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Knowledge, Motivation, and Environmental Awareness as Predictors of Vocational Students' Recycling Attitudes

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ABSTRACT

Effective waste management remains a global challenge, particularly within educational institutions where practice-based and creative learning activities often generate considerable waste. Vocational programs such as Fashion Design and Culinary Arts produce residual materials that can potentially be reused through recycling, making students' recycling attitudes an important concern for sustainability-oriented education. This study examined the influence of perceived knowledge, motivation, and environmental awareness on vocational students' recycling attitudes in the Craft course. A quantitative cross-sectional survey design was employed involving 100 second-semester students from the Department of Family Welfare Education, Universitas Negeri Makassar. Data were collected using a validated and reliable questionnaire and analyzed using multiple linear regression with EViews 13. Classical assumption tests indicated that the dataset met the requirements of normality, absence of multicollinearity, and homoscedasticity. The findings showed that perceived knowledge, motivation, and environmental awareness were positive and significant predictors of students' recycling attitudes, with motivation emerging as the strongest predictor. The regression model explained 83.57% of the variance in recycling attitudes. These findings suggest that recycling attitudes in vocational higher education are shaped not only by students' knowledge, but also by motivational and awareness-related factors. The study provides practical insights for designing recycling-based projects and environmental literacy initiatives in vocational learning contexts.

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1. INTRODUCTION

Waste management remains a pressing environmental concern in many countries, including Indonesia, where rising consumption, material use, and technological development continue to increase the volume and complexity of waste generated in daily life (Sholihah & Hariyanto, 2020). Educational institutions are closely implicated in this issue because they are not only spaces where environmental values are taught, but also environments in which waste is routinely produced through institutional and learning activities (Gabriella & Sugiarto, 2020). Vocational higher education is especially relevant in this regard because its learning processes are strongly practice-based and materially intensive. Residual materials, packaging waste, fabric offcuts, and food waste are not incidental outcomes in such settings; they are regular consequences of how teaching and learning are organised. Recycling therefore becomes more than a general sustainability principle because it represents a concrete behavioural issue embedded in students' everyday academic experience. Understanding the factors that shape students' attitudes toward recycling is thus important for sustainability education and for the development of environmentally responsible practices in vocational institutions (Wardani et al., 2025).

Vocational learning environments provide a distinctive context that deserves closer attention in environmental education research. Programs such as Fashion Design and Culinary Arts expose students to direct and repeated encounters with waste generated through their own practical activities. This condition differs from more theory-oriented disciplines, where environmental problems are often addressed through lectures, readings, or awareness-based instruction rather than through immediate engagement with material consequences. Direct contact with waste may influence how pro-environmental attitudes are formed because students do not merely learn about environmental responsibility as an abstract value; they confront the practical implications of resource use, leftover materials, and disposal decisions as part of their routine coursework (Luo et al., 2025). Recycling, in this context, is integrated into lived academic practice rather than positioned as an

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external moral expectation. Such a setting makes vocational education particularly important for examining whether the predictors of recycling attitudes operate differently from those reported in broader student populations (Daoud et al., 2025; Wardani et al., 2025).

Recycling has long been recognized as a practical strategy for reducing waste volume, extending the useful life of materials, and supporting resource conservation. Positive attitudes toward environmentally responsible behavior are also important because they are associated with stronger environmental concern and greater willingness to support sustainable practices (Palupi & Sawitri, 2017). Several individual-level factors have been linked to such attitudes, yet three constructs are especially relevant for the present study: perceived knowledge, motivation, and environmental awareness. Perceived knowledge matters because students are more likely to respond positively to recycling when they believe they understand waste categories, recycling procedures, and the environmental consequences of improper disposal (Dwibarto & Sa'adah, 2022). Motivation matters because pro-environmental behavior rarely depends on understanding alone; individuals may know what should be done but remain passive without sufficient personal drive, commitment, or socially reinforced engagement (Duong et al., 2023). Environmental awareness is also important because it reflects concern for ecological sustainability and recognition of the broader significance of responsible waste-related action (Gabriella & Sugiarto, 2020). These three variables were selected because they represent complementary cognitive, motivational, and value-oriented dimensions that are closely related to the formation of recycling attitudes at the individual level. Other factors, such as peer influence, institutional support, and infrastructure, are also relevant, but they fall beyond the scope of the present study.

Existing research has documented meaningful associations between knowledge, motivation, environmental concern, and pro-environmental behaviour. General student populations have dominated much of the literature, whereas vocational learners in materially intensive, practice-based environments have received far less attention (Daoud et al., 2025). Separate examination of these predictors has also been more common than integrated assessment of their relative influence within the same model. Current scholarship therefore provides limited evidence on how perceived knowledge, motivation, and environmental awareness jointly function in vocational settings where waste is encountered as an immediate and recurring consequence of academic work (Luo et al., 2025). Uncertainty also remains regarding whether the relative strength of these predictors shifts under conditions of direct material exposure. Knowledge may remain important, yet motivation may become more decisive when students must translate understanding into repeated behavioural responses in everyday practice. Environmental awareness may also retain an independent role by linking immediate waste-related experiences to broader ecological concern (Perea et al., 2025). This unresolved issue matters because it moves the discussion beyond the simple question of whether these predictors are significant and toward the more analytically meaningful question of which predictor is most influential in a vocational context and why.

Theory of Planned Behavior (TPB) offers a useful background for interpreting this issue because it explains behavior as broadly shaped by intention, which is commonly associated with attitudes, subjective norms, and perceived behavioral control (Ajzen, 1991; Mahyarni, 2013). Full operationalization of TPB is not the aim of the present study. Subjective norms and perceived behavioral control are not directly measured, and the study does not claim to test the model in its complete theoretical form. TPB is therefore used here in a more modest manner, namely as a broad conceptual lens for understanding why selected individual antecedents may be associated with the attitudinal dimension of environmentally responsible behavior. Within this framing, perceived knowledge may support informed evaluation of recycling, motivation may strengthen readiness to engage in environmentally responsible action, and environmental awareness may reinforce value-based concern for sustainability.

This study therefore examines the relative influence of perceived knowledge, motivation, and environmental awareness on vocational students' recycling attitudes. This focus is expected to contribute to the literature in two ways. Conceptually, the study clarifies whether the relative importance of key psychological predictors shifts in a vocational environment where students regularly confront the material consequences of their own learning practices. Practically, the study provides evidence that may inform sustainability-oriented educational design in vocational higher education, including recycling-based projects, environmental literacy initiatives, and teaching strategies that strengthen students' active engagement in responsible waste management.

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2. MATERIAL AND METHOD

Research Design

This study adopted a quantitative cross-sectional survey design to examine the relative influence of perceived knowledge, motivation, and environmental awareness on vocational students' recycling attitudes. Data were collected once through a self-administered questionnaire administered between March and May 2025 at the Department of Family Welfare Education, Faculty of Engineering, Universitas Negeri Makassar. The vocational setting was considered particularly relevant because students were engaged in practice-based learning activities that routinely generated residual materials and waste, thereby providing a meaningful context for investigating recycling attitudes within everyday academic practice. As illustrated in Figure 1, the research process consisted of several stages, including research preparation, instrument development, instrument validation and revision, data collection, data analysis, and interpretation of findings. Because the study was non-experimental and cross-sectional, the results should be interpreted as evidence of statistical association and predictive relevance rather than causal effect.

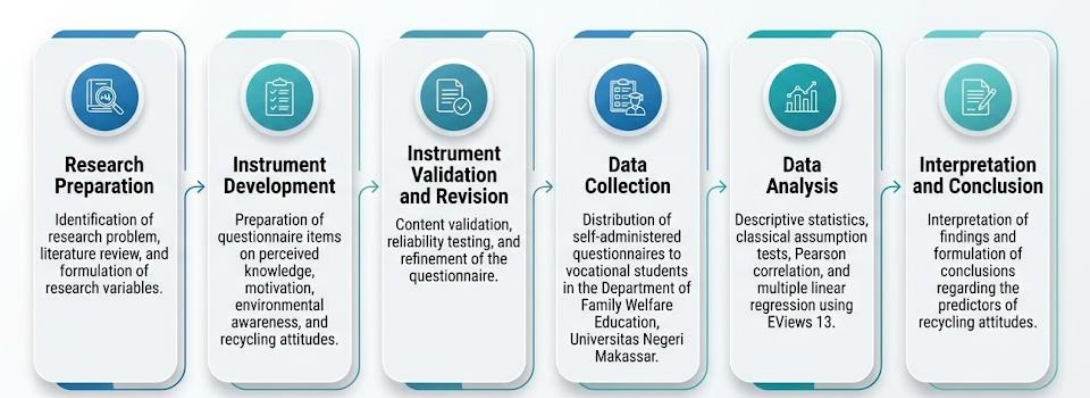

Figure 1. Research procedure of the study

Participants

The study population consisted of 113 active second-semester students enrolled in the Craft course during the even semester of the 2024/2025 academic year at the Department of Family Welfare Education, Faculty of Engineering, Universitas Negeri Makassar. The population was drawn from two vocational study programs, namely Fashion Design (56 students) and Culinary Arts (57 students). Participant selection was conducted using purposive sampling because the study specifically targeted students who were engaged in practice-based learning activities and had direct exposure to waste or residual materials generated during coursework. The inclusion criteria were: (1) enrollment in the Craft course, (2) active participation in practical learning activities, and (3) experience handling or observing material waste produced during classroom practice. Based on these criteria, 100 students were included in the final sample.

Table 1. Respondent Characteristics

Program of Study	Gender		Total
	Female	Male	
Fashion Design	50	0	50
Culinary Arts	48	2	50
Total	98	2	100

Sample distribution was balanced across the two study programs, with 50 students from Fashion Design and 50 students from Culinary Arts. Table 1 shows that the sample was predominantly female, consisting of 98 female students and 2 male students. All participants from the Fashion Design program were female, whereas the Culinary Arts group consisted of 48 female students and 2 male students. This gender distribution reflects the demographic profile of the vocational programs included in the study, although it may limit the generalizability of the findings to other educational contexts with more balanced gender representation.

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Instrument

A closed-ended questionnaire was used as the main instrument to measure four constructs, namely perceived knowledge, motivation, environmental awareness, and students' recycling attitudes. Each construct consisted of 10 items, resulting in a total of 40 statements, and all items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Instrument development was based on theoretical indicators and previous studies on environmental behavior, recycling practices, and pro-environmental attitudes. Item wording was then adapted to the context of vocational higher education, particularly practice-based learning activities in which students routinely encounter waste and residual materials during coursework.

Perceived knowledge in this study referred to students' self-perceived understanding of waste types, recycling procedures, and the environmental consequences of waste management rather than objectively tested knowledge. Motivation covered both intrinsic and extrinsic drivers of environmentally responsible behavior, while environmental awareness reflected students' concern for the ecological impacts of waste and the importance of sustainability. Recycling attitude referred to students' tendency to support and value recycling practices in daily life. Example items included "I understand different types of waste that can be recycled" for perceived knowledge, "I feel motivated to recycle because it benefits the environment" for motivation, "I am concerned about the environmental impact of waste" for environmental awareness, and "I support recycling practices in daily life" for recycling attitude. Item validity was assessed using item-total correlation, and all items exceeded the required cut-off value of 0.361, indicating acceptable item validity. Internal consistency was examined using Cronbach's alpha, and as presented in Table 2, the reliability coefficients were 0.720 for recycling attitudes, 0.966 for perceived knowledge, 0.846 for motivation, and 0.800 for environmental awareness. These results indicate that the instrument demonstrated acceptable to very high internal consistency and was therefore suitable for subsequent analysis.

Table 2. Reliability Test Results

Variable	Cronbach's Alpha	Result
Students' Recycling Attitudes (Y)	0.720	Reliable
Perceived Knowledge (X_1)	0.966	Reliable
Motivation (X_2)	0.846	Reliable
Environmental Awareness (X_3)	0.800	Reliable

Data Analysis

The collected data were analyzed using EViews 13 to examine the predictive relationships between perceived knowledge, motivation, environmental awareness, and students' recycling attitudes. Prior to the main analysis, the dataset was screened for missing values and potential outliers to ensure data quality (Sharifnia et al., 2025). Descriptive statistics, including minimum, maximum, mean, and standard deviation, were then calculated to summarize the characteristics of each study variable (Blbas, 2024; El Omda & Sergent, 2024). Pearson correlation analysis was also conducted to examine the bivariate relationships among the variables (Wisniewski & Brannan, 2024). In this study, each construct was represented by the summed score of its respective items. Multiple linear regression assumptions were then examined to evaluate the suitability of the model, and residual normality was assessed using the Jarque–Bera test (Glinskiy et al., 2024). Multicollinearity was assessed using tolerance and Variance Inflation Factor (VIF) values as conventional collinearity diagnostics, although such thresholds should be interpreted cautiously as heuristic rather than absolute criteria (Akhtar et al., 2024; Kalnins & Hill, 2025). Heteroscedasticity was tested using the White test, where a non-significant probability value indicated that the model did not suffer from heteroscedasticity (Akewugberu et al., 2024). Multiple linear regression was then used to estimate the relative contribution of perceived knowledge, motivation, and environmental awareness to students' recycling attitudes, with statistical significance evaluated at the 5% level and the model interpreted using the coefficient of determination (R^2), the F-test, and the t-test (Wisniewski & Brannan, 2024). Given the cross-sectional and non-experimental nature of the study, the findings were interpreted as associative and predictive rather than causal (Maier et al., 2023).

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3. RESULTS

Descriptive Statistics

Descriptive statistics provide an overview of students' recycling attitudes and their levels of knowledge, motivation, and environmental awareness, highlighting patterns and variations within the sample.

Table 3. Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
Students' Recycling Attitudes (Y)	35	46	40.12	2.38
Perceived Knowledge (X_1)	20	50	35.23	6.58
Motivation (X_2)	32	50	41.99	3.57
Environmental Awareness (X_3)	32	50	41.05	3.36

The descriptive statistics presented in Table 3 indicate that students generally reported relatively positive attitudes toward recycling, as reflected in the high average score for recycling attitudes. Among the predictor variables, motivation and environmental awareness showed higher mean scores than perceived knowledge. This pattern suggests that students tended to demonstrate stronger affective commitment and ecological concern toward recycling than confidence in their own understanding of recycling-related issues. Greater variability was observed in perceived knowledge than in the other predictor variables, as indicated by its larger standard deviation. This finding suggests that students differed more substantially in how they assessed their understanding of waste management and recycling. In contrast, motivation and environmental awareness not only showed higher average scores but also appeared more consistent across respondents. This initial pattern is important because it indicates that motivational and awareness-related orientations toward recycling may be more uniformly developed than students' self-perceived knowledge, a tendency that is further examined in the subsequent analyses (Daoud et al., 2025; Wardani et al., 2025).

Correlation Matrix

Correlation analysis examines the relationships among knowledge, motivation, environmental awareness, and recycling attitudes, showing the strength and direction of associations between variables.

Table 4. Correlation Matrix of Independent Variables

Variable	Y	X1	X_2	X_3
Students' Recycling Attitudes (Y)	1.000	0.468	0.557	0.467
Perceived Knowledge (X1)	0.468	1.000	0.013	-0.071
Motivation (X_2)	0.557	0.013	1.000	-0.107
Environmental Awareness (X_3)	0.467	-0.071	-0.107	1.000

The correlation results presented in Table 4 show that perceived knowledge, motivation, and environmental awareness were all positively associated with students' recycling attitudes. Among these predictors, motivation showed the strongest correlation with recycling attitudes, followed by perceived knowledge and environmental awareness. This pattern provides an initial indication that students' willingness and drive to engage in environmentally responsible behavior may be more strongly related to recycling attitudes than cognitive understanding alone. The correlations among the independent variables were relatively low, ranging from weak negative to negligible positive values. Such results suggest that perceived knowledge, motivation, and environmental awareness represent related but distinct dimensions of students' responses to recycling-related issues. The low intercorrelations also support the inclusion of these variables in the same regression model, as they do not indicate problematic overlap at the bivariate level.

Classical Assumption Test

Classical assumption tests, including normality, multicollinearity, and heteroscedasticity tests, were conducted using EViews 13 to ensure the validity of the regression model. Assessment of residual normality was carried out using the Jarque–Bera test to determine whether the distribution of residuals met the assumption required for multiple linear regression. The result presented in Figure 2 shows that the Jarque–Bera probability value was greater than 0.05, indicating that the residuals were normally distributed. This finding suggests that

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the regression model did not violate the normality assumption and that the distribution of error terms was sufficiently appropriate for further analysis. Adequate residual normality is important because it supports the reliability of statistical inference in the regression model, particularly in relation to significance testing and coefficient estimation. Thus, the normality test result provides initial evidence that the model was statistically suitable for examining the predictive relationships among the study variables (Glinskiy et al., 2024).

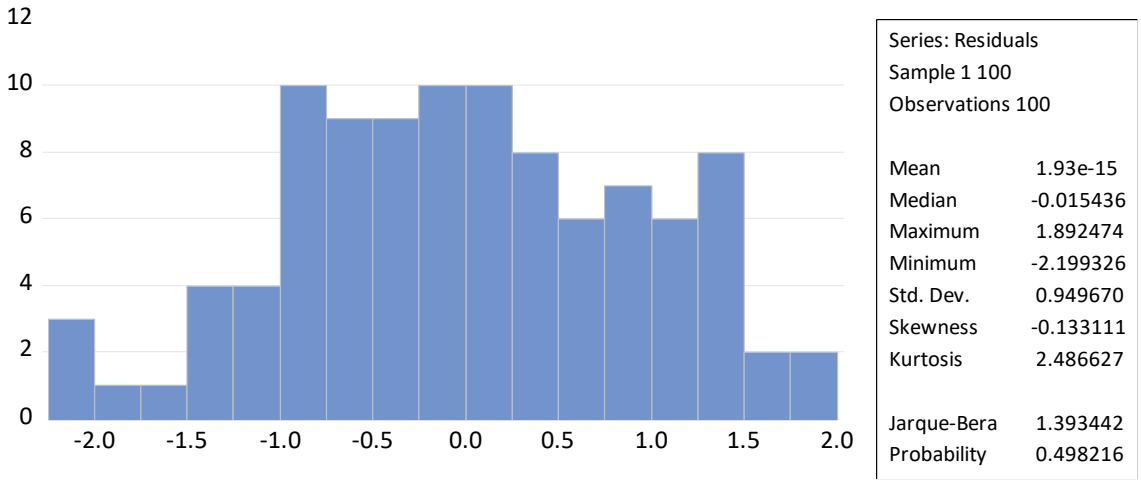

Figure 2. Normality Test Results

Evaluation of the remaining classical assumptions further confirmed the appropriateness of the model. Values reported in Table 5 show that all VIF values were well below the commonly accepted threshold of 10, indicating that no problematic multicollinearity was detected among perceived knowledge, motivation, and environmental awareness. This result suggests that the independent variables did not exhibit excessive overlap and that each predictor contributed sufficiently distinct information to the model. In addition, results presented in Table 6 show that the probability value for Obs*R-squared in the White test was greater than 0.05, indicating the absence of heteroscedasticity. This means that the residual variance was relatively constant across the model, supporting the assumption of homoscedasticity. Taken together, the results of the multicollinearity and heteroscedasticity tests indicate that the regression model met the key assumptions required for multiple linear regression and was therefore appropriate for subsequent analysis (Akhtar et al., 2024; Akewugberu et al., 2024).

Table 5. Multicollinearity Test Results

No.	Variable	VIF Value
1.	Perceived Knowledge (X_1)	1.005131
2.	Motivation (X_2)	1.011712
3.	Environmental Awareness (X_3)	1.016702

Table 6. Heteroscedasticity Test Results

F-statistic	0.9679	Prob. F	0.4718
Obs*R-Squared	8.8249	Prob. Chi-Square	0.4536

Statistical Test

Multiple linear regression analysis was conducted to examine the predictive effects of perceived knowledge, motivation, and environmental awareness on students' recycling attitudes. Results presented in Table 7 indicate that all three predictors had positive and statistically significant coefficients, a pattern that is broadly consistent with recent evidence showing that environmental awareness and related educational experiences are meaningfully associated with sustainability-oriented attitudes and waste-related behavior among higher education students (Yang et al., 2024; Luo et al., 2025). Perceived knowledge showed a positive association with recycling attitudes, while motivation and environmental awareness demonstrated stronger coefficients. Among the three predictors, motivation emerged as the strongest predictor, followed closely by environmental awareness, whereas perceived knowledge showed a comparatively smaller contribution. This

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pattern suggests that students' recycling attitudes were more strongly associated with motivational and awareness-related factors than with their self-perceived understanding alone, which is in line with recent student-based recycling research showing that intrinsic motivation and awareness can exert especially strong effects on recycling behavior (Daoud et al., 2025).

Substantial explanatory power was also observed in the regression model, as indicated by the R^2 value of 0.8407 and the adjusted R^2 value of 0.8357. The overall model was statistically significant, with an F-statistic of 168.905 and a probability value below 0.05, indicating that the predictors jointly explained a significant proportion of variance in students' recycling attitudes. Cautious interpretation is nevertheless warranted because the relatively high R^2 may partly reflect the use of self-reported measures across all variables as well as the relatively homogeneous characteristics of the sample. Such caution is methodologically important because self-administered survey data remain vulnerable to common method variance, which can affect the validity of observed relationships when predictor and outcome measures are collected using the same method (Baumgartner et al., 2024).

Table 7. Regression Results

Variable	Coefficient	Prob.
C	0.1342	0.9419
Perceived Knowledge (X_1)	0.1810*	0.0000
Motivation (X_2)	0.4072*	0.0000
Environmental Awareness (X_3)	0.4022*	0.0000
Model Summary		**ue**
R-squared	0.8407	
Adjusted R-squared	0.8357	
F-Statistic	168.905	
Prob (F-Statistic)	0.0000	

*Notes= Significance α = 0,05

4. DISCUSSION

Interpreting the Main Regression Findings

The regression findings indicate that perceived knowledge, motivation, and environmental awareness were all significant positive predictors of students' recycling attitudes. As reported in Table 7, motivation showed the strongest association, followed closely by environmental awareness, whereas perceived knowledge made a smaller, though still significant, contribution. This overall pattern suggests that positive recycling attitudes in vocational education are shaped not only by students' perceived understanding of recycling-related issues, but more strongly by their willingness to engage in environmentally responsible action and by their concern for the ecological consequences of waste. Similar tendencies have been reported in recent studies showing that student recycling and waste-related behavior are often more strongly linked to motivational and awareness-related factors than to knowledge alone (Daoud et al., 2025; Luo et al., 2025).

Interpretation of the model should nevertheless remain cautious. The relatively high coefficient of determination shown in Table 7 indicates that the three predictors jointly accounted for a substantial proportion of variance in recycling attitudes within this vocational sample. Such explanatory strength supports the relevance of the selected predictors, particularly in a learning environment where waste is encountered directly through practice-based activities. Caution is still warranted, however, because strong model fit in cross-sectional self-report research may partly reflect the use of a common measurement source as well as the relatively homogeneous characteristics of the sample (Chen & Ding, 2025). Recent research has also shown that motivation can function as a particularly influential mechanism linking environmental understanding to behavioral intention, which is consistent with the tendency observed in the present study (Teh et al., 2025).

Why Motivation Emerged as the Strongest Predictor in Relation to Knowledge and Environmental Awareness

Motivation may have emerged as the strongest predictor because recycling in vocational education is embedded in routine practice rather than treated merely as an abstract environmental principle. Students in practice-based programs are repeatedly confronted with tangible waste generated through their own academic

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activities, so favorable recycling attitudes are likely to depend not only on what students know, but also on whether they feel personally driven to respond to those material consequences. A similar tendency is reflected in Table 4, where motivation showed the strongest correlation with recycling attitudes among the three predictors. In such contexts, motivation functions as a more immediate driver of attitudinal commitment because it helps translate environmental understanding into readiness for action. This interpretation is consistent with recent recycling research showing that motivational and awareness-related factors can exert strong effects on recycling behavior in educational settings (Daoud et al., 2025; Wardani et al., 2025).

Environmental awareness also remained substantial because it links immediate waste-related experiences to broader ecological concern and sustainability values, which are important in shaping environmentally responsible attitudes (Perea et al., 2025). Perceived knowledge nevertheless remained significant, indicating that cognitive understanding still provides an important foundation for positive recycling attitudes. Its comparatively smaller contribution, however, suggests that understanding alone may be insufficient to sustain environmentally responsible orientations when students must respond to waste in everyday practice. Additional support for this interpretation can be drawn from the pattern reported in Table 4, where perceived knowledge was positively associated with recycling attitudes but less strongly than motivation. Recent evidence from higher education also shows that environmental education can improve students' waste-sorting behavior through mediating mechanisms such as value cognition, health benefit, and usability, implying that knowledge becomes more influential when it is translated into reasons for action rather than retained as information alone (Luo et al., 2025). Taken together, these findings suggest that knowledge, motivation, and environmental awareness do not operate as competing influences, but as related dimensions in which motivation serves as the strongest mechanism linking understanding and concern to favorable recycling attitudes in vocational education.

Theoretical Interpretation and Boundaries

Current findings are broadly consistent with the Theory of Planned Behavior (Ajzen, 1991; Mahyarni, 2013). Evidence of residual normality shown in Figure 2 supports the statistical adequacy of the model and strengthens confidence in the interpretability of the estimated relationships. Absence of problematic multicollinearity, as indicated in Table 5, further suggests that perceived knowledge, motivation, and environmental awareness captured related but sufficiently distinct dimensions of students' responses to recycling. Such a pattern is in line with earlier work emphasizing that pro-environmental behavior is shaped by multiple personal and contextual influences, including environmental awareness and social modelling (Rifayanti et al., 2018; Gabriella & Sugiarto, 2020). Full TPB operationalization was not the aim of the present study, however, because subjective norms and perceived behavioral control were not directly measured. Recent TPB-based studies likewise show that these constructs can make meaningful contributions to recycling intention and pro-environmental behavior, indicating that the present model captures only part of the broader behavioral process (Correia et al., 2022; Jia et al., 2024).

These theoretical boundaries remain important when interpreting the findings. Evidence of homoscedasticity reported in Table 6 supports the stability of the regression estimates, yet statistical adequacy does not remove the conceptual limitations of the model. Knowledge and environmental awareness remain meaningful antecedents, as earlier studies have also highlighted the role of environmental knowledge and campus-based environmental behavior in shaping responsible action (Khoiri & Rudiansyah, 2019; Gabriella & Sugiarto, 2020). Social influence, institutional guidance, and behavioral control may also shape recycling attitudes in vocational settings where routine practice and role modelling are central to student experience (Rifayanti et al., 2018; Wardani et al., 2025). Methodological caution is also necessary because cross-sectional self-report research remains vulnerable to common method bias, even when the regression assumptions are statistically acceptable (Podsakoff et al., 2024).

Implications for Vocational Education and Sustainability Practice

Practical implications of the findings can be drawn from the descriptive pattern reported in Table 3. Motivation and environmental awareness showed relatively high average scores, whereas perceived knowledge displayed greater variability across respondents. This pattern suggests that vocational students may already possess a relatively strong affective orientation toward recycling, but differ more substantially in how they

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understand waste management and recycling-related practices. Educational interventions should therefore not focus on information delivery alone. Greater impact is likely to be achieved when vocational curricula combine environmental knowledge with practice-based activities that strengthen students' motivation to act and connect sustainability concepts to the material realities of their everyday coursework (Gabriella & Sugiarto, 2020; Luo et al., 2025).

Implications for campus practice are equally important. Recycling-based projects, accessible waste-sorting facilities, and structured green campus participation may help sustain students' positive attitudes while also strengthening their practical understanding of how recycling can be implemented in daily academic routines. Broader environmental awareness should also be continuously reinforced, because awareness helps connect immediate waste-related practices to wider sustainability values and long-term ecological responsibility (Perea et al., 2025). Such an approach is especially relevant in vocational education, where learning is closely tied to repeated material use and direct exposure to waste. Future research should extend this model by examining the role of social influence, institutional support, and perceived behavioral control in order to build a more comprehensive explanation of recycling behavior in applied educational settings (Wardani et al., 2025).

5. CONCLUSION

This study demonstrates that perceived knowledge, motivation, and environmental awareness are all significant positive predictors of vocational students' recycling attitudes, with motivation emerging as the strongest predictor. These findings suggest that favorable recycling attitudes in vocational education are shaped not only by students' perceived understanding of recycling-related issues, but more strongly by their willingness to engage in environmentally responsible action and by their awareness of the ecological consequences of waste. Conceptually, the study contributes to the literature by showing that, in a practice-based vocational context where students are directly exposed to material waste, motivation may play a more prominent role than knowledge in shaping recycling attitudes. Empirically, the results support the relevance of these three predictors within the study context, but they do not establish causal relationships and should not be generalized beyond similar vocational settings without caution. Practical implications can nevertheless be drawn, particularly for the design of vocational sustainability education that combines environmental knowledge, motivational engagement, and authentic recycling-related activities. Future research is needed to examine additional factors, such as subjective norms, perceived behavioral control, and institutional support, in order to develop a more comprehensive explanation of recycling behavior in vocational education.

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