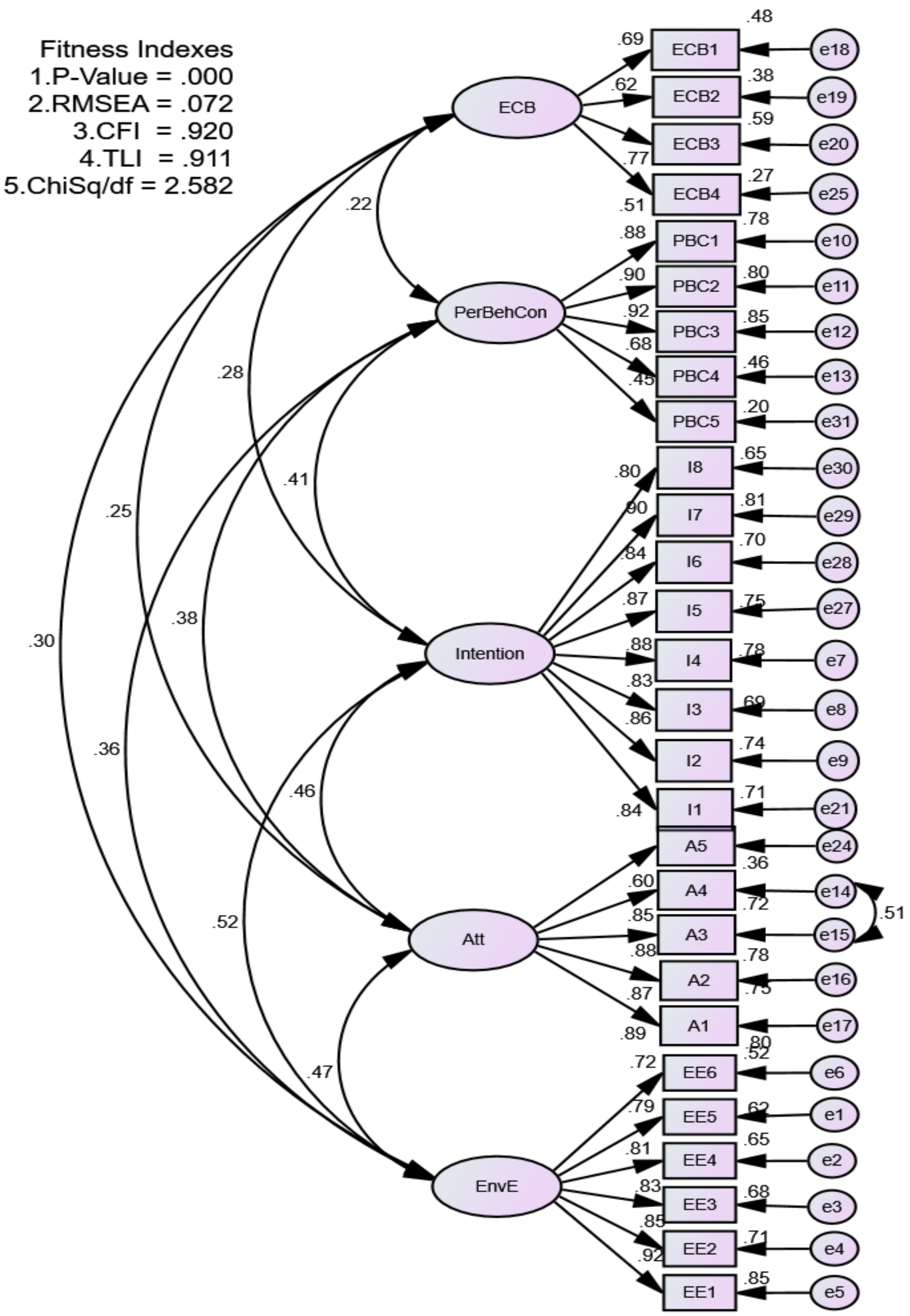

Figure 2 Result from Pooled CFA Procedure

Unidimensionality

Unidimensionality refers to a set of variables that can be explained by a single construct (Hair et al., 2014). Achieving unidimensionality means that all measuring items for a given construct must have acceptable factor loadings. According to Awang (2015), this is accomplished when each item in the construct shows sufficient factor loading. If some CFA items exhibit low factor loadings, these items should be removed from the measurement model until the fit indices meet the acceptable criteria (Afthanorhan et al., 2017; Hair et al., 2014).

Despite the general guideline that factor loadings should be 0.5 or higher for newly developed items (Awang et al., 2018), one item in our measurement model exhibited a factor loading of 0.45. This value is below the recommended threshold, indicating that the item may not strongly contribute to the construct it is intended to measure. However, we decided to retain this item in the measurement model for several reasons. First, the overall model fit remained acceptable even with the lower factor loading, suggesting that the item's inclusion did not significantly compromise the model's performance. Second, the item "*I believe I am responsible for the environment we are living in*" plays a crucial role in representing the construct comprehensively. Its retention ensures that the breadth of the construct is maintained, capturing essential aspects that might be overlooked if the item were removed.Therefore, while the factor loading is lower than ideal, the decision to keep the item was made to preserve the construct's full representation and maintain the model's robustness.Table 3 depicts that all items from every construct have surpassed the required factor loading values recommended by Awang et al. (2018). Thus, no item was deleted from this survey.

Table 3 Factor Loading of All Items

	Construct/Item	Factor Loading
	Environment Education	
EE1	Environment course I attended improve my knowledge in conserve energy	0.79
EE2	I learned about environment since elementary school	0.83
EE3	Integrating EE can be done in different learning methods.	0.92
EE4	I learn about environment from various media.	0.85
EE5	Learning material about the environment is interesting.	0.79
EE6	I learn diverse topic about energy conservation in University.	0.70
	ECB	
ECB 1	I switch off the lights when i leave a room	0.69
ECB 2	I turn off the water while brushing my teeth	0.62
ECB 3	I turn off my computer when sleep at night	0.77
ECB 4	I use energy saving light bulbs	0.51
	Attitude	
A1	Student are responsible to reduce energy consumption in campus.	0.89
A2	I am responsible to reduce energy resources I use in campus	0.87
A3	The whole society has responsibility to save energy.	0.88
A4	It is important to conserve energy at home.	0.85
A5	I am worry if hearing the energy-related issues	0.60
	Intention	
I1	I want to conserve energy for environmental reasons.	0.84
I2	I intend to conserve energy for environmental reasons.	0.96
I3	I intend to use natural resources like natural gas in a responsible manner.	0.83
I4	I intend to use natural resources like petroleum in a responsible manner	0.88
I5	I will try to reduce my carbon footprint in the forthcoming month.	0.87
I6	I will encourage my classmates to conserve energy all the time.	0.84
I7	I intend to engage in energy-saving activities in the future	0.90
I8	I intend to join energy awareness campaign in campus	0.80
	PBC	
PBC 1	I believe I am responsible for the environment we are living in.	0.45
PBC 2	I believe it is adequate to conserve energy	0.67
PBC 3	I choose energy saving activities if I can save my money.	0.90
PBC 4	I choose energy saving activities if it is convenient.	0.92
PBC 5	I choose energy saving activities if it can save the time.	0.88

Convergent Validity

Convergent validity refers to a group of indicators that are believed to measure the same construct (Kline, 2011; Awang et al., 2018). According to Brown (2006), convergent validity reflects the strength of the relationships among items expected to represent a single latent construct. This validity can be assessed by calculating the average variance extracted (AVE). A construct is considered to have achieved convergent validity if its AVE surpasses the threshold of 0.5 (Awang et al., 2018; Hair et al., 2014). As indicated in Table 4, the AVE for all constructs exceeded the minimum value of 0.5. Specifically, Intention had the highest AVE at 0.750, while ECB had the lowest acceptable AVE at 0.528. Therefore, it can be concluded that the model has successfully achieved convergent validity.

Table 4 Average Variance Extracted for All Constructs

Codes	Construct	AVE (above 0.5)
A	Attitude	0.582
EE	Environment education	0.666
ECB	Environment Conservation Behaviour	0.528
I	Intention	0.750
PBC	Perceived Behaviour Control	0.514

Construct Validity

Construct validity is achieved when all the fitness indices for a model fulfil the required levels (Awang et al., 2018). The three categories of model fit—absolute fit indices, incremental fit indices, and parsimonious fit indices—are sufficient to establish construct validity (Awang et al., 2018; Asnawi et al., 2019). The most widely used indicators include the root mean square error of approximation (RMSEA), comparative fit index (CFI), and normed Chi-Square (χ^2/df) (Awang et al., 2018). Table 5 summarizes the fitness indices categories and the levels of acceptance according to the literature.
As shown in Table 5, ECOBS fulfilled all three categories of fitness indices:

1. Absolute Fit Index: The RMSEA value was 0.068, which is lower than the threshold of 0.08, thus establishing the absolute fit index.
2. Incremental Fit Index: The CFI value was 0.931, surpassing the recommended value of 0.90, thereby fulfilling the incremental fit index category.
3. Parsimonious Fit Index: The normed Chi-Square (χ^2/df) value was 2.377, which is below the recommended maximum of 3.0 (Bentler, 1990), thus fulfilling the parsimonious fit index.

Therefore, this study has successfully addressed the construct validity of the ECOBS by meeting the criteria across all three fitness index categories.

Table 5 Fitness Indices

Name of category	Name of index	Level of acceptance	Result	Status
Absolute Fit Index	RMSEA	RMSEA < 0.08 (Browne & Cudeck, 1992; Hu & Bentler, 1999)	0.072	Fulfilled
Incremental Fit Index	CFI	CFI > 0.90 (Bentler, 1990)	0.920	Fulfilled
	TLI	TLI >0.90	0.911	Fulfilled
Parsimonious Fit Index	Chisq/df	Chi-Square/df < 3.0 (Bentler, 1990)	2.582	Fulfilled

Discriminant Validity

Discriminant validity of the survey was also established to ensure that no redundant constructs were present in the model. A redundant construct occurs when any pair of constructs in the model are highly correlated. To assess discriminant validity, a discriminant validity index summary was developed (Table 6). The diagonal values (in bold) represent the square root of the AVE for each construct, while the other values represent the correlation coefficients between pairs of constructs.

Discriminant validity was confirmed as the square root of each construct's AVE exceeded its correlation with other constructs in the model (Table 6) (Awang et al., 2018; Hair et al., 2014). This indicates that each construct is distinct from the others. The higher diagonal values (in bold) compared to any other values in the corresponding rows and columns demonstrated the discriminant validity for all constructs in the ECOBS. Therefore, the results in Table 6 meet the criteria for discriminant validity.

Table 6 Summary of Discriminant Validity Indexes for the Pooled CFA Model

Construct	ECB	PBC	ATT	EE	Int
ECB	***0.65***				
PBC	0.22	***0.78***			
ATT	0.25	0.38	***0.83***		
EE	0.30	0.36	0.47	***0.82***	
Int	0.28	0.41	0.46	0.52	***0.85***

Composite Reliability

Composite reliability is employed to assess reliability within the structural equation model (Awang et al., 2018; Hair et al., 2014). A composite reliability estimate of 0.7 or higher signifies good reliability, whereas a value between 0.6 and 0.7 is deemed acceptable (Awang, 2018; Hair et al., 2014). The analysis revealed that the composite reliability for all constructs within the ECOBS surpassed the minimum threshold of 0.6 (Table 7). Specifically, perceived behavioral control achieved the highest composite reliability, while the negative component of attitude had the lowest. Therefore, the composite reliability for the ECOBS constructs was satisfactorily established.

Table 7 Composite Reliability

Codes	Construct	CR (above 0.6)
A	Attitude	0.848
EE	Env education	0.922
ECB	Environment Conservation Behaviour	0.746
I	Intention	0.960
PBC	Perceived Behaviour Control	0.831

Normality Assessment

Finally, the normality distribution of all items measuring the constructs in ECOBS was evaluated. According to Asnawi et al. (2019), and Hair et al. (2014), the skewness values for all items should remain within acceptable limits to ensure normality. Skewness values ranging from -1.5 to 1.5 are considered acceptable. The skewness values for all components in the model fell within this range, indicating that their distribution adhered to normality (Table 8). Consequently, the data distribution in the ECOBS satisfied the normality requirement.

Table 8 Normality Assessment Results

Codes	Item	**Skewness**
	Environment Education	
EE1	Environment course I attended improve my knowledge in conserve energy	-.464
EE2	I learned about environment since elementary school	-.931
EE3	Integrating EE can be done in different learning methods.	-.849
EE4	I learn about environment from various media.	-.610
EE5	Learning material about the environment is interesting.	-.637
EE6	I learn diverse topic about energy conservation in University.	-.725
	ECB	
ECB 1	I switch off the lights when i leave a room	-.666
ECB 2	I turn off the water while brushing my teeth	-.522
ECB 3	I turn off my computer when sleep at night	-.832
ECB 4	I use energy saving light bulbs	-.257

continued

	Attitude	
A1	Student are responsible to reduce energy consumption in campus.	-1.144
A2	I am responsible to reduce energy resources I use in campus	-1.179
A3	The whole society has responsibility to save energy.	-1.401
A4	It is important to conserve energy at home.	-1.008
A5	I am worry if hearing the energy-related issues	-.687
	Intention	
I1	I want to conserve energy for environmental reasons.	-.928
I2	I intend to conserve energy for environmental reasons.	-.887
I3	I intend to use natural resources water in a responsible manner.	-1.020
I4	I intend to use natural resources like petroleum in a responsible manner	-.660
I5	I will try to reduce my carbon footprint in the forthcoming month.	-.744
I6	I will encourage my classmates to conserve energy all the time.	-.683
I7	I intend to engage in energy-saving activities in the future	-.665
I8	I intend to join energy awareness campaign in campus	-.677
	PBC	
PBC 1	I believe I am responsible for the environment we are living in.	-1.218
PBC 2	I believe it is adequate to conserve energy	-.403
PBC 3	I choose energy saving activities if I can save my money.	-.651
PBC 4	I choose energy saving activities if it is convenient.	-.548
PBC 5	I choose energy saving activities if it can save the time.	-.645

CONCLUSION

This study set out to validate the Environment Conservation Behavioural Survey (ECOBS), an instrument designed to assess university students' behaviours and intentions regarding energy conservation. The results from both the Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) indicate that ECOBS was effectively developed to identify the predictors influencing students' energy conservation behaviours. The CFA confirmed that ECOBS meets the stringent criteria for convergent validity, construct validity, and discriminant validity. Furthermore, evaluations of unidimensional and normality provided additional validation for the items within the ECOBS instrument. Consequently, the findings from the EFA and CFA demonstrate that ECOBS is a reliable tool for measuring students' intentions and behaviours towards energy conservation.

Validity and reliability are inherently related concepts in measurement instruments. As Nasution (2023) asserts an instrument can be reliable without being valid, however it cannot be valid if it is not reliable. In other words, a valid instrument must also be reliable. The ECOBS instrument, through rigorous validation processes, not only demonstrated reliability but also achieved various forms of validity. This dual validation underscores the robustness of the ECOBS instrument in measuring students' energy conservation behaviours and intentions accurately.

Given its rigorous validation, the ECOBS instrument can be used to empirically test respondents' energy conservation behaviours and intentions. Before full-scale deployment, a pilot study with a small group of respondents can help ensure the instrument's applicability and clarity. Subsequent empirical research should involve a representative sample, considering factors such as gender, age, courses, and ethnicity to enhance the robustness and generalizability of the findings. Future research could explore additional factors that may influence students' intentions to conserve energy, such as environmental commitment, environmental consciousness, knowledge, and awareness. Incorporating these moderating variables can further refine the ECOBS instrument and provide deeper insights into the determinants of energy conservation behaviours among students. By ensuring that the ECOBS instrument is both reliable and valid, researchers can confidently use it to investigate the factors driving energy conservation behaviours. This dual focus on reliability and validity not only enhances the credibility of the findings but also ensures that the ECOBS instrument remains a valuable tool for future studies aimed at promoting sustainable behaviours among students.

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