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Environmental awareness influences green innovation intention among Saudi Generation Z through attitude and perceived behavioral control

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Abstract

Environmental awareness is widely assumed to motivate sustainable behavior, yet a persistent gap remains between knowledge and action. This study examines whether awareness directly drives green innovation intention among Saudi Generation Z or operates through psychological mediation. Drawing on the Theory of Planned Behavior, a structural equation model was tested using survey data from university students. The findings show that environmental awareness does not directly predict intention. Instead, its influence is transmitted through attitude toward green innovation and perceived behavioral control, with perceived control emerging as the dominant pathway. These results clarify the mechanisms underlying the awareness–action gap and demonstrate that youth sustainability engagement depends more on perceived agency than on information alone. By extending behavioral sustainability research into a rapidly transforming non-Western context, the study highlights the importance of empowerment-based strategies for mobilizing young populations in support of long-term green transformation.

1. Introduction

The scale of environmental degradation poses significant risks to economic resilience, social stability, and long-term development. Climate change, ecological imbalance, and resource depletion are progressively influencing national policy agendas, positioning sustainability as a core element of economic planning. In response, governments globally have emphasized green innovation—environmentally responsible technologies, practices, and behavioral systems—as a fundamental strategy for achieving sustainable transformation (Geels, 2011; Stern, 2020). Nevertheless, advancements in technology by themselves are insufficient to guarantee sustainability. The effectiveness of green innovation is primarily contingent upon human behavior, specifically the willingness of individuals to adopt, support, and integrate environmentally responsible practices into their daily routines.

A substantial amount of research indicates that sustainability transitions involve both behavioral and technological dimensions (Gifford, 2011; Yuriev et al., 2020). The availability of green solutions does not guarantee uniform adoption, as it is influenced by various psychological and contextual factors. It is often posited that environmental awareness serves as the main driving force behind pro-environmental behavior. Empirical evidence consistently reveals a notable awareness–action gap: individuals often acknowledge environmental risks but fail to develop a definitive intention to act (Kollmuss & Agyeman, 2002; Song et al., 2024). This disconnect underscores a fundamental issue in sustainability science: the need to comprehend the process by which environmental knowledge translates into readiness for behavioral change.

The Theory of Planned Behavior (TPB) offers a robust framework for tackling this issue. TPB posits that intention is predominantly influenced by attitudes toward behavior and perceived behavioral control, rather than being determined solely by awareness (Ajzen, 1991). In this context, awareness serves as a remote precursor that shapes individuals' assessments of sustainability and their perception of the feasibility of acting. Comprehensive empirical studies indicate that positive attitudes and a strong sense

of perceived control are key predictors of intentions related to pro-environmental behavior and innovation (Yuriev et al., 2020; García-Salirrosas et al., 2024). The findings indicate that transitioning from awareness to action necessitates psychological conversion mechanisms that convert knowledge into motivation and a sense of agency.

This behavioral perspective holds significant importance when analyzing younger generations. Generation Z is transitioning into adulthood at a time when sustainability initiatives are being formalized on a global scale. As emerging professionals, consumers, and policymakers, they will influence the long-term path of green innovation adoption. While young people frequently demonstrate significant environmental concern, this concern does not necessarily translate into active behavioral engagement (Krettenauer et al., 2024). It is essential to analyze how young individuals transform awareness into intention to create effective sustainability strategies.

Saudi Arabia presents a unique and significant framework for examining this process. In the context of Vision 2030 and the Saudi green initiative, there is a clear emphasis on prioritizing sustainability and fostering green innovation as key components of national development. Significant investments in renewable energy, intelligent infrastructure, and eco-friendly industries indicate a foundational dedication to sustainable change. In this transition, Saudi Generation Z emerges as a crucial group. This generation is poised to take on roles within public institutions, private enterprises, and technological sectors that are crucial to the Kingdom's green transition. While the strategic significance is acknowledged, there is a notable lack of empirical evidence detailing the process through which Saudi youth convert environmental awareness into behavioral intention.

Current regional studies frequently consider awareness as a straightforward predictor of pro-environmental behavior, neglecting the psychological mechanisms that influence this connection. Furthermore, a significant portion of the literature on sustainability grounded in the Theory of Planned Behavior is primarily focused on Western and East Asian contexts. This concentration prompts an examination of the applicability of these models to non-Western societies that are undergoing rapid transformation. Understanding the processes by which awareness translates into intention is crucial for developing youth-focused sustainability initiatives that align with national transformation objectives.

In light of this context, the current study investigates the direct impact of environmental awareness on green innovation intention, as well as the potential mediation of this effect through two psychological mechanisms: attitude toward green innovation and perceived behavioral control. This study utilizes the Theory of Planned Behavior to examine a mediation framework that elucidates the transition of Saudi Generation Z from environmental awareness to the formation of behavioral intentions. The research reframes the understanding of the knowledge–action relationship by identifying evaluative orientation and perceived agency as key factors that transform awareness into intention, rather than relying on a linear model.

This study makes three contributions to sustainability behavior research. First, it challenges the assumption that environmental awareness directly motivates green behavioral intention by

demonstrating a fully mediated psychological pathway in which awareness influences intention only through attitude and perceived behavioral control. This reframes awareness as a distal cognitive precursor rather than a direct behavioral driver. Second, the study empirically tests a fully mediated Theory of Planned Behavior model of green innovation intention, refining the explanatory precision of TPB in sustainability contexts. Third, it extends behavioral sustainability research into a rapidly transforming Middle Eastern setting, providing empirical evidence on how youth engagement with green innovation operates within the framework of Saudi Vision 2030.

2. Literature Review and Theoretical Framework

Green innovation is increasingly acknowledged as a crucial approach for attaining both environmental and economic sustainability. Previous studies characterized GI primarily as a technological and organizational issue; however, current academic discourse highlights its underlying behavioral aspects. Sustainable transitions rely on a combination of institutional frameworks and infrastructure, as well as the individual decision-making processes and psychological preparedness necessary for adopting environmentally responsible practices (Geels, 2011; Stern, 2020).

Research in the field of behavior indicates that pro-environmental actions are influenced by motivational frameworks, perceived trade-offs, and individual agency, rather than being driven solely by awareness (Gifford, 2011; Saxena et al., 2025). Individuals often demonstrate robust support for sustainability; however, they may postpone action when factors such as uncertainty, inconvenience, or perceived costs significantly influence their assessment. This behavioral framing presents GI as a decision-making process influenced by psychological factors, rather than merely a technical adoption. A prominent issue in sustainability research is the awareness–action gap, which refers to the disparity between environmental concern and the behaviors that follow (Kollmuss & Agyeman, 2002; Gifford, 2011). Many individuals express support for pro-environmental values; however, they often do not translate this support into consistent action, hindered by various cognitive, emotional, and structural obstacles.

Data suggests that awareness does not typically serve as a direct predictor of behavior. Rather, it operates as a distal antecedent that shapes intention via intermediate psychological mechanisms (Stern, 2020). Recent studies indicate that sustainability awareness enhances behavioral intention solely when it alters evaluative attitudes and perceived feasibility (Shang et al., 2024; **Enginkaya et al., 2025**). Awareness functions as a catalyst that necessitates transformation into evaluative commitment and agency.

The Theory of Planned Behavior (TPB) is a highly effective framework for elucidating intentions related to sustainability. TPB suggests that intention is predominantly influenced by attitudes regarding the behavior and the perception of behavioral control (Ajzen, 1991). This framework redirects attention from knowledge to the immediate factors influencing decision-making.

TPB has received extensive validation in various sustainability areas, such as green consumption, renewable energy adoption, and environmental entrepreneurship (Paul et al., 2016; Wang et al., 2019).

Recent research that combines the Theory of Planned Behavior with social cognitive factors indicates that intention arises from the interplay between evaluation and perceived capability (Utami, 2024). The results support the Theory of Planned Behavior as a robust and adaptable framework for analyzing sustainability behavior.

Environmental awareness involves the identification of environmental issues and an understanding of sustainable practices. While awareness serves as a crucial cognitive precursor, its capacity to predict outcomes directly is constrained (Kollmuss & Agyeman, 2002; Stern, 2020). Awareness influences behavior in an indirect manner by shaping attitudes and the perception of behavioral control. Recent empirical studies indicate that environmental awareness influences intention through mediating mechanisms, including innovativeness, perceived support, and self-efficacy (Utami, 2024). In a similar vein, it has been observed that sustainability awareness plays a moderating role in the relationships between attitudes, perceived control, and intention (Shang et al., 2024). The findings indicate a mediation perspective, suggesting that awareness triggers psychological processes that translate cognition into behavioral readiness.

Attitude reflects a person's assessment regarding participation in green innovation. Individuals who hold positive sustainability attitudes tend to exhibit a stronger intention to act when they perceive environmental actions as meaningful and beneficial (Paul et al., 2016; Saxena et al., 2025).

Nevertheless, positive attitudes by themselves do not ensure commitment to behavior. The presence of competing priorities and the perception of inconvenience could diminish the effectiveness of translating attitude into intention (Gifford, 2011). Research on green purchasing indicates that the influence of attitude is contingent upon individuals' perceptions of the feasibility of acting (Shang et al., 2024). Attitude serves as a necessary yet inadequate condition for intention.

Perceived behavioral control (PBC) reflects an individual's confidence in their capacity to execute a behavior based on the resources and opportunities at their disposal. In various sustainability contexts, PBC is often recognized as a significant predictor of intention (Ajzen, 1991; Wang et al., 2019). Recent research indicates that self-efficacy and control beliefs significantly influence green entrepreneurial and consumer intentions (Utami, 2024; **Enginkaya et al., 2025**). Individuals who possess a strong awareness yet perceive their agency as limited tend to exhibit lower levels of action. This observation underscores the importance of perceived behavioral control as a vital mechanism that connects cognitive processes with behavioral outcomes. The integration of these theoretical strands establishes a mediation framework where environmental awareness impacts intention via attitudes and perceived behavioral control. Awareness influences the evaluation of green innovation and determines the perceived feasibility of acting. Attitude reflects the level of desirability, whereas perceived control indicates the degree of feasibility. Awareness translates into intention solely when both mechanisms are activated.

Research indicates that awareness enhances intention mainly by interacting with constructs of the Theory of Planned Behavior, rather than through a direct route (Utami, 2024; Shang et al., 2024; **Enginkaya et al., 2025**). This mediation logic elucidates the reasons behind the limited behavioral change

often observed from awareness campaigns alone: it is essential that knowledge is accompanied by a sense of agency and a commitment to evaluation.

3. Hypotheses Development

Environmental awareness is expected to foster a favorable attitude toward green innovation by increasing individuals' understanding of environmental risks and the value of sustainable solutions. Within the Theory of Planned Behavior, awareness contributes to evaluative beliefs that shape how a behavior is perceived (Ajzen, 1991). Recent empirical evidence confirms this mechanism: (**García-Salirrosas et al.,2024**) demonstrate that environmental awareness significantly strengthens positive attitudes toward green alternatives, also the environmental knowledge and cognition systematically enhance pro-environmental evaluations (Ikuemonisan et al., 2025; Benzehaf et al., 2025). Together, these findings indicate that greater ecological understanding consistently translates into more supportive attitudes toward environmentally oriented practices. Accordingly, as Saudi Gen Z becomes more aware of environmental challenges, green innovation is more likely to be perceived as meaningful, valuable, and desirable.

H1. Environmental Awareness positively influences Attitude Toward Green Innovation.

Environmental awareness is expected to strengthen perceived behavioral control by enhancing individuals' understanding of how sustainable actions can be performed. Within the Theory of Planned Behavior, perceived behavioral control reflects beliefs about feasibility and personal capability (Ajzen, 1991). Empirical evidence shows that environmentally informed individuals report higher control over pro-environmental behavior. (Shen and Wang, 2022; Khan et al., 2025) demonstrate that environmental awareness and knowledge increase confidence in adopting and managing green practices by clarifying feasibility and personal impact. (García-Salirrosas et al., 2024) confirm that awareness significantly predicts perceived control toward green alternatives, while (Zhao et al., 2025) show that ecological awareness enhances green self-efficacy, directly elevating perceived behavioral control.

Accordingly, as Saudi Gen Z becomes more environmentally aware, green innovation is increasingly perceived as feasible and within personal reach.

H2. Environmental Awareness positively influences Perceived Behavioral Control.

Recent empirical evidence consistently shows that favorable attitudes toward sustainability-oriented practices translate into stronger intentions to act. (Pai et al., 2024) demonstrate that positive environmental attitudes enhance pro-environmental behavioral intention, while (Becerra et al., 2023; Cubillas-Para et al., 2024) confirm that pro-green attitudes significantly increase intentions to adopt and support green innovations among young consumers. (Mabkhot et al., 2024) further report that positive evaluations of green innovation strengthen youth entrepreneurial intention. Extending this evidence, (Prabowo et al., 2022; Al-Mamary, 2025) established attitude as a decisive and dominant antecedent of green innovation intention.

Accordingly, when Saudi Gen Z perceives green innovation as valuable and desirable, they are substantially more likely to develop a concrete intention to engage in it.

H3. Attitude Toward Green Innovation positively influences Behavioral Intention Toward Green Innovation

Perceived behavioral control reflects individuals' beliefs about their ability to perform a behavior and its feasibility (Ajzen, 1991). Empirical evidence consistently shows that higher perceived control strengthens sustainability-oriented intentions. (Khan et al., 2023; Kotyza et al., 2024) demonstrate that individuals who feel capable of adopting green practices exhibit significantly stronger pro-environmental and innovation intentions. Similarly, (Khan et al., 2025) find that perceived ease of implementation and self-efficacy predict eco-innovative intentions among young consumers. Extending this evidence, (Nguyen et al., 2018; Al-Mamary, 2025) confirmed that perceived behavioral control is a key determinant of green innovation intention.

Accordingly, when Saudi Gen Z perceives green innovation as feasible and within personal reach, their intention to engage in and support such innovation is expected to increase.

H4. Perceived Behavioral Control positively influences Behavioral Intention Toward Green Innovation

Within the Theory of Planned Behavior, attitude serves as the key mechanism through which cognitive factors shape intention (Ajzen, 1991). Environmental awareness influences evaluative beliefs underlying attitude, and these evaluations subsequently drive behavioral intention. Empirical evidence supports this mediating pathway. (García-Salirrosas et al., 2024) show that environmental awareness affects intention toward green alternatives primarily through attitude, while (Ikuemonisan et al., 2025) demonstrate that environmental knowledge enhances attitude, which then predicts intention. Extending this evidence, (Al-Mamary, 2025) confirmed that attitude fully or partially mediates the effect of environmental values and awareness on green innovation intention.

Accordingly, as Saudi Gen Z becomes more environmentally aware, this awareness is expected to translate into favorable attitudes toward green innovation, which in turn foster stronger intentions to engage in and support such innovation.

H5. Environmental Awareness indirectly affects Behavioral Intention Toward Green Innovation through Attitude Toward Green Innovation

Perceived behavioral control functions as a central transmission channel through which environmental awareness is converted into intention. By clarifying what sustainable action entails and reducing uncertainty, awareness strengthens beliefs about feasibility and personal capability, which in turn shape intention (Ajzen, 1991). Empirical evidence supports this mechanism. (Shen and Wang, 2022; Khan et al., 2023; Khan et al., 2025) show that environmental awareness enhances perceived ease, self-efficacy, and control beliefs, which subsequently increase green and eco-innovative intentions. Extending this evidence, (García-Salirrosas et al., 2024), and several studies (Nguyen et al., 2018.; Al-Mamary, 2025)

confirm that perceived behavioral control partially or fully mediates the effect of environmental awareness on green innovation intention.

Accordingly, as Saudi Gen Z becomes more environmentally aware, this awareness is expected to strengthen perceived behavioral control, thereby transforming knowledge into concrete intention to engage in and support green innovation.

H6. Environmental Awareness indirectly affects Behavioral Intention Toward Green Innovation through Perceived Behavioral Control.

Together, these hypotheses articulate a parsimonious behavioral framework in which environmental awareness serves as a cognitive foundation, while attitudes and perceived control function as the central conduits transforming knowledge into intention among Saudi Generation Z. The research model and hypotheses are depicted in Fig. 1, providing a clear illustration of the conceptual framework being examined. The model consists of four latent constructs: Environmental Awareness (EA), Attitude Toward Green Innovation (ATT), Perceived Behavioral Control (PBC), and Behavioral Intention (BI). Arrows illustrate the proposed direct effects among these latent variables.

4. Methodology

Research Design and Data Collection

This study adopts a quantitative, cross-sectional design to examine the determinants of behavioral intention toward green innovation among Saudi university students. The conceptual framework is grounded in the Theory of Planned Behavior and incorporates four latent constructs: Environmental Awareness (EA), Attitude toward Green Innovation (ATT), Perceived Behavioral Control (PBC), and Behavioral Intention (BI). The hypothesized relationships among these constructs are specified in the structural model illustrated in Fig. 1. Data were collected using a structured self-administered questionnaire distributed to university students in Saudi Arabia. A total of 322 valid responses from participants aged 18 years and above were obtained. Participants under the age of 18 were excluded from the final analysis to ensure full compliance with ethical research standards. The sample is predominantly undergraduate (98.2%) and female (58.1%), with most respondents aged between 18 and 30, reflecting a Gen Z–oriented cohort. These characteristics are appropriate for examining youth perceptions and intentions toward green innovation.

Sampling and Procedure

A non-probability purposive sampling method was utilized to recruit participants who satisfied the study's inclusion criteria. Participants were enlisted via academic networks and social media sites frequently utilized by young individuals.

The purposive sampling strategy was selected to support theory-driven analysis rather than population estimation. The objective of the study is to examine psychological mechanisms linking awareness,

attitudes, perceived control, and intention within a defined youth cohort, not to produce nationally representative prevalence estimates. In mediation-focused SEM research, analytical generalization of behavioral relationships is prioritized over statistical representativeness (Kline, 2024; Hair et al., 2019). Accordingly, purposive sampling is appropriate when the research goal is to test theoretically specified causal structures within a relevant population segment. Saudi Generation Z university students constitute a strategically meaningful group for examining sustainability engagement in the context of Vision 2030, as they represent the emerging workforce and future decision-makers in green innovation sectors. While findings should not be interpreted as population-level statistics, the sample is adequate for testing the proposed behavioral model and identifying mechanism-level relationships.

The sample size exceeds the minimum requirements for SEM using maximum likelihood estimate and surpasses the recommended ratios for each latent variable (Kline, 2024). The sample size also satisfies power requirements for detecting medium indirect effects (β ≈ 0.20) in mediation SEM models. A secure web-based survey and structured questionnaire collected data. Before its introduction, a pilot test was conducted to evaluate its clarity, language, and comprehension. Feedback on the pilot research altered the terminology. The survey incorporated translation and back translation to guarantee linguistic and conceptual equivalence in Arabic and English (Brislin, 1980). Study participants were anonymous, voluntary, and could withdraw at any time. The mean time required to complete the questionnaire was 8 to 10 minutes.

Measurement of the Constructs

The data analysis was conducted using Structural Equation Modelling (SEM) via Jamovi 2.7.6. SEM was chosen for its capability to handle complex models with multiple mediations, its robustness against non-normal data, and its focus on predictive accuracy (Hair et al., 2019). All constructs were evaluated using well-established multi-item scales derived from prior research, adapted to suit the context of Saudi Arabia. All latent variables in this study were assessed through multi-item scales derived from recognized instruments in previous peer-reviewed studies. Each item was evaluated using a 5-point Likert scale, where 1 represents Strongly Disagree and 5 represents Strongly Agree. Table 1 illustrates the measurement scales utilized in this study.

Table 1
Measurement Scales

Construct	Source	Sample Items	Scale
Environmental Awareness (EA)	Boermans et al. (2024)	I am aware of the environmental challenges facing Saudi Arabia; I understand how human activity contributes to environmental degradation.	5-point Likert
Attitude Toward Green Innovation (ATT)	Chen and Tung (2014); Zaremohzzabieh et al. (2021).	I believe green innovation is necessary for a better future; I think adopting green technologies benefits both the economy and the environment.	5-point Likert
Perceived Behavioural Control (PBC)	Ajzen (1991); Li et al. (2022)	I feel confident in my ability to engage in green activities; I have access to the resources needed to adopt green practices.	5-point Likert
Green Innovation Behavioural Intention (BI):	Hagger et al. (2022)	I intend to engage in green innovation activities at my university; I am willing to adopt environmentally friendly practices in my lifestyle.	5-point Likert

Ethical Considerations

Participation was completely voluntary, with a strong emphasis on anonymity, ensuring that no identifying personal data was gathered. Participants were made aware of the scholarly objectives of the research. The study design adhered to institutional ethical guidelines for research involving human participants.

5. Results

5.1. Descriptive Statistics

The sample, comprising 322 individuals, is primarily female, with 187 respondents representing 58.1% of the total, while males account for 135 respondents, or 41.9% as shown on Table 2. The majority of participants are undergraduate students, comprising 316 individuals or 98.1% of the total, whereas only 6 respondents, accounting for 1.9%, are postgraduates. This suggests that the data predominantly represents the viewpoints of early-stage university learners. The age distribution indicates a significant concentration of younger individuals: 209 respondents (64.9%) are in the 25–30 age bracket, 113 (35.1%) are aged 18–24. The demographic composition is closely aligned with the study's focus on Saudi youth, particularly Gen Z, thereby enhancing the relevance of the findings for understanding green innovation intentions within this population.

Table 2
Descriptive measures of the sample data

Category	Subcategory	Frequency(N)	Percentage (%)
Gender	Female	187	58.1%
	Male	135	41.9%
Level of Study	Undergraduate	316	98.1%
	Postgraduate	6	1.9%
	18–24	113	35.1%
	25–30	209	64.9%

5.2. Common Method Bias Assessment

To evaluate the risk of common method bias (CMB), Harman's single-factor test was applied in accordance with the procedure recommended by Podsakoff et al. (2003). All measurement items were entered into an unrotated principal component analysis to examine whether a single factor would account for the majority of the covariance among indicators. The variance explained by the first factor was inspected against the conventional 50% criterion used to diagnose potential common method effects. The analysis produced three factors with eigenvalues greater than 1.0, as displayed in Table 3. The first and largest factor explained 41.764% of the total variance, which remains below the critical threshold. This result indicates that no single latent factor dominates the variance structure, suggesting that common method bias is unlikely to pose a serious threat to the validity of the study's findings.

Table 3
Initial Eigenvalues from Harman's Single-Factor Test

Component	Eigenvalue	% of Variance	Cumulative %
1	5.429	41.764	41.764
2	1.583	12.176	53.940
3	1.233	9.486	63.426
4	0.957	7.362	70.788
5	0.693	5.331	76.119
6	0.636	4.896	81.014
7	0.515	3.964	84.978
8	0.426	3.280	88.258
9	0.414	3.185	91.443
10	0.367	2.826	94.269
11	0.301	2.317	96.586
12	0.242	1.863	98.448
13	0.202	1.552	100.000

5.3. Measurement Model Assessment

The results of the confirmatory factor analysis presented in Table 4 indicate a measurement model that performs effectively. The standardized factor loadings predominantly surpass the suggested threshold of 0.70, suggesting that the observed indicators effectively represent their corresponding latent constructs. While several items show moderate loadings, all coefficients are statistically significant at $p < .001$, indicating that each indicator plays a meaningful role in the measurement of the construct. The consistently elevated z-values provide additional evidence for the robustness and reliability of the relationships between the indicator and the construct. The findings collectively present compelling evidence for convergent validity and affirm the sufficiency of the latent structure outlined in the model (Kline, 2024; Hair et al., 2019).

Table 4
Factor loadings

Latent Variable	Observed Indicator	β	z	P
Environmental Awareness (EA)	EA1: I am aware of the environmental challenges facing Saudi Arabia.	0.562		
	EA2: I understand how human activity contributes to environmental degradation.	0.643	10.709	< .001
	EA3: I am familiar with the concept of green innovation.	0.728	12.097	< .001
	EA4: I believe environmental issues are a serious concern for my generation	0.707	11.495	< .001
Attitude Toward Green Innovation (ATT)	ATT1: I believe green innovation is necessary for a better future.	0.766		
	ATT2: I think adopting green technologies benefits both the economy and the environment.	0.838	23.203	< .001
	ATT3: I support the idea of using sustainable solutions in daily life.	0.914	17.322	< .001
Perceived Behavioral Control (PBC)	PBC1: I feel confident in my ability to engage in green activities.	0.892		
	PBC2: I have access to the resources needed to adopt green practices.	0.590	16.180	< .001
	PBC3: I believe I can influence environmental change through my actions.	0.827	30.005	< .001
Behavioral Intention (BI)	BI1: I intend to engage in green innovation activities at my university.	0.793		
	BI2: I am willing to adopt environmentally friendly practices in my lifestyle.	0.879	28.327	< .001
	BI3: I plan to contribute to environmental sustainability in my future career.	0.889	27.894	< .001

The reliability statistics presented in Table 5 demonstrate the Environmental Awareness construct exhibits comparatively lower composite reliability (CR = 0.580) and AVE (0.440) relative to other constructs. While these values fall slightly below conventional thresholds, they remain within ranges considered acceptable for exploratory or psychologically diffuse constructs, particularly when indicator loadings are statistically significant and theoretically coherent (Hair et al., 2019; Henseler et al., 2015). Although CR is below 0.70, values above 0.50 are considered acceptable in early-stage or theoretically broad constructs (Hair et al., 2019). Environmental awareness represents a broad cognitive domain encompassing knowledge, concern, and familiarity with sustainability concepts, which may naturally produce greater indicator variance. All EA items load significantly on the latent factor, and the overall

measurement model demonstrates excellent global fit (RMSEA = 0.043; CFI = 0.998), supporting retention of the construct. Nonetheless, results involving EA should be interpreted with appropriate caution, and future research may benefit from refining awareness measurement through additional or more specialized indicators.

Table 5
Reliability Measures

Variable	α	Ordinal α	Composite Reliability (CR)	AVE
EA	0.702	0.779	0.580	0.440
ATT	0.848	0.909	0.837	0.708
PBC	0.764	0.823	0.740	0.609
BI	0.833	0.884	0.856	0.731

Discriminant validity was assessed using the heterotrait–monotrait (HTMT) ratio of correlations (Table 6). The HTMT statistics evaluate the extent to which constructs are empirically distinct by comparing inter-construct correlations relative to within-construct variance (Henseler et al., 2015; Hair et al., 2022). All HTMT values fall below the recommended threshold of 0.90, indicating adequate discriminant validity and confirming that the latent constructs are conceptually and empirically distinguishable.

Table 6
HTMT

	EA	ATT	PBC	BI
EA	1.000			
ATT	0.759	1.000		
PBC	0.598	0.478	1.000	
BI	0.649	0.660	0.813	1.000

5.4. Structural Model Evaluation

Global fit statistics for the proposed structural model are summarized in Table 7. The chi-square test was statistically significant ($\chi^2(53) = 85.33$, $p = 0.003$), formally indicating some degree of model–data discrepancy. However, the chi-square statistics are well known to be sensitive to sample size and model complexity, frequently rejecting well-specified models in moderate-to-large samples (n = 322) (Barrett, 2007; West et al., 2012). Consequently, model evaluation relied on approximate and incremental fit indices. The RMSEA of 0.043 falls below the recommended cutoff of 0.06, indicating close approximate fit. Incremental fit indices also demonstrate excellent fit, with CFI = 0.998, TLI = 0.997, and NFI = 0.994, each exceeding the 0.95 criterion proposed by (Hu and Bentler, 1999). Taken together, these indices

indicate minimal model misspecification and support the adequacy of the hypothesized covariance structure.

Table 7
Model Fit Indices

X^2	df	P	RMSEA	Comparative Fit Index (CFI)	Tucker-Lewis Index (TLI)	Bentler-Bonett Normed Fit Index (NFI)
85.33	53	0.003	0.043	0.998	0.997	0.994

5.5. Direct Effects

The structural path estimates reported in Table 8 indicate several significant relationships among the latent constructs. Environmental Awareness (EA) exerts a strong positive effect on Attitude Toward Green Innovation (ATT) ($\beta = 0.773$, $p < 0.001$) and a substantial effect on Perceived Behavioral Control (PBC) ($\beta = 0.471$, $p < 0.001$). In contrast, the direct path from EA to Behavioral Intention (BI) is not statistically significant ($\beta = 0.043$, $p = 0.677$), suggesting that EA influences intentions primarily through indirect mechanisms. ATT positively predicts BI ($\beta = 0.318$, $p < 0.001$) and shows a marginal effect on PBC ($\beta = 0.204$, $p = 0.053$). Among all predictors, PBC demonstrates the largest direct effect on BI ($\beta = 0.634$, $p < 0.001$), identifying it as the dominant proximal determinant of behavioral intention within the model. Collectively, the pattern of coefficients supports a mediated structure in which awareness shapes intentions chiefly through attitudinal and control-related pathways.

Table 8
Direct effects

Dep	Pred	Estimate	SE	B	z	P
ATT	EA	1.053	0.102	0.773	10.344	< .001
PBC	EA	0.747	0.172	0.471	4.344	< .001
PBC	ATT	0.238	0.123	0.204	1.935	0.053
BI	EA	0.061	0.146	0.043	0.417	0.667
BI	ATT	0.329	0.088	0.318	3.718	< .001
BI	PBC	0.563	0.053	0.634	10.687	< .001

The estimated structural relationships and their significance levels are visually summarized in **Fig. 2**, which provides an integrated representation of the empirical findings.

5.6. Indirect Effects and Mediation Analysis

Indirect effects reported in Table 9 provide evidence of mediation within the structural model. Environmental Awareness (EA) influences Behavioral Intention (BI) primarily through Attitude Toward Green Innovation (ATT) and Perceived Behavioral Control (PBC). The sequential mediation pathway EA

→ ATT → PBC → BI is statistically significant (β = 0.100, z = 1.958, p = 0.050), indicating a joint mediating role of ATT and PBC. Stronger indirect effects are observed for EA → ATT → BI (β = 0.245, z = 3.658, p < 0.001) and EA → PBC → BI (β = 0.299, z = 3.828, p < 0.001), with the latter suggesting that perceived behavioral control constitutes the dominant transmission mechanism. The indirect path ATT → PBC → BI is also significant (β = 0.129, z = 1.971, p = 0.049), supporting the role of PBC as a proximal mediator of attitudinal effects. Overall, the mediation pattern indicates that EA affects intentions largely through attitudinal and control-related processes, consistent with a theoretically structured indirect influence on behavioral intention.

Table 9
Indirect Effects

Description	Estimate	SE	B	Z	P
EA ⇒ ATT ⇒ PBC ⇒ BI	0.141	0.072	0.100	1.958	0.050
EA ⇒ ATT ⇒ BI	0.346	0.095	0.245	3.658	< .001
EA ⇒ PBC ⇒ BI	0.421	0.110	0.299	3.828	< .001
ATT ⇒ PBC ⇒ BI	0.134	0.068	0.129	1.971	0.049

5.7. Summary of Structural Equation Modeling Results

The results of hypothesis testing for the structural model are summarized in Table 10, encompassing both direct and indirect effects among the latent constructs. Six structural hypotheses were evaluated using standardized path coefficients (β) and corresponding significance levels. Statistical decisions were determined using an α = 0.05 criterion, classifying each hypothesized path as supported or not supported. This summary provides a direct correspondence between the theoretical framework and the estimated structural relationships.

Table 10
Summary of the SEM analysis

Hypotheses	Description	Supported (Yes/No)	p-value	Std β
H1: EA → ATT	Environmental Awareness positively affects Attitude Toward Green Innovation	Yes	< 0.001	0.773
H2: EA → PBC	Environmental Awareness positively affects Perceived Behavioral Control	Yes	< 0.001	0.471
H3: ATT → BI	Attitude Toward Green Innovation positively affects Behavioral Intention	Yes	< 0.001	0.318
H4: PBC → BI	Perceived Behavioral Control positively affects Behavioral Intention	Yes	< 0.001	0.634
H5: EA → ATT → BI	Environmental Awareness indirectly affects BI through ATT	Yes	< 0.001	0.245
H6: EA → PBC → BI	Environmental Awareness indirectly affects BI through PBC	Yes	< 0.001	0.299

6. Discussion

This study analyzed the translation of environmental awareness into green innovation intention among Saudi Generation Z, utilizing the psychological mechanisms outlined in the Theory of Planned Behavior. The findings indicate that sustainability engagement can be understood through a mediation framework: environmental awareness does not have a direct effect on intention (β = 0.043, p = 0.667) but instead influences it indirectly via attitude and perceived behavioral control. This finding offers a clear empirical understanding of the awareness–action gap identified in sustainability research (Kollmuss & Agyeman, 2002; Gifford, 2011) by showing that knowledge gains behavioral significance only when it transforms both evaluative meaning and perceived capability. The lack of a direct relationship between awareness and intention holds considerable theoretical importance. The relationship between environmental awareness and attitude is significant (β = 0.773, p < 0.001), as is its connection to perceived behavioral control (β = 0.471, p < 0.001). However, environmental awareness does not directly drive intention; rather, it must be processed through these psychological mechanisms to exert influence. This pattern corresponds with research on the Theory of Planned Behavior, indicating that distal cognitive factors affect behavior solely through proximal determinants (Ajzen, 1991; Yuriev et al., 2020). Awareness serves as a cognitive basis that guides interpretation instead of functioning as an instinctive behavioral response. In the absence of attitudinal internalization and perceived agency, awareness is relegated to an abstract concern, lacking the potential for actionable commitment.

The perspective on green innovation has surfaced as a significant motivational channel. The effect of attitude toward green innovation on intention is moderate in magnitude (β = 0.318), indicating that evaluative commitment plays a meaningful but not dominant role in shaping youth engagement. This suggests that positive beliefs about sustainability contribute to intention, yet attitude alone is insufficient

to drive action without a parallel sense of feasibility. In practical terms, valuing green innovation increases readiness to act, but motivation must be supported by perceived capability. The result aligns with contemporary research indicating that positive environmental attitudes enhance green behavioral intentions among youth demographics (García-Salirrosas et al., 2024; Krettenauer et al., 2024). For Saudi Gen Z, green innovation gains traction when it is framed as socially meaningful and professionally relevant rather than merely an environmental obligation. In a context influenced by Vision 2030, the concept of sustainability is likely to be more impactful when presented as a matter of modernization and professional relevance instead of a mere obligation. Perceived behavioral control emerges as the primary predictor of intention. Perceived behavioral control exhibits a strong effect on intention ($\beta = 0.634$), emerging as the dominant predictor within the model. This magnitude indicates that agency and perceived feasibility outweigh awareness and attitude in determining whether intention forms. In practical terms, Saudi Generation Z is more likely to engage in green innovation when sustainability feels actionable rather than merely desirable. The findings imply that empowerment mechanisms—access to resources, opportunities, and visible pathways to participation—are more influential than informational awareness campaigns alone. The contrast between moderate attitudinal effects and strong control effects suggests that sustainability engagement is constrained less by belief and more by perceived opportunity structures.

The results of the mediation support this interpretation. Environmental awareness affects intention mainly via indirect routes: EA → ATT → BI ($\beta = 0.245$, $p < 0.001$) and EA → PBC → BI ($\beta = 0.299$, $p < 0.001$), with the control pathway demonstrating a more robust transmission channel. This indicates that awareness is behaviorally significant only when it improves both evaluative commitment and perceived capability. Mediation structures are gaining recognition in behavioral sustainability models (Yuriev et al., 2020), but they have not been thoroughly tested in Middle Eastern contexts. Taken together, the findings indicate that sustainability engagement among Saudi Generation Z depends less on awareness alone and more on whether young individuals perceive green innovation as both meaningful and actionable. Awareness without perceived agency generates concern without commitment, while motivation without feasibility produces intention without implementation. Effective sustainability engagement therefore requires the simultaneous development of evaluative commitment and practical empowerment. This explains why information-based awareness campaigns frequently produce limited behavioral change: knowledge must be accompanied by visible pathways for participation. Within the Vision 2030 context, positioning youth as active agents in green transformation strengthens both meaning and capability, converting sustainability from abstract concern into behavioral intention.

The findings hold practical significance within the context of Saudi policy. Vision 2030 positions sustainability as a pivotal national transformation initiative, with Gen Z anticipated to play a crucial role in its long-term advancement. The data indicates that strategies focused solely on informational awareness are probably insufficient for achieving lasting behavioral change. The engagement of youth is contingent upon redefining the criteria for assessing sustainability and enhancing the perceived ability to act. Educational institutions, training systems, and public programs are essential in both informing and empowering young individuals to recognize their potential as agents of green innovation. Successful

intervention requires converting sustainability from theoretical discussion into practical experience. Experiential learning, youth innovation programs, and real-world environmental projects can enhance the sense of control by translating action into tangible outcomes. When clear pathways to participation are established, sustainability transitions from a mere aspiration to a defined intention. The transition from awareness to action is influenced by various psychological factors and is dependent on specific conditions. Identifying these mechanisms is crucial for transforming national sustainability goals into behaviors that span generations. Several limitations should be considered when interpreting the findings. First, the cross-sectional design prevents causal inference regarding the temporal development of awareness, attitudes, perceived control, and intention. Although the structural relationships are theoretically grounded, longitudinal research is needed to confirm whether these psychological mechanisms translate into sustained behavioral change over time. Second, the purposive sampling strategy restricts statistical generalization to the broader Saudi youth population. The study prioritizes theory testing over population estimation; however, future research using probability-based or multi-institutional sampling could strengthen external validity. Third, reliance on self-reported survey measures introduces the possibility of common method bias and social desirability effects, which may inflate associations among constructs. While procedural steps were taken to ensure anonymity and reduce evaluation apprehension, future studies may benefit from multi-source or behavioral data. Finally, the Environmental Awareness construct demonstrated moderate reliability relative to other latent variables, suggesting that awareness may represent a heterogeneous cognitive domain requiring more refined measurement. Subsequent research should expand and validate awareness indicators to improve construct precision. These limitations do not invalidate the findings but highlight important directions for advancing behavioral sustainability research.

7. Conclusion, Policy Implications, and Future Research

The findings indicate that the shift from environmental awareness to the intention for green innovation within Saudi Generation Z is complex and does not follow a straightforward or predictable path. Awareness gains significance in behavior when it transforms the evaluation of sustainability and enhances the sense of agency. Awareness functions not by directly motivating intention, but rather through the mechanisms of attitudinal commitment and perceived behavioral control. Saudi Gen Z transitions from awareness to intention solely when green innovation is recognized as both valuable and practical. The results enhance the Theory of Planned Behavior within the framework of sustainability, demonstrating that distal awareness impacts intention via proximal psychological processes. Within the broader national transformation agenda, sustainability engagement is first recognized as a psychological process, which subsequently translates into behavioral actions.

The findings indicate significant considerations for sustainability policy and strategies aimed at engaging youth in Saudi Arabia. Relying solely on informational campaigns is improbable to produce lasting changes in behavior. Awareness should be complemented by interventions that effectively foster meaning and agency. Policymakers ought to position green innovation as not merely an environmental obligation, but as a strategic opportunity, a pathway to modernization, and a means of maintaining

professional relevance. Connecting sustainability with career identity and national advancement could enhance the attitudinal commitment of young adults.

The significance of perceived behavioral control highlights the critical nature of empowerment. Individuals in the younger demographic establish intentions when they perceive that they possess the necessary resources and avenues to act. Educational systems and public institutions have the potential to enhance this sense of agency by implementing experiential sustainability programs, establishing innovation labs, promoting youth entrepreneurship initiatives, and engaging in applied environmental projects. When sustainability is made tangible and accessible, it transitions from a mere aspiration to a concrete commitment.

Aligning with Vision 2030 has the potential to strengthen these outcomes. Framing youth as integral participants in the national green transformation enhances both significance and competence. Policies that incorporate youth involvement in renewable energy, circular economy, and green innovation ecosystems can transform sustainability from a theoretical concept into a tangible reality.

Numerous constraints indicate potential avenues for subsequent investigation. Cross-sectional design fails to account for the temporal evolution of awareness, attitudes, and agency. Longitudinal studies are essential for investigating the extent to which intentions lead to sustained behavior and for understanding the development of psychological mechanisms throughout different life stages. The emphasis on Saudi Generation Z might not adequately capture the diversity of youth demographics. Future research ought to encompass a broader range of socio-economic groups and incorporate comparative samples from different regions. Incorporating additional behavioral and contextual variables into the model could significantly improve its explanatory power. The interplay between social norms, institutional trust, policy awareness, and perceived structural barriers can significantly influence attitude and control mechanisms that shape sustainability behavior. Employing mixed-methods research may yield a more nuanced understanding of how young individuals perceive sustainability, identity, and agency in the context of rapidly evolving societies. Cross-national comparisons could clarify whether the mediation structure identified in this study represents a universal pattern or is influenced by specific contextual factors. Comprehending the variations in youth sustainability engagement across different institutional and cultural contexts is crucial for the development of universally applicable sustainability strategies.

Declarations

Data Availability

The datasets generated and analysed during the current study are not publicly available due to participant confidentiality but are available from the corresponding author on reasonable request.

Ethical Declarations

Ethics approval

Ethical approval was waived by the Arab Open University Research Ethics Committee because the study involved anonymous voluntary survey participation with no identifiable personal data.

Accordance with guidelines

The research was conducted in accordance with institutional ethical guidelines for research involving human participants.

Consent to Participate

All participants in this study were aged 18 years or older. Participation was voluntary and anonymous. Prior to completing the questionnaire, respondents were informed about the academic purpose of the research, the anonymous nature of data collection, and their right to withdraw at any time without consequence. Informed electronic consent was obtained from all participants before participation.

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Clinical Trial Number

Clinical trial number: not applicable.

Consent to Publish

Consent to Publish: not applicable.

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Figures

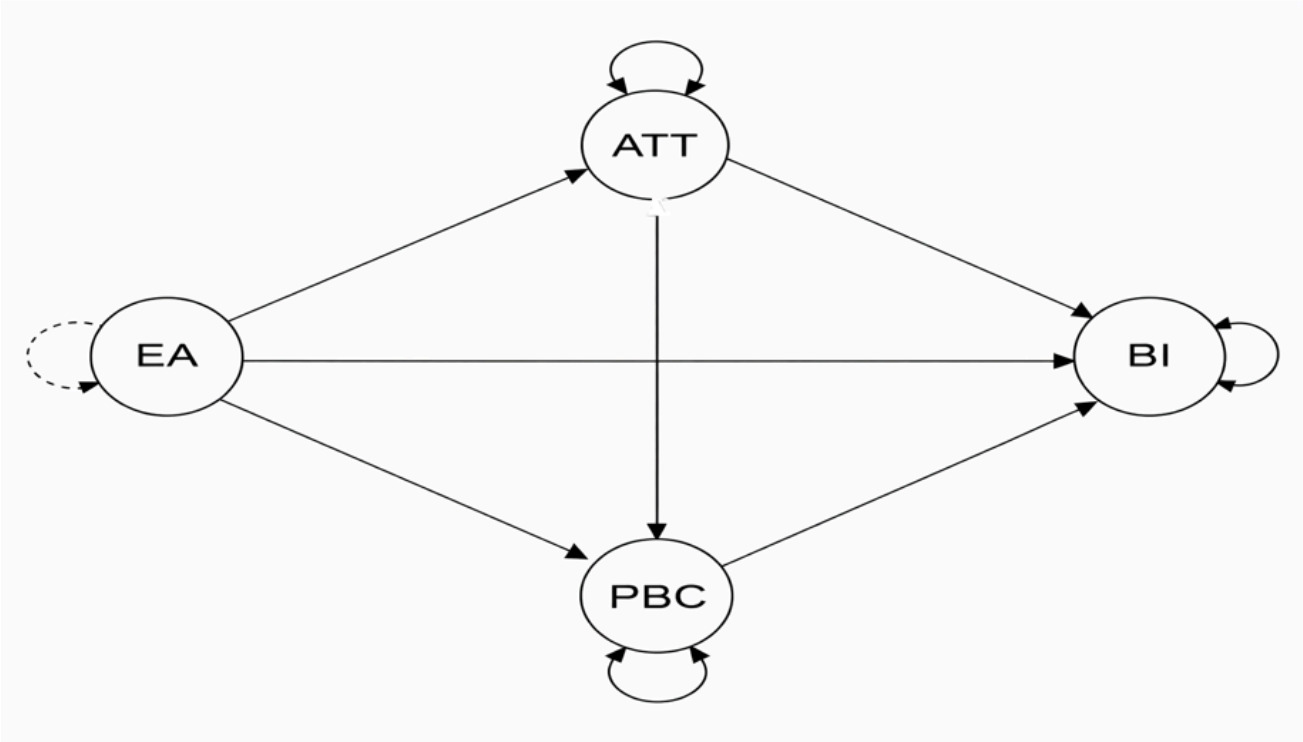


Figure 1

Model and Hypotheses

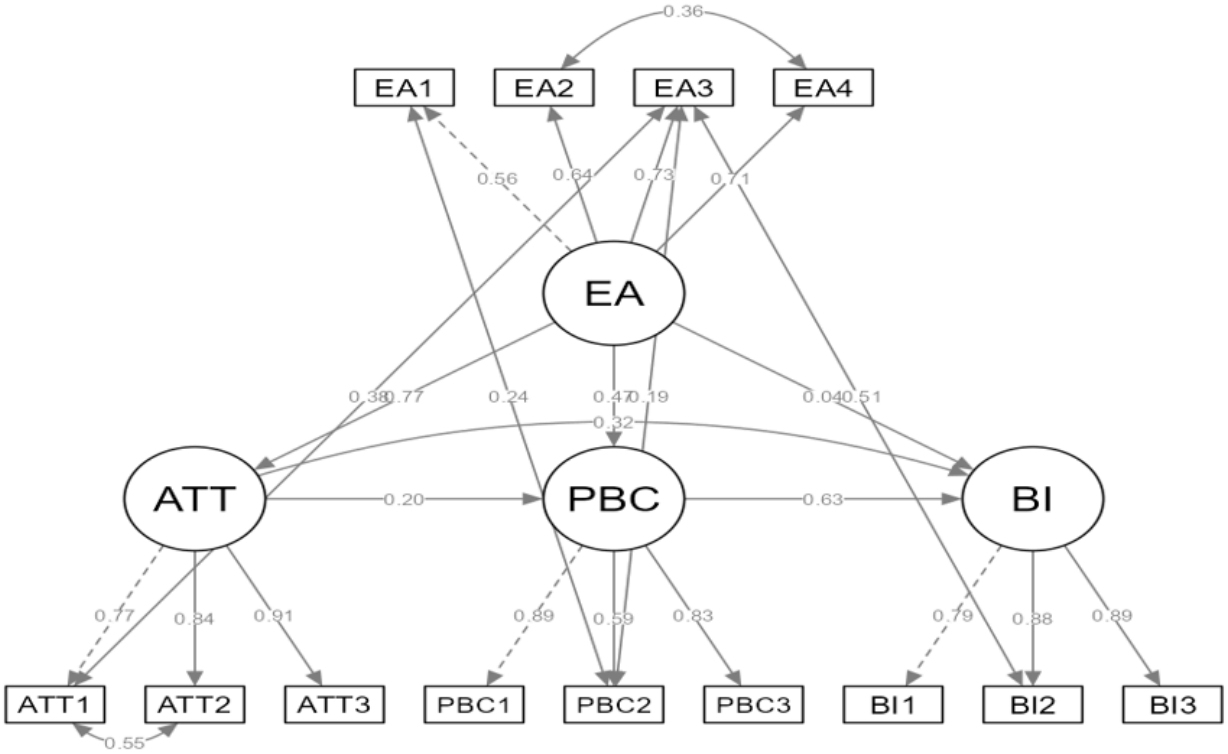


Figure 2

Legend not included with this version.