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# The impact of sustainability literacy, social support, and attitudes towards innovation on sustainable energy consumption among Indonesian youth

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Sustainable energy consumption has become an essential goal in addressing climate change and reducing environmental degradation. Despite increasing awareness, behavioural change toward sustainable energi use, especially among youth, remains limited. Existing studies often focus on either individual knowledge or social environments in isolation, leaving a gap in understanding how sustainability literacy and social support jointly influence sustainable energy consumption behaviour. This study aims to explore these relationships in an educational context, focusing on university students as future agents of sustainable transformation. This research employed a quantitative approach using Covariance-Based Structural Equation Modeling (CB-SEM). Data were collected from 337 undergraduate students enrolled in business and economics programs at three Indonesian universities. The analysis examined the direct effects of sustainability literacy and social support on sustainable energy consumption behaviour. The findings reveal that both sustainability literacy and social support significantly and positively impact students' sustainable energy consumption behaviour. Sustainability literacy equips students with knowledge to make informed energy choices, while social support reinforces these choices through motivation and affirmation from peers and social networks. These results highlight the importance of combining educational interventions and social reinforcement to foster behavioural change. Universities play a strategic role in embedding sustainability knowledge and cultivating supportive communities that enable sustainable lifestyles.

KEYWORDS

sustainability literacy, social support, innovative attitudes, energy behavior, youth consumption, SEM analysis

## 1 Introduction

Residential and commercial energy usage forms a significant portion of electrical system demand (Pérez-Lombard et al., 2008). Most of the energy is used to maintain an acceptable indoor atmosphere through ventilation, heating, and air conditioning, along with additional requirements for lighting, hot water, and a variety appliances (Chel and Kaushik, 2018). Consumers play a crucial role in managing energy demand, particularly given the unpredictable nature of renewable energy sources such as solar and wind (Wall et al., 2021).

There has been an increase in energy consumption in Indonesia in various energy sources (Ritchie et al., 2022b; Hilmiyati-Mas'adah et al., 2024; Kanugrahan et al., 2022; Kanugrahan and Hakam, 2023; Paradongan et al., 2024; Pramana et al., 2024). Increasing domestic energy consumption in developing countries, such as Indonesia, has a significant impact at the global level, as it affects trade flows, investment, and the climate (Darrian et al., 2023; Elfaki et al., 2021). Thus, there is an entanglement between energy and development in developing countries. Balancing energy use requires the integration of environmental sustainability, technological progress, and economic growth (Qian and Ji, 2022). Meeting the demands of society and business while keeping a closer eye on the environmental impacts of energy generation presents two significant challenges for the energy sector (Zakharov et al., 2022).

When fossil fuels are burned, harmful gases like carbon dioxide ($CO_2$), sulfur dioxide ($SO_2$), carbon monoxide (CO), nitrogen oxides (NOx), particulate matter (PM), and heavy metals are released. These gases can have detrimental effects on the environment, including global warming and climate change. Fuel burning will require more electricity to be produced when energy consumption rises, which could result in higher emissions (Gasparotto and Da Boit Martinello, 2021; Perera, 2018). Indonesia's GDP expanded dramatically from 1990 to 2022, accompanied by a 370% increase in total $CO_2$ emissions. According to the findings, Indonesia's rapid economic growth has had a significant impact on $CO_2$ emissions. As a result, the nation needs to work harder to mitigate the adverse environmental effects of its rapid economic growth by implementing policies and initiatives that reduce $CO_2$ emissions and enhance energy efficiency (Darrian et al., 2023; Ritchie et al., 2022a).

Sustainability is a broad concept that includes economic, social, governance, and environmental aspects, all of which interact to influence how people use energy (Najjar, 2022). Energy-saving practices are closely linked to sustainability values (Bian, 2020; Fraj and Martinez, 2006). Although prior research has demonstrated a positive correlation between Sustainable Energy Consumption Behavior, Sustainability Literacy, and Social Support, it frequently neglects to examine the mediating role of Attitude Towards Sustainable Innovation in this context (Acquadro Maran et al., 2023; Chel and Kaushik, 2018; Fischbach and Yauney, 2023).

This study aims to fill the gaps by investigating the intricate relationships between social Support, sustainability literacy, and attitudes toward sustainable innovation in influencing young Indonesians' sustainable energy consumption behavior. The study will provide insights for developing sustainable policies, energy-efficient products, and educational initiatives that promote sustainability in Indonesia, utilizing structural equation modelling (SEM).

This research also contributes to the development of literature on sustainability and consumption behavior. In this study, we focused on the main five research questions.

*RQ1:* Is there a relationship between Sustainability Literacy and Sustainable Energy Consumption Behavior?

*RQ2:* Is there a relationship between Social Support and Sustainable Energy Consumption Behavior?

*RQ3:* Is there a relationship between Attitudes Towards Sustainable Innovation and Sustainable Energy Consumption Behavior?

*RQ4:* Is there a mediating effect of Attitudes Towards Sustainable Innovation among Sustainability Literacy and Sustainable Energy Consumption Behavior?

*RQ5:* Is there a mediating effect of Attitudes Towards Sustainable Innovation among Social Support and Sustainable Energy Consumption Behavior?

This study is significant in the context of growing global concerns about sustainable behavior among young individuals, particularly university students who represent the future agents of change. Despite various educational campaigns, gaps remain in understanding how internal (e.g., sustainable literacy) and external (e.g., social support) factors jointly influence pro-environmental behaviors. By empirically examining the relationships among sustainable literacy, social support, and sustainable behavior, this study makes a significant contribution to both theory and practice.

The main contributions of this paper are threefold: (1) it extends the current literature by integrating social support into the framework of sustainable behavior modeling; (2) it empirically validates the mediating role of sustainable literacy and sustainable consumption behavior in shaping environmentally responsible actions; and (3) it provides actionable insights for educational institutions and policymakers to design more targeted sustainability interventions.

In addition to these contributions, this study provides several innovations that differentiate it from prior research. Most existing studies have examined the influence of social support and sustainable literacy in isolation. By contrast, our study integrates these variables into a comprehensive model that incorporates sustainable consumption behavior as a previously underexplored mediating factor. Moreover, by focusing on Indonesian university students, a population rarely examined in this context, the study offers context-specific insights. Finally, the use of a robust SEM technique with AMOS 28 enhances the methodological rigor of our findings, offering stronger empirical support than traditional regression-based approaches.

The remainder of this research is organized as follows. Literature Reviews are discussed in Section 2. Methods are discussed in Section 3. Section 4 examines the analysis of Covariance-based structural equation modelling (CB-SEM) results. Section 5 Discussion section interprets these findings, explores the causal relationships among constructs and highlights the theoretical and practical value of the research. The conclusion of the work is presented in Section 6.

## 2 Literature review

The literature review highlights previous results, as presented in Table 1. Studies on sustainability literacy emphasize the importance of promoting environmentally responsible consumption behaviors. Chamcham et al. (2024) illustrate how media literacy on sustainability in Iran enhances sustainable consumption behavior, while Brody and Ryu (2006) demonstrate how sustainability education positively affects students' consumption behavior in the U.S. Pšurný et al. (2023) in the Czech Republic report the understanding food quality and reducing waste contribute to more responsible consumption, with Biswas (2020) in India also emphasizing the influence of environmental Literacy on healthier, sustainable lifestyle choices. Similarly, Tomás

TABLE 1 Literature review.

| No. | Authors & year | Context | Country/region | Dependent variable | Independent variable | Metrics used | Method |
|---|---|---|---|---|---|---|---|
| 1 | Chamcham et al. (2024) | Role of media literacy in sustainable consumption | Iran | Sustainable consumption behavior | Media literacy aspects | Variance in sustainable behavior | PLS-SEM |
| 2 | Al-Nuaimi and Al-Ghamdi (2022) | Sustainable consumption in higher education | Qatar | Pro-environmental behavior | Sustainability education | Influence on behavior | Literature review |
| 3 | Brody and Ryu (2006) | Educational impact on sustainable development | USA | Student consumption patterns | Graduate course on sustainability | Ecological footprint | Pretest-Posttest |
| 4 | Biswas (2020) | Environmental literacy and health | India | Healthy lifestyle practices | Environmental literacy | Lifestyle adoption metrics | Quantitative analysis |
| 5 | Tomás et al. (2022) | Environmental literacy among teachers | Peru | Pedagogical behaviors | Environmental literacy | Literacy and behavior levels | Correlational-causal |
| 6 | Watkins et al. (2019) | SCP literacy in children | New Zealand | SCP knowledge and behavior | SCP literacy intervention | Knowledge and behavior scores | Mixed methods |
| 7 | Sharma and Jha (2017) | Sustainable behavior among children | India | Environmentally sustainable behavior | Cognitive factors (e.g., self-regulation) | Impact on consumption behavior | Regression analysis |
| 8 | Lee et al. (2015) | Place identity and sustainable consumption | New Zealand | Sustainable consumption behavior | Consumption values and place identity | Influence on behavior | Structural equation modeling |
| 9 | Bui et al. (2022) | SCB model for social impacts | Indonesia | Sustainable consumption behavior | Social impact, consumer behavior | Qualitative hierarchy | Delphi and Fuzzy DEMATEL |
| 10 | Geng et al. (2017) | Motivating SC among adolescents | China | SC behavior | Education, awareness, product differentiation | SC behavior levels | Hierarchical regression |
| 11 | Cao and Liu (2023) | AI technology's impact on sustainable consumption | China | Sustainable consumption behavior | AI technology stimuli, perceived value | Sustainable behavior frequency | Regression analysis, bootstrapping |
| 12 | Banyte et al. (2020) | Sustainable consumption in home and workplace | UK | Sustainable consumption behavior | Enthusiasm, attention, gender, age | Levels of sustainable behavior | Online survey |
| 13 | Adua (2020) | Energy efficiency technologies and behavior | USA | Residential energy consumption | Interactive and fixed efficiency technologies | Energy consumption metrics | Structural equation modeling |
| 14 | Niamir et al. (2020) | Household energy behavior change | Netherlands, Spain | Energy-saving behavior | Awareness, social norms, household attributes | Behavior change frequency | Probit regression |
| 15 | Singh et al. (2022) | Geodemographic factors on electricity use | Canada | Electricity consumption | Socio-economic, dwelling factors | Correlation of factors with usage | Spearman correlation |
| 16 | Frederiks et al. (2015) | Psychological predictors of energy consumption | Australia | Energy consumption | Socio-demographic, psychological traits | Consumption patterns | Literature review |
| 17 | Kuhe and Bisu (2020) | Situational factors on household energy use | Nigeria | Household energy consumption | Policy, economic, environmental factors | Consumption levels by factor | Scoping review |
| 18 | Pšurný et al. (2023) | Food purchasing and waste behavior | Czechia | Sustainable consumption behavior | Food usability, pricing, quality, convenience | Waste frequency, sustainability level | Factor analysis |
| 19 | Dong et al. (2018) | Material possession love on sustainable behavior | China | Sustainable consumption of durable goods | Material possession love, needs (autonomy, control) | Sustainable product use | Structural equation modeling |
| 20 | Masoodian and Luz (2016) | Visualization of energy consumption | New Zealand | User engagement in energy saving | Time-load visualization model | Percentage use of energy over time | Visualization |
| 21 | Jailani et al. (2020) | Residential energy consumption patterns | Malaysia | Energy consumption levels | Appliance usage, consumer behavior | Electricity usage distribution | Survey and analysis |

et al. (2022) highlight the impact of sustainability literacy on teachers' pedagogical behaviors in Peru, demonstrating that an increased understanding of sustainability leads to more mindful consumption practices. These findings focus on the role of sustainability literacy in fostering environmentally responsible behaviors, which is significant to this study's focus on Indonesian youth. These results underscore the importance of sustainability literacy in promoting environmentally responsible behavior, which is particularly relevant to the study's focus on young Indonesians.

Another key factor in increasing sustainable consumption is social support. Research from Watkins et al. (2019) in New Zealand and Geng et al. (2017) in China shows that social support in sustainability education influences children's sustainable consumption practices, which supports the findings of Al-Nuaimi and Al-Ghamdi (2022) that educational environments in Qatar encourage pro-environmental behavior among students. While Niamir et al. (2020), who studied families in the Netherlands and Spain, demonstrate that social norms and awareness lower energy use, Banyte et al. (2020) in the UK emphasize that excitement and support in the home and work environments increase sustainable behaviors. These research findings show that social Support, particularly in educational settings, can be critical in encouraging young people to engage in sustainable consumption, which is relevant to the Indonesian setting under discussion.

Sustainable consumption decisions are also significantly influenced by attitudes toward innovation. According to research conducted in India by Deka et al. (2023), children's environmentally friendly activities are influenced by cognitive aspects, including self-regulation and receptivity to innovation. According to Dong et al. (2018), in China, sustainable consumption decisions are promoted by attachment to long-lasting products influenced by material values. In New Zealand, Lee et al. (2015) also demonstrates how place identification values can positively impact sustainable consumption. In Indonesia, Bui et al. (2022) also emphasize the role of consumer behavior and social impact in promoting the development of sustainable purchasing habits. According to these studies, a favourable attitude toward innovation, especially regarding sustainable goods and services, greatly influences consumers' decisions to make environmentally friendly purchases. Showed important information for figuring out how young Indonesians feel about sustainability.

Furthermore, it has been discovered that technology and energy efficiency are crucial for promoting sustainable energy use. In the United States, Adua (2020) examines the efficacy of energy-saving devices, including insulation and programmable thermostats, concluding that they lower residential energy use but have some rebound effects. While Jailani et al. (2020) in Malaysia emphasize that increasing awareness of energy use patterns helps optimize home energy consumption, Masoodian and Luz (2016) offer a time-load visualization in New Zealand that improves public understanding of energy consumption. In Canada, Singh et al. (2022) investigate how geodemographic characteristics influence electricity use, while in Australia, Frederiks et al. (2015) discuss the impact of psychological and sociodemographic factors on energy use. These studies show how energy-efficient technologies and high literacy levels can help individuals manage their energy use more sustainably, which is essential for promoting sustainable practices among young Indonesians.

In summary, prior studies have indicated that social support plays a significant role in shaping environmentally responsible behaviors by providing emotional, informational, and instrumental resources.

Sustainable literacy has also been identified as a key predictor of sustainable behavior, enabling individuals to understand environmental information better, evaluate it more effectively, and act upon it more effectively. Furthermore, sustainable consumption behavior is recognized as a mediating factor linking cognitive awareness and actual sustainable practices.

Based on the literature, the main hypothesized relationships examined in this study are as follows:

1 Social support has a positive effect on sustainable behavior.
2 Social support positively influences sustainable literacy.
3 Sustainable literacy positively affects sustainable behavior.
4 Social support has a positive impact on sustainable consumption behavior.
5 Sustainable consumption behavior has a positive effect on sustainable behavior.

These relationships form the theoretical foundation of our conceptual model, which integrates both personal and contextual factors in predicting sustainable behavior among university students.

# 3 Research methodology

The theoretical framework for examining the relationship between social Support, sustainability literacy, and sustainable energy consumption behavior with attitudes toward sustainable innovation acting as a mediating factor is depicted in Figure 1.

Covariance-based structural equation modeling (CB-SEM) was employed in this study for statistical analysis, implemented using IBM SPSS AMOS 28 to ensure analytical precision. This technique is well-suited for testing theoretical models involving latent variables and mediating relationships. It estimates model fit using the covariance matrix, allowing for a rigorous evaluation of how well the hypothesized structure aligns with the observed data. CB-SEM was applied to examine the interrelationships among attitudes toward sustainable innovation, social support, sustainability literacy, and sustainable energy consumption behavior. Before testing the structural model, a Confirmatory Factor Analysis (CFA) was conducted to validate the measurement model in terms of reliability and construct validity (see Figure 2).

In this study, Indonesian students enrolled in a business and economics program were selected for sampling using a probability-based approach. Students pursuing degrees in business and economics are given particular consideration due to their immense potential to impact people's actions about using renewable energy. Since they will probably make decisions in the future and are expected to be knowledgeable and skilled in sustainability, these students make an ideal group to study attitudes and behaviors toward sustainable energy. Students with higher education, especially in business and economics, are better equipped to make judgments that promote sustainable growth, according to Žalėnienė and Pereira (2021). Additionally, business and economics curricula frequently address energy consumption, economic development, and social impacts, enhancing students' understanding of and ability to persuade others to adopt sustainable practices (Ling et al., 2021). Social influences, innovation-friendly attitudes, and sustainability knowledge can

be more directly linked to practical, sustainable energy practices thanks to the framework provided by their educational experience.

The minimal sample size is defined as the result of GPower 3.1, a tool frequently used in psychological and economic studies (Hakam D. F. et al., 2024; Hakam L. I. et al., 2024). The data collection was carried out by trained enumerators who distributed standardized questionnaires to students across three different higher education institutions. These enumerators were instructed to assist respondents throughout the process to ensure clarity and accuracy in their responses. A total of 350 initial responses were collected, of which 337 were retained after data cleaning, resulting in a valid response rate of 96.28%.

The final sample comprised 337 university students. Of these, 198 (58.75%) were female and 139 (41.25%) were male. Participants ranged in age from 18 to 25 years, with a mean age of 20.4 years. All respondents were enrolled in undergraduate programs, primarily in fields related to economics, education, and environmental sciences. Approximately 62% of the students had previously participated in sustainability-related courses or programs. To minimize potential bias, instructors from the respective institutions facilitated the distribution process and provided support to students as they completed the questionnaires.

Previous research was adapted to create and develop questionnaires. A 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), and a score calculation using an assessment method in the form of positive questions were employed to measure the four variables included in this study. We adapted the items aimed at measuring Sustainability Literacy from Ozdemir (2024) and Sousa et al. (2021) items aimed at measuring Social Support were taken from Abdullah et al. (2022) and Benazzi et al. (2006). We adapted the Attitudes Towards Sustainable Innovation construct items from Ahn et al. (2020) and Jiang et al. (2022). The Sustainable Energy Consumption Behavior construct items were modified from Hasan (2024) and Hasibuan and Judijanto (2023). To improve understanding of the questionnaire and translation errors, experts repeatedly validated the translation of the instrument from English to Indonesian.

We involve professionals in the fields of economics, business, and education in the development of the items used in the questionnaire. This professional involvement ensures the relevance and depth of the questionnaire items. To validate the instrument, we conducted a pilot study involving 100 participants and conducted an Exploratory Factor Analysis (EFA). Through the pilot study, we refined the questionnaire items based on empirical evidence. EFA findings provide a basis for field studies, enabling the application of Structural Equation Modelling (SEM) and Confirmatory Factor Analysis (CFA).

We adapted the two-phase SEM model developed by Anderson and Gerbing (1988). The first phase involves assessing the measurement model by validating the validity of the constructs used. The second phase consists of assessing the structural model, which determines the relationships between latent variables. These two phases demonstrate the importance of validating the measurement model before evaluating the structural model, thereby increasing the reliability and validity of this research.

A technique was used in the study that concurrently assesses first- and second-order factor loadings. We can gain a deeper understanding of the structure and effectiveness of the proposed measurement model by employing Confirmatory Factor Analysis (CFA). Validity, reliability, normality, and one-dimensionality are characteristics of this methodology. Measures must fulfil specific criteria to be reliable and accurate. CFA conducts a thorough evaluation of the model's overall effectiveness and performance.

The structural model analysis aims to assess predictive correlations and investigate interactions among constructs to gain insight into the overall structural dynamics of the model. This method enables the examination of both direct and indirect effects, particularly when attitudes toward sustainable innovation are used as a mediator. The proposed hypotheses guiding this analysis are presented in Table 2.

*Hypothesis 1:* Indonesian youth with greater sustainability literacy are more likely to engage in sustainable energy consumption practices. Few studies highlight the link between environmentally conscious behavior and sustainability literature. Media literacy on sustainability improves sustainable behavior, suggest Chamcham et al. (2024). In a similar vein, Brody and Ryu (2006) demonstrate that sustainability education has a positive impact on the purchasing behavior of American students. By bridging the information and action gap, an awareness of sustainability promotes responsible behaviors (Pšurný et al., 2023). There are also counterarguments that, without encouraging social frameworks, greater Literacy might not be enough to influence behavior (Muslimah and Muhyidin, 2024). As a result, opinions on how sustainability literacy influences sustainable consumption habits vary.

*Hypothesis 2:* Among Indonesian teenagers, higher levels of social Support are associated with higher levels of sustainable energy use behavior. Research has indicated a robust association between sustainable consumption and social Support. For instance, Watkins et al. (2019) in New Zealand and Geng et al. (2017) in China show how social Support has a significant impact on the sustainable behaviors of young people. Studies conducted in the Netherlands and Spain have shown that social norms and household encouragement can further boost sustainable actions (Niamir et al., 2020). However, sustainable consumption might not be viable in the long run if social reinforcement is inconsistent. Although social networks are essential for promoting sustainable behavior, their effects can differ based on the type and degree of Support received.
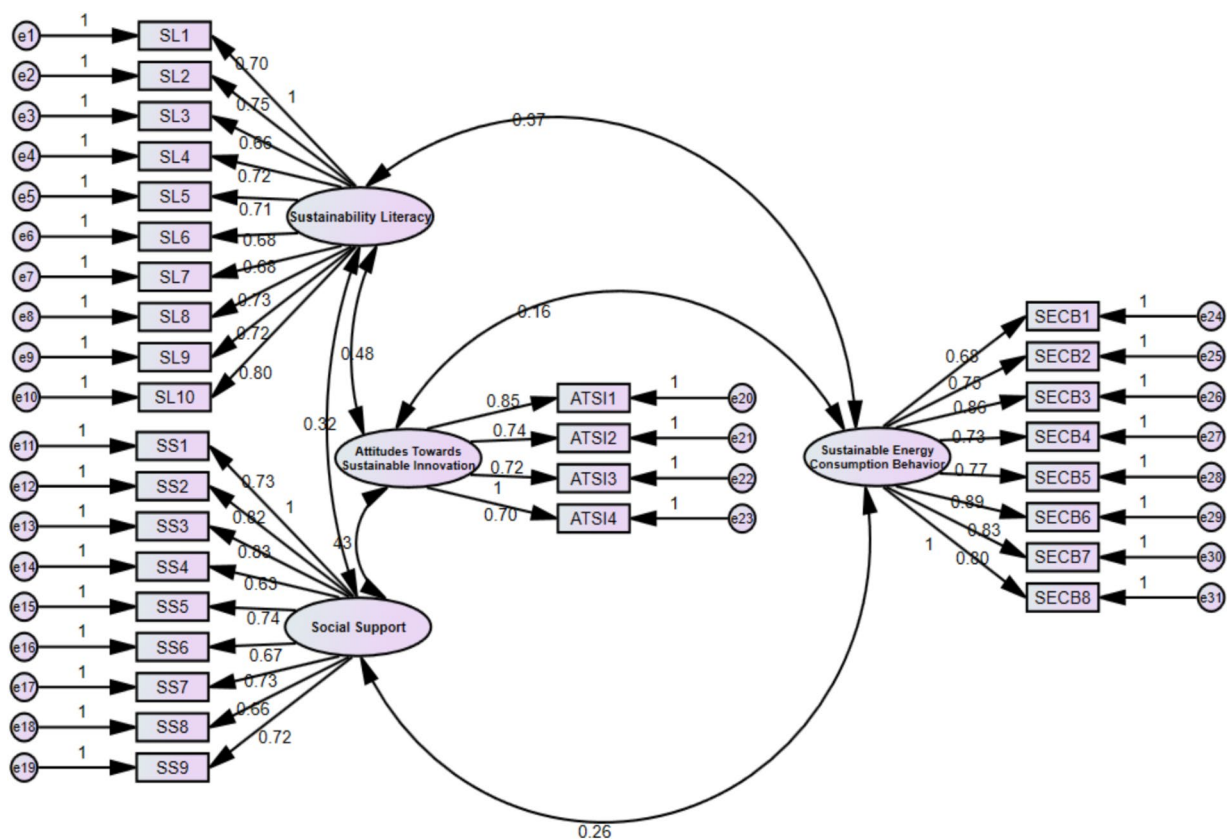


FIGURE 1
Theoretical framework for sustainable energy consumption behavior.
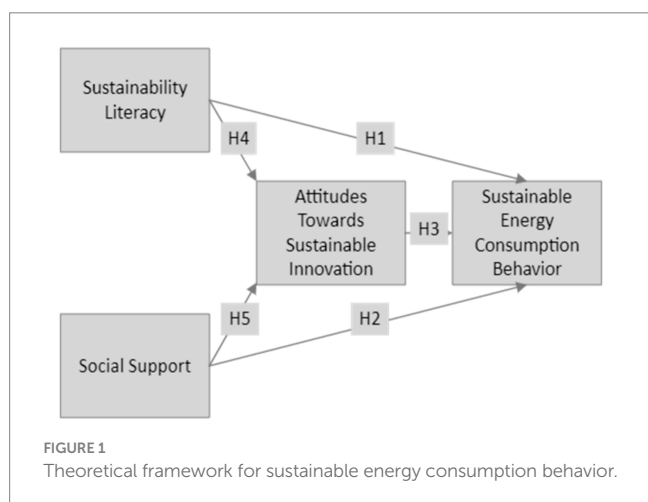
FIGURE 2
Pooled confirmatory factor analysis.

*Hypothesis 3:* A positive attitude toward sustainable innovation implies higher Sustainable Energy Consumption Behavior. Choices on sustainable consumption are influenced by attitudes toward innovation, particularly in sustainable technology and products. Sustainable behavior in New Zealand is significantly influenced by place identification and values, according to Lee et al. (2015). Karmokar et al. (2021) further emphasize that an environmentally friendly attitude is encouraged by a favourable attitude toward sustainable products. However, some research indicates that adoption rates of innovations may vary without continuous engagement and reinforcement.

*Hypothesis 4:* The impact of Sustainability Literacy on sustainable energy consumption behavior is mediated by attitudes toward sustainable innovation. According to this hypothesis, people are more likely to engage in sustainable energy practices if they have a favourable attitude toward innovation and a high level of sustainability literacy. Englis and Phillips (2013) point out that innovation amplifies the impact of perceptions about the environment on behavior. The effect of Literacy on behavior is also strongly mediated by attitudes toward sustainability, according to Danish Habib et al. (2021).

*Hypothesis 5:* The relationship between social Support and sustainable energy consumption behavior is mediated by attitudes toward sustainable innovation. Positive views on sustainable innovation can be fostered by social Support, which in turn

TABLE 2  Hypothesis.

| Hypothesis description | |
|---|---|
| H1 | Sustainability literacy positively impacts sustainable energy consumption behavior. |
| H2 | Social support positively impacts sustainable energy consumption behavior. |
| H3 | Attitudes towards sustainable innovation positively impact sustainable energy consumption behavior. |
| H4 | Attitudes towards sustainable innovation mediate the influence of sustainability literacy on sustainable energy consumption behavior. |
| H5 | Attitudes towards sustainable innovation mediate the influence of social support on sustainable energy consumption behavior. |

promotes sustainable consumption. Although Xiao and Su (2022) further reinforce the relevance of social structures in promoting sustainability-related behaviors, Wyrwa et al. (2023) highlight how social influence can form sustainable attitudes.

## 4 Results

The results from Table 3 show the reliability analysis using Cronbach's Alpha Value method, which compares the number of shared variables between items and forms an instrument with a total

number of variables (Cho and Kim, 2015; Christmann and Van Aelst, 2006). This analysis is conducted on variables such as Sustainability Literacy (0.72), Social Support (0.74), Attitudes Towards Sustainable Innovation (0.78), and Sustainable Energy Consumption Behavior (0.75). The results of this analysis revealed significant findings obtained using valid measurement instruments. Apart from that, Table 3 also presents the results of descriptive statistics, which provide information about the main trends and variability in the dataset by measuring the average value and standard deviation. The following are the average results of variable data, ranging from high to medium perception, including Sustainable Energy Consumption Behavior (M = 3.9), Social Support (M = 3.8), Attitude Towards Sustainable Innovation (M = 3.7), and Sustainability Literacy (M = 3.5).

Confirmatory factor analysis (CFA) serves as validation of a hypothesized model consisting of one or more latent variables, which are measured by one or more indicator variables, including Sustainability Literacy, Social Support, Attitudes Towards Sustainable Innovation, and Sustainable Energy Consumption Behavior (Kyriazos, 2018). CFA factor analysis is conducted to assess the accuracy and suitability of the proposed model from a study. The variables in this study are used to evaluate the fitness of the confirmatory factor analysis (CFA) model. Bentler (1990) introduced the Comparative Fit Index (CFI), categorized as an Incremental Fit measure, which assesses how well the hypothesized model compares to a baseline model. A CFI value above 0.90 indicates a good fit, and in this study, the obtained value is 0.93, reflecting a satisfactory model fit. Browne and Cudeck (1992) proposed the Root Mean Square Error of Approximation (RMSEA) as an Absolute Fit index, which evaluates how well the model fits the data directly. An RMSEA value below 0.08 is considered good, and the obtained value of 0.07 suggests an adequate fit. Hu and Bentler (1999) discussed the Chi-Square to Degrees of Freedom ratio (Chisq/df), an index of Parsimony Fit, where a ratio below 3 indicates a simple and well-fitting model. The obtained Chisq/df value is 2.52, indicating that the model is adequately parsimonious. Overall, based on these three fit indices (CFI, RMSEA, and Chisq/df), the tested model meets the criteria for good fit and is considered suitable for the analyzed data.

Table 4 presents the factor loadings obtained from the Confirmatory Factor Analysis (CFA) for the measurement model used in this study. The items are grouped under four latent constructs: *Sustainability Literacy*, *Social Support*, *Attitude Toward Sustainable Innovation*, and *Sustainable Energy Consumption Behavior*. All factor loadings exceed the acceptable threshold of 0.60 (Hair et al., 2019), indicating strong convergent validity for each item in measuring its respective construct.

For *Sustainability Literacy*, factor loadings range from 0.66 to 0.80, reflecting consistent agreement among items measuring awareness and concern toward environmental sustainability. The construct also demonstrates acceptable reliability with a Cronbach's alpha of 0.72. *Social Support* includes items with loadings between 0.63 and 0.83, capturing the influence of peers, family, and social networks on individuals' pro-environmental behaviors. This construct shows a reliability coefficient of 0.74. Items under *"Attitude Toward Sustainable Innovation"* demonstrate strong loadings, ranging from 0.70 to 0.85, indicating that respondents have positive perceptions of environmentally sustainable technologies and products. The internal consistency of this scale is also acceptable, with a Cronbach's alpha of 0.78. Finally, *Sustainable Energy Consumption Behavior*, the behavioral outcome construct, includes eight items with extreme loadings ranging from 0.68 to 0.89. The reliability score for this construct is 0.75, indicating high internal consistency and supporting the robustness of the behavioral measurements. Overall, the CFA results confirm that all four constructs demonstrate both convergent validity and internal consistency, making them suitable for use in the subsequent structural model analysis.

Table 5 presents the results of the HTMT ratio of correlations analysis, which is used to assess the discriminant validity of the latent constructs in the measurement model. The HTMT ratio evaluates whether the constructs are empirically distinct from one another by comparing the average correlations across constructs with those within the same construct.

All HTMT values in Table 5 are below the conservative threshold of 0.85 (Henseler et al., 2015), which suggests that discriminant validity is established. Specifically, the HTMT values range from 0.06 to 0.31, indicating that each construct —*Sustainability Literacy*, *Social Support*, *Attitudes Toward Sustainable Innovation*, and *Sustainable Energy Consumption Behavior* —measures a unique concept and is not overly correlated with the others. For example, the HTMT ratio between *Sustainability Literacy* and *Social Support* is 0.31, which is well below the threshold. In contrast, the ratio between *Attitudes Toward Sustainable Innovation* and *Sustainable Energy Consumption Behavior* is the lowest at 0.06, indicating a clear conceptual distinction between these constructs. These results confirm that the measurement model exhibits strong discriminant validity, supporting the use of these constructs in the structural equation modeling analysis.

This study employed one representative indicator from each of the three significant categories of model fit: parsimony fit, incremental fit, and absolute fit (Bentler, 1990). For incremental fit, the Comparative Fit Index (CFI) exceeded the recommended threshold of 0.90 with a value of 0.91, indicating a strong model fit. Regarding absolute fit, the Root Mean Square Error of Approximation (RMSEA) was 0.07, which

TABLE 3 Analysis of reliability and descriptive statistics.

| Variables | Realibility analysis | | Descriptive statistics | | |
|---|---|---|---|---|---|
| | Items | Cronbach's alpha value | Mean | Std. deviation | N |
| Sustainability literacy | 10 | 0.72 | 3.5 | 0.93 | 337 |
| Social support | 9 | 0.74 | 3.8 | 0.85 | 337 |
| Attitudes towards sustainable innovation | 7 | 0.78 | 3.7 | 0.76 | 337 |
| Sustainable energy consumption behavior | 7 | 0.75 | 3.9 | 0.62 | 337 |

TABLE 4 Factor loading of items.

| Author | Scale | Items | Factor loading | Scale reliability |
|---|---|---|---|---|
| Ozdemir (2024) and Sousa et al. (2021) | Sustainability literacy | I think that environmental concerns are frequently overstated. | 0.70 | 0.72 |
| | | I think humans are entitled to use natural resources as needed to meet our requirements. | 0.75 | |
| | | I am concerned about the potential extinction of certain species | 0.66 | |
| | | I believe it is not a significant concern if certain species that do not directly benefit human needs face extinction | 0.72 | |
| | | I am worried about the unfair distribution of resources across the world | 0.71 | |
| | | I am interested in getting involved in local environmental activities on a voluntary basis | 0.68 | |
| | | I am prepared to make personal sacrifices to support sustainability, such as reducing energy consumption and minimizing waste | 0.68 | |
| | | I am confident that my actions can positively impact the quality of the environment | 0.73 | |
| | | My personal intentions do not have a significant effect on environmental issues | 0.72 | |
| | | I believe that personal sacrifices do not significantly impact overall sustainability | 0.80 | |
| Abdullah et al. (2022) and Benazzi et al. (2006) | Social support | I feel encouraged by my social network to explore creative approaches to eco-friendly energy use | 0.73 | 0.74 |
| | | I am motivated to adopt advanced methods for responsible energy consumption when those around me show support | 0.82 | |
| | | I am more likely to embrace environmentally conscious energy practices when I receive positive feedback from others | 0.83 | |
| | | I believe the support from my peers plays a crucial role in my willingness to implement energy-efficient habits | 0.63 | |
| | | I find that my commitment to reducing energy waste increases when those close to me encourage mindful energy usage | 0.74 | |
| | | I am encouraged to maintain green energy habits when my family and friends show interest in these responsible practices | 0.67 | |
| | | I feel supported in experimenting with low-impact energy techniques when I discuss them with people who care about sustainability | 0.73 | |
| | | I am more inclined to pursue energy-conserving behaviors when others express enthusiasm for these efforts | 0.66 | |
| | | I am likely to adopt energy-conscious practices when I perceive strong social support for environmentally responsible actions | 0.72 | |
| Ahn et al. (2020) and Jiang et al. (2022) | Attitude towards sustainable innovation | I trust products and services that emphasize environmental sustainability. | 0.85 | 0.78 |
| | | I feel that investing in sustainable innovation is a wise choice for the future. | 0.74 | |
| | | I believe that renewable energy technologies are essential for a sustainable future. | 0.72 | |
| | | I am willing to pay more for products that are sustainably produced | 0.70 | |
| Hasan (2024) and Hasibuan and Judijanto (2023) | Sustainable energy consumption behavior | I make conscious efforts to reduce energy consumption in my daily life | 0.68 | 0.75 |
| | | I prioritize using energy-efficient appliances at home to minimize environmental impact | 0.75 | |
| | | I am committed to turning off lights and electronic devices when they are not in use | 0.86 | |
| | | I regularly monitor and adjust my energy usage to align with sustainable practices | 0.73 | |
| | | I am willing to invest in technologies or methods that support energy conservation in my household | 0.77 | |
| | | I believe that small changes in my energy consumption behavior can contribute to larger environmental benefits | 0.89 | |
| | | I am committed to adopting sustainable energy habits for the long-term, even if it requires some adjustments to my routine | 0.83 | |
| | | I prefer choosing products and services from companies that promote energy sustainability | 0.80 | |

falls within the acceptable range below 0.08 (Browne and Cudeck, 1992). For parsimony fit, the Chi-Square to Degrees of Freedom Ratio ($\chi^2$/df) was 1.90, well below the cut-off of 3.0, suggesting a parsimonious model (Hu and Bentler, 1999). Collectively, these indices confirm that the model provides an adequate and theoretically sound fit to the data.

The direct effect of the independent variables on the dependent variable is illustrated in Figure 3. The path analysis diagram in this figure excludes the mediator variable, which would have revealed the direct association between the independent and dependent variables (Wang et al., 2021). Variable Sustainability Literacy has a direct influence, with a coefficient value of 27, on Sustainable Energy Consumption Behavior compared to social Support, which has a coefficient value of 20. Between the two factors, Sustainability Literacy and Social Support have a considerable correlation of 31, which shows that the two factors are interrelated. The model shown in Figure 4 indicates that the higher the Sustainability Literacy and Social Support, the greater the tendency for a person to Exhibit Sustainable Energy Consumption Behavior.

The indirect effects are shown in Table 6. Significant relationships are observed between Attitudes Towards Sustainable Innovation, Sustainable Energy Consumption Behavior, Sustainability Literacy, and social support, as hypothesised in H1, H3, and H5. The standardized estimates and $p$-values highlight the strength and statistical significance of the connections (Prior et al., 2016).

Table 7 presents the direct and indirect beta values, providing more detailed information on indirect effects. H4 shows partial mediation, whereas H2 shows full mediation.

The structural equation model in this study shows that Attitude Towards Sustainable Innovation has a function as a significant mediating variable (coefficient 37) in linking Sustainability Literacy and Social Support to Sustainable Energy Consumption Behavior. Sustainability Literacy has a direct influence on Sustainable Energy Consumption Behavior with a coefficient value of 38, compared to social support which has a value of 31. Additionally, Sustainability Literacy and Social Support show a relatively high correlation (31), indicate the two variables are intertwined and can influence each other in the context of sustainability (Figure 3).

Table 7 adopts the alternative hypothesis regarding the relationship between sustainability literacy and social support for sustainable energy consumption behavior. The results indicate that sustainable energy consumption behavior is significantly enhanced by social support and sustainability literacy. Attitude Towards Sustainable Innovation, a predictor of Sustainable Energy Consumption Behavior, has a significant influence. The role of Attitude Towards Sustainable Innovation as a mediator between Social Support and sustainability literacy in sustainable energy consumption behavior has a significant impact. Therefore, social support and sustainability literacy have a

considerable influence on sustainable energy consumption behavior, either directly or indirectly, through an attitude toward sustainable innovation.

This study correlates with several other similar studies that address attitudes toward social Support, sustainability literacy, and sustainable innovation. The premise of this study, which emphasises the substantial importance of sustainability literacy in influencing sustainable energy consumption behavior, is supported, for example, by Ling et al. (2021) findings in the United States, which show that sustainability literacy positively affects sustainable behavior. Consistent with this research's conclusions about the beneficial association between social support and sustainable energy practices, a study conducted in Malaysia by Abdullah et al. (2022) also suggests that social support has a substantial impact on an individual's energy consumption behavior. Siddiqui et al. (2023) from Pakistan make an additional contribution by proving that workplace energy usage awareness affects sustainable behavior and supports the claim that sustainable actions are driven by sustainability literacy.

Research conducted in South Korea by Hwang and Yeo (2022) and Indonesia by Bui et al. (2022) confirms the importance of societal norms, values, and social factors in determining sustainable energy usage. These results support the idea that attitudes toward sustainable innovation and social Support have a beneficial impact on energy consumption patterns. In India, Chel and Kaushik (2018) emphasise the importance of technological improvements and energy efficiency in promoting sustainable energy behavior. The results align with this study's emphasis on sustainability literacy and creative attitudes, which impact energy use, despite the strategy being more technology-oriented.

The present study's hypothesis that attitudes toward sustainable innovation play a mediating role in attitudes toward sustainable innovation is supported by a study done in China by Lin et al. (2023). This study focuses on sustainable clothing behavior and the influence of social media on encouraging eco-friendly shopping choices. It also emphasizes the value of social support in promoting sustainable behavior. These conclusions are reinforced by a Polish study by Gajdzik et al. (2024), which demonstrates that economic awareness and sustainability knowledge have a significant influence on energy consumption behavior and support the notion that sustainability literacy is necessary to promote responsible energy use.

The research's general hypothesis regarding how attitudes toward sustainable innovation, Social Support, and sustainability Literacy might all positively impact sustainable energy consumption behavior is consistent with previous research findings. The reviewed literature as a whole strengthens the connections between these factors, providing additional evidence for the critical roles that psychological, social, and educational factors play in shaping patterns of sustainable

TABLE 5 The Heterotrait–Monotrait (HTMT) ratio of correlations analysis.

| | Sustainability literacy | Social support | Attitudes towards sustainable innovation | Sustainable energy consumption behavior |
|---|---|---|---|---|
| Sustainability literacy | | | | |
| Social support | 0.31 | | | |
| Attitudes towards sustainable innovation | 0.28 | 0.22 | | |
| Sustainable energy consumption behavior | 0.19 | 0.07 | 0.06 | |

**FIGURE 3**
Direct influences in path analysis.



**FIGURE 4**
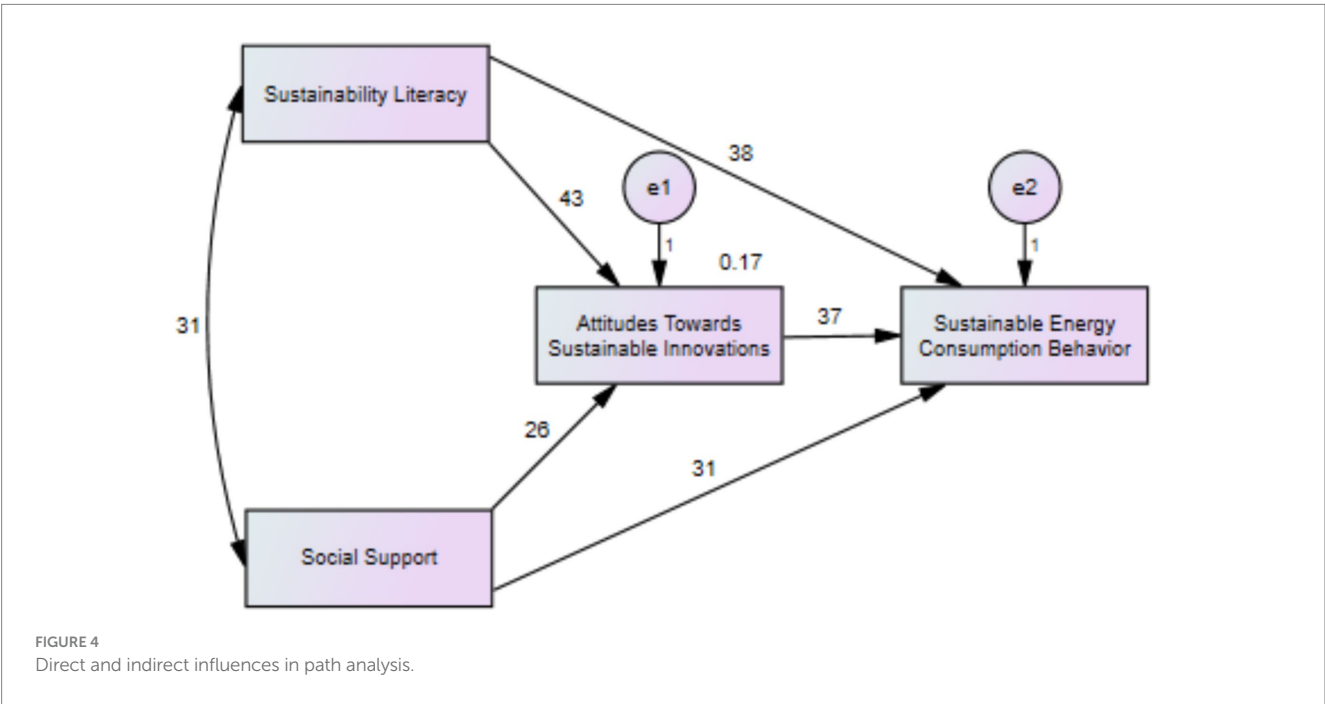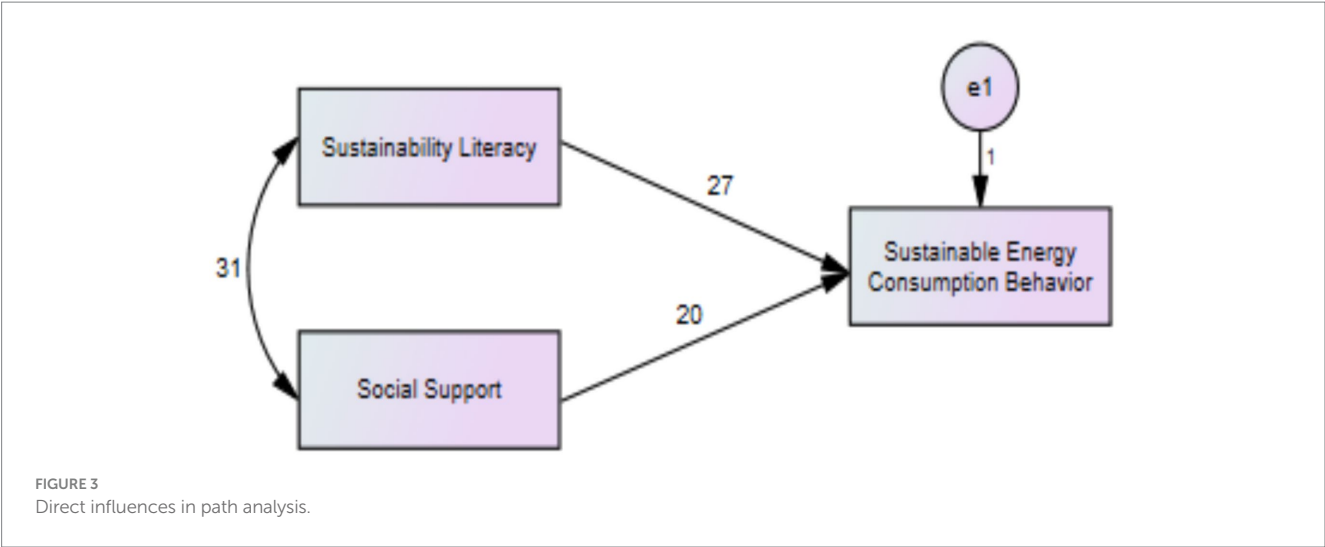Direct and indirect influences in path analysis.

TABLE 6  Results of indirect effects.

| Hypothesis | Path of influence | Lower estimate | Upper estimate | Estimate (standardized) | Significance (*p*-value) |
|---|---|---|---|---|---|
| H$_1$ | Sustainability Literacy→Sustainable Energy Consumption Behavior | −0.14 | 0.08 | 0.22 | 0 |
| H$_3$ | Social Support→Sustainable Energy Consumption Behavior | −0.16 | 0.04 | 0.19 | 0.06 |
| H$_5$ | Attitudes Towards Sustainable Innovation →Sustainable Energy Consumption Behavior | −0.12 | 0.06 | 0.37 | 0.04 |

energy use. There were no significant conflicts found. The complexity of sustainable behavior and the importance of a complete plan for promoting sustainability in social and educational contexts are highlighted by the convergence of research findings (see Table 8).

## 5 Discussion

This study confirms that Sustainability Literacy and Social Support significantly affect Sustainable Energy Consumption

TABLE 7 Results of indirect effects.

| Hypothesis | Path of influence | Unmediated direct effect | Mediated direct effect | Indirect effect estimate | Mediation type observe |
|---|---|---|---|---|---|
| H2 | Sustainability Literacy→Attitudes Towards Sustainable Innovation→Sustainable Energy Consumption Behavior | 0.22*** | 0.34 | 0.15 | Full mediation |
| H4 | Social Support→Attitudes Towards Sustainable Innovation→Sustainable Energy Consumption Behavior | 0.19** | 0.28*** | 0.08 | Partial mediation |

*** = Significance level 1%. ** = Significance level at 5%.

Behavior, either directly or indirectly. Attitudes Towards Sustainable Innovation serve as a key mediator in these relationships. These findings emphasize the interconnected roles of knowledge, social dynamics, and attitudes in shaping environmentally responsible behavior. The study also systematically addresses five research questions (RQ1–RQ5), confirming that Sustainability Literacy (RQ1) and Social Support (RQ2) significantly predict Sustainable Energy Consumption Behavior. Additionally, Attitudes Towards Sustainable Innovation (RQ3) are shown to have a direct and substantial effect on such behavior. The mediating role of attitudes is further validated, as it partially mediates the relationship between literacy and behavior (RQ4) and also between social support and behavior (RQ5), highlighting its pivotal function in shaping pro-environmental action. The significant path coefficients and model fit indices support the robustness of the proposed theoretical framework. Compared to existing studies (e.g., Abdullah et al., 2022; Ling et al., 2021), the results are consistent with the literature and provide new evidence from an Indonesian context. For instance, while previous research confirmed the role of social support in Malaysia, this study reinforces its relevance in a different socio-cultural setting.

What differentiates this study is its integration of both internal (literacy) and external (social support) variables in a unified model using CB-SEM, a method not commonly employed in earlier studies of sustainability behavior. Additionally, whereas studies such as Chel and Kaushik (2018) emphasize technological improvements, our work focuses on psychosocial drivers that are more relevant to behavioral change, particularly in educational settings. Furthermore, most previous research has centered on developed countries; by concentrating on Indonesian university students, this study captures behavioral dynamics in a developing country context, an area that remains underexplored. The exploration of causal relationships in the model underscores the need for multidimensional interventions to improve sustainability outcomes. Enhancing both literacy and supportive social environments while fostering positive attitudes toward innovation can yield effective outcomes in sustainable behavior.

This research contributes to the growing body of literature on environmental psychology and sustainable development by providing empirical validation for the complex interplay of cognitive, social, and attitudinal factors. It further suggests that educational institutions and policy programs should integrate these elements when designing sustainability interventions. The overall value of this research lies in providing a comprehensive, theory-driven, and statistically validated model that can be adapted

TABLE 8 Outcomes of hypothesis testing.

| Hypothesis | Description | Result |
|---|---|---|
| H1 | Sustainability literacy positively impacts sustainable energy consumption behavior | Accepted |
| H2 | Social support positively impacts sustainable energy consumption behavior | Accepted |
| H3 | Attitudes towards sustainable innovation positively impacts sustainable energy consumption behavior | Accepted |
| H4 | Attitudes towards sustainable innovation mediates the influence of sustainability literacy on sustainable energy consumption behavior | Accepted |
| H5 | Attitudes towards sustainable innovation mediates the influence of social support on sustainable energy consumption behavior | Accepted |

for use in various educational or cultural settings to promote sustainable energy practices among young people.

# 6 Conclusion

This study highlights the mediation effect of attitudes toward sustainable innovation. It provides thorough insights into how Sustainability Literacy and Social Support impact Sustainable Energy Consumption Behavior. The results verify that increased Sustainability Literacy delivers people with the information they need to make informed decisions about their energy usage and that social Support gives them the motivation and validation they need to initiate and maintain these habits. Views on sustainable innovation play a crucial role as a mediator, showing that people who value and benefit from innovation are more likely to adopt energy-saving behaviors.

This study successfully confirmed the intricate interactions between these variables by utilizing Covariance-Based Structural Equation Modeling (CB-SEM), providing a comprehensive understanding of how psychological, social, and educational elements work together to drive sustainable behavior. According to this study, interventions should not only focus on improving knowledge but also on creating supportive social situations and fostering positive attitudes toward sustainability, as the study emphasises the importance of cultivating both cognitive and affective components of sustainability.

This research highlights the importance of education in shaping young people's behavior towards sustainability. This research focuses on economics and business students. It illustrates how targeted educational interventions can enhance sustainability literacy and, consequently, behavior. The high response rate and solid analytical results lend credibility to this study, demonstrating that academic institutions play a crucial role in sustainability. Results show that social networks and peers significantly influence sustainability behavior and can provide social Support for change. Educational strategies that incorporate experiential learning, collaboration, and real-world applications are needed to strengthen the link between Sustainability Literacy and Sustainable Energy Consumption Behavior. Attitudes Towards Sustainable Innovation can bridge the gap between knowledge and action.

A comprehensive approach is necessary to ensure that students understand sustainability concepts and internalise and apply them in their daily lives. This study will provide opportunities for future exploration by focusing on demographic and geographic groups to increase the generalizability of the findings. In the long term, this research will provide insights into how these relationships evolve. Additionally, we can employ qualitative research to enhance our understanding of the motivations and challenges that arise when adopting sustainable behaviors. Policymakers, educators, and community leaders can utilise these insights to design programs that are more geared toward sustainability, thereby creating a more preserved environment and promoting community welfare.

## Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the (patients/participants or patients/participants legal guardian/next of kin) was not required to participate in this study in accordance with the national legislation and the institutional requirements.

## Author contributions

LH: Writing – original draft, Investigation, Conceptualization, Formal analysis, Data curation, Methodology. DH: Conceptualization, Supervision, Resources, Investigation, Writing – review & editing, Validation. SW: Investigation, Supervision, Conceptualization, Writing – review & editing, Resources. RR: Supervision, Writing – review & editing, Methodology, Resources, Validation.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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