



From Collective Identity to Individual Action: The Logic Behind Thai University Students' Carbon Reduction Behavior

Yuxuan Wan¹, Nutteera Phakdeephrot^{2*}

Rattanakosin International College of Creative Entrepreneurship, Rajamangala
University of Technology Rattanakosin, Nakhon Pathom 73170, Thailand

Email: 1681110471137@rmutr.ac.th

Rattanakosin International College of Creative Entrepreneurship, Rajamangala
University of Technology Rattanakosin, Nakhon Pathom 73170, Thailand

Email: nutteera.pha@rmutr.ac.th (Correspondence)

Abstract: This study aimed to examine the formation mechanism of carbon reduction behavior among university students in Thailand by integrating the Theory of Planned Behavior and Social Identity Theory. A quantitative cross-sectional survey was conducted using a structured questionnaire. Data were collected from university students studying in Thailand, and 347 valid responses were retained after data screening. SPSS and AMOS were used to conduct descriptive statistics, reliability analysis, confirmatory factor analysis, structural equation modeling, and Bootstrap mediation analysis. The results showed that behavioral attitude, subjective norm, perceived behavioral control, and collective identity all had significant positive effects on carbon reduction behavior. Collective identity had the strongest direct effect. The Bootstrap results further showed that collective identity significantly mediated the relationships between behavioral attitude and carbon reduction behavior, subjective norm and carbon reduction behavior, and perceived behavioral control and carbon reduction behavior. These findings indicate that carbon reduction behavior is shaped not only by individual cognitive factors and perceived social influence, but also by the internalization of low-carbon values as part of students' shared group identity.

Keywords: Carbon Reduction Behavior; Collective Identity; Theory of Planned Behavior; Social Identity Theory; University Students; Thailand

1. Introduction

1.1 Research Background

Climate change has become a major global challenge, and reducing greenhouse gas emissions requires not only governmental policies and technological innovation but also changes in individual daily behavior. Carbon reduction behavior includes energy conservation, low-carbon transportation, green consumption, waste reduction, and other actions that help decrease environmental impact. Individual behavioral change is therefore an important component of broader climate mitigation efforts.

University students are an important group in promoting carbon reduction because their environmental values, consumption habits, and lifestyles are still developing. Their behavior may also influence peers, families, and wider society. In Thailand, universities have increasingly promoted green campuses, environmental education, and low-carbon activities. However, students' environmental awareness does not always translate into stable carbon reduction behavior. Their actions may be influenced by personal evaluations, social expectations, available resources, and group relationships.

The Theory of Planned Behavior provides a useful framework for explaining this process. According to Ajzen (1991), behavioral attitude, subjective norm, and perceived behavioral control are important predictors of individual behavior. Students are more likely to engage in carbon reduction behavior when they consider such behavior valuable,

perceive support from important others, and believe that they have sufficient ability and opportunities to perform it. Previous studies have confirmed that these psychological factors are closely related to pro-environmental behavior (Bamberg & Möser, 2007; Steg & Vlek, 2009).

However, the Theory of Planned Behavior mainly emphasizes individual decision-making and provides only a limited explanation of group belonging and identity internalization. Social Identity Theory suggests that individuals define themselves partly through their membership in social groups and tend to adopt attitudes and behaviors consistent with relevant group values and norms (Hornsey, 2008). When students perceive carbon reduction as a shared responsibility and a common value of the university community, they may be more likely to internalize low-carbon norms and maintain corresponding behavior. Collective identity may therefore serve as an important psychological mechanism connecting individual cognition with actual action (Fielding & Hornsey, 2016; Fritzsche et al., 2018).

Although previous studies have examined planned behavior factors and pro-environmental behavior, limited research has integrated collective identity into the Theory of Planned Behavior to explain the carbon reduction behavior of university students in Thailand. Therefore, this study examines the direct effects of behavioral attitude, subjective norm, and perceived behavioral control on carbon reduction behavior and further investigates the direct and mediating roles of collective

identity.

1.2 Research Gap and Purpose

Previous studies have widely applied the Theory of Planned Behavior to explain pro-environmental behavior. Behavioral attitude, subjective norm, and perceived behavioral control have been identified as important predictors of environmental action (Ajzen, 1991; Bamberg & Möser, 2007). However, this approach primarily emphasizes individual cognitive evaluation and does not fully explain how group belonging and shared identity transform environmental beliefs into stable behavior.

Social identity research suggests that individuals are more likely to adopt pro-environmental behavior when environmental responsibility is regarded as part of the values and norms of an important group (Fielding & Hornsey, 2016; Fritzsche et al., 2018). Nevertheless, relatively few studies have integrated collective identity with the Theory of Planned Behavior to examine carbon reduction behavior. Existing research also tends to focus on behavioral intention or a single environmental action, while limited attention has been paid to students' actual behaviors across energy conservation, low-carbon transportation, and green consumption.

In addition, empirical evidence concerning carbon reduction behavior among university students in Thailand remains limited. The group-oriented campus environment and the relatively collectivist social context make Thai university students particularly suitable for examining the role of collective identity. Therefore, this study integrates

the Theory of Planned Behavior and Social Identity Theory to investigate how behavioral attitude, subjective norm, and perceived behavioral control influence carbon reduction behavior. It also examines whether collective identity directly affects carbon reduction behavior and mediates the relationships between the three planned behavior factors and actual carbon reduction behavior.

1.3 Research Questions

Based on the research gap, this study addresses the following questions:

RQ1: How do behavioral attitude, subjective norm, and perceived behavioral control affect the carbon reduction behavior of Thai university students?

RQ2: How does collective identity affect the carbon reduction behavior of Thai university students?

RQ3: Does collective identity mediate the relationships between behavioral attitude, subjective norm, perceived behavioral control, and carbon reduction behavior?

1.4 Research Objectives

Accordingly, the objectives of this study are:

RO1: To identify the principal psychological determinants of carbon reduction behavior among Thai university students by evaluating the relative effects of behavioral attitude, subjective norm, and perceived behavioral control.

RO2: To clarify the contribution of group belonging and shared low-carbon values to individual action by incorporating collective identity into the explanation of students' carbon reduction behavior.

RO3: To reveal the psychological transformation mechanism from individual cognition to actual low-carbon action by testing collective identity as a mediating mechanism within the proposed research model.

1.5 Research Significance

1.5.1 Theoretical Significance

This study extends the application of the Theory of Planned Behavior by incorporating collective identity into the explanation of carbon reduction behavior. Traditional TPB mainly focuses on behavioral attitude, subjective norm, and perceived behavioral control at the individual level (Ajzen, 1991). By introducing collective identity, this study further explains how group belonging and shared low-carbon values may strengthen the transformation from individual cognition to actual behavior.

This study also contributes to environmental behavior research by integrating the Theory of Planned Behavior and Social Identity Theory within a single framework. The proposed model helps clarify whether carbon reduction behavior is influenced only by individual psychological factors or is also reinforced through group identification and shared responsibility (Fielding & Hornsey, 2016; Fritzsche et al., 2018).

1.5.2 Practical Significance

The findings may provide practical guidance for universities in promoting carbon reduction behavior among students. Universities can improve low-carbon education not only by increasing environmental knowledge but also by strengthening peer support, campus norms, and students' sense of

collective responsibility.

The results may also support the design of campus policies and environmental activities. Green campus campaigns, student organizations, volunteer programs, and peer-led low-carbon initiatives may help students view carbon reduction as a shared group value rather than only an individual responsibility. This may improve the continuity and effectiveness of students' low-carbon practices.

2. Literature Review and Theoretical Foundation

2.1 Carbon Reduction Behavior

Carbon reduction behavior refers to individual actions that reduce energy consumption, resource use, and greenhouse gas emissions. It includes energy conservation, low-carbon transportation, green consumption, waste reduction, recycling, and reduced use of disposable products (Stern, 2000; Steg & Vlek, 2009). These behaviors represent practical efforts through which individuals contribute to climate change mitigation and sustainable development.

Environmental knowledge alone does not necessarily lead to actual environmental action. Individuals may understand environmental problems but fail to change their behavior because of inconvenience, additional costs, insufficient resources, weak social support, or limited perceived control. Carbon reduction behavior should therefore be understood as the result of interactions among individual evaluation, social influence, perceived feasibility, and situational conditions (Kollmuss & Agyeman, 2002).

University students are an

important group for studying carbon reduction behavior because their values, lifestyles, and consumption habits are still developing. Their daily activities involve frequent decisions related to electricity use, transportation, consumption, and waste management. These behaviors may also be affected by university policies, peer expectations, environmental education, and campus culture. In this study, carbon reduction behavior refers to actual actions undertaken by university students in their daily lives rather than their future behavioral intentions.

2.2 Theory of Planned Behavior

The Theory of Planned Behavior is widely used to explain how individual cognition influences behavior. According to Ajzen (1991), behavior is primarily determined by behavioral intention, which is shaped by behavioral attitude, subjective norm, and perceived behavioral control. Perceived behavioral control may also directly influence actual behavior when it accurately reflects the resources and opportunities available to the individual.

Behavioral attitude refers to an individual's positive or negative evaluation of performing a particular behavior. Subjective norm reflects the perceived expectations and support of significant others. Perceived behavioral control represents an individual's judgment of whether they possess the necessary abilities, resources, and opportunities to perform the behavior (Ajzen, 1991).

The theory has been extensively applied to pro-environmental behavior. Previous research has demonstrated that attitudes, social norms, and perceived

control are important psychological determinants of recycling, green consumption, energy conservation, and other environmentally responsible actions (Bamberg & Möser, 2007; Steg & Vlek, 2009). Accordingly, students who evaluate carbon reduction positively, perceive support from important others, and believe that low-carbon actions are feasible are more likely to engage in carbon reduction behavior.

However, the Theory of Planned Behavior mainly emphasizes individual cognitive evaluation. Although subjective norm represents social influence, it does not fully explain how individuals internalize group values or define environmental behavior as part of their shared identity. Therefore, Social Identity Theory is introduced to provide an additional explanation of the group-based psychological process underlying carbon reduction behavior.

2.3 Social Identity Theory and Collective Identity

Social Identity Theory proposes that individuals define themselves not only through personal characteristics but also through membership in social groups. When group membership becomes important to an individual's self-concept, the individual is more likely to adopt attitudes and behaviors consistent with the values and norms of that group (Hornsey, 2008).

Collective identity refers to an individual's sense of belonging to a group and identification with its shared values, responsibilities, and behavioral standards. In the environmental context, individuals with stronger collective identity may view environmental

protection as something that “we” should do rather than merely a personal choice. This identity-based understanding may encourage individuals to internalize environmental norms and maintain consistent pro-environmental behavior.

Fielding and Hornsey (2016) argued that social identity processes influence how people understand environmental problems and respond to environmental norms. Similarly, the Social Identity Model of Pro-Environmental Action proposes that group identification, group norms, collective efficacy, and related identity processes can promote pro-environmental action (Fritzsche et al., 2018).

Collective identity differs conceptually from subjective norm. Subjective norm concerns whether individuals perceive that others expect or encourage them to behave in a particular way. Collective identity concerns whether individuals regard that behavior as part of the shared values and identity of their group. Therefore, collective identity may provide a deeper explanation of how external social expectations become internalized and transformed into sustained personal action.

In this study, collective identity refers to the extent to which university students view carbon reduction as part of the shared values, responsibilities, and identity of the university student community.

2.4 Integration of the Theory of Planned Behavior and Social Identity Theory

The Theory of Planned Behavior

and Social Identity Theory explain different but complementary aspects of carbon reduction behavior. The Theory of Planned Behavior explains how personal evaluation, perceived social expectations, and perceived feasibility contribute to behavioral action. Social Identity Theory explains how group belonging and shared values strengthen and internalize these psychological influences.

Behavioral attitude may contribute to collective identity because students who regard carbon reduction as meaningful and responsible may be more willing to accept low-carbon values as part of their group identity. Subjective norm may strengthen collective identity when support from classmates, teachers, universities, and other important groups signals that carbon reduction is a shared behavioral expectation. Perceived behavioral control may also contribute to collective identity because behaviors that are considered practical and achievable are more likely to become accepted as sustainable group standards.

Collective identity may subsequently translate these individual-level psychological factors into actual carbon reduction behavior. When students perceive carbon reduction as consistent with “who we are” as responsible university students, low-carbon action may become more stable than behavior based only on personal preference or external pressure. Collective identity therefore serves as a psychological bridge between individual cognition and actual action.

The integrated framework provides a more comprehensive explanation of

carbon reduction behavior than either theory alone. The Theory of Planned Behavior identifies the cognitive and social foundations of behavior, whereas Social Identity Theory explains how these foundations are internalized through group membership and shared responsibility.

2.5 Research Model

Based on the preceding theoretical discussion, this study proposes an integrated research model combining the Theory of Planned Behavior and Social Identity Theory. The model includes behavioral attitude, subjective norm, and perceived behavioral control as independent variables, collective identity as a mediating variable, and carbon reduction behavior as the dependent variable.

The research model contains two types of relationships. First, behavioral attitude, subjective norm, perceived behavioral control, and collective identity are expected to have direct

effects on carbon reduction behavior. These paths examine whether individual cognition, perceived social influence, perceived feasibility, and group identification directly promote actual low-carbon action.

Second, behavioral attitude, subjective norm, and perceived behavioral control are expected to influence carbon reduction behavior indirectly through collective identity. These paths examine whether individual psychological factors become more effectively transformed into actual behavior when students internalize carbon reduction as part of shared group values and responsibilities.

Accordingly, the model explains carbon reduction behavior as a process moving from individual cognition to collective identification and finally to actual low-carbon action.

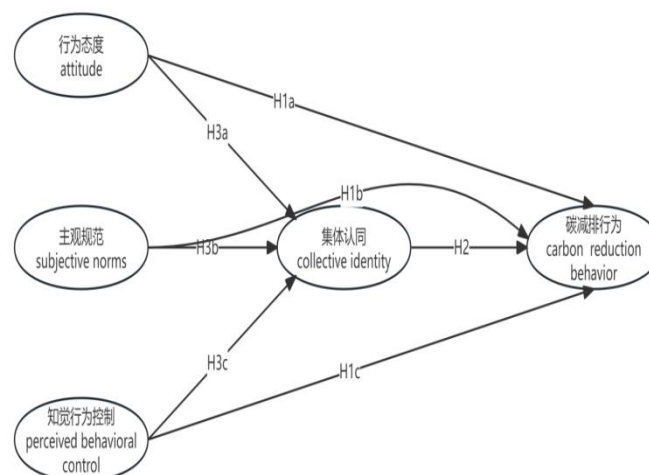


Figure 2.1 Research Model

2.6 Research Hypotheses

H1a: Behavioral attitude has a significant positive effect on carbon reduction behavior.

H1b: Subjective norm has a significant positive effect on carbon reduction behavior.

H1c: Perceived behavioral control has a significant positive effect on carbon reduction behavior.

H2: Collective identity has a significant positive effect on carbon reduction behavior.

H3a: Collective identity mediates the relationship between behavioral attitude and carbon reduction behavior.

H3b: Collective identity mediates the relationship between subjective norm and carbon reduction behavior.

H3c: Collective identity mediates the relationship between perceived behavioral control and carbon reduction behavior.

3. Research Methodology

3.1 Research Design and Data Collection

This study employed a cross-sectional survey method, collecting data from respondents at the same time point. This design is suitable for examining the relationships between attitudes, cognitions, and self-reported behaviors within a specific population (Sedgwick, 2014). A quantitative design was used to measure the research constructs and to statistically test the direct and mediating relationships presented in the model. The target population consisted of university students studying in Thailand. Convenience sampling was used because a complete sampling frame was

unavailable and eligible respondents could be efficiently reached through university-related networks (Etikan et al., 2016). The questionnaire was distributed online through student groups, class communication channels, social media communities, and campus organizations. Online surveys can facilitate efficient access to geographically or institutionally dispersed respondents, although researchers must also consider sampling and response-quality limitations (Wright, 2005). Respondents came from multiple universities, academic years, and disciplines to improve sample diversity.

The questionnaire consisted of two sections. The first section collected demographic and background information. The second section measured behavioral attitude, subjective norm, perceived behavioral control, collective identity, and carbon reduction behavior. Each construct contained six items, resulting in 30 measurement items. All items were measured using a seven-point Likert scale ranging from 1, “strongly disagree,” to 7, “strongly agree.”

Participation was voluntary and anonymous, and respondents were informed that their information would be used only for academic purposes. After responses with substantial missing values, straight-line answering, abnormal completion times, or logical inconsistencies were removed, 347 valid questionnaires were retained for analysis.

3.2 Questionnaire Reliability Test

Before the formal analysis, the internal consistency of the questionnaire was assessed using Cronbach’s alpha.

Cronbach's alpha is commonly used to evaluate the extent to which multiple items consistently measure the same underlying construct. The coefficient should be interpreted together with the number of items and the conceptual structure of the scale rather than being treated as an isolated indicator (Tavakol & Dennick, 2011)

The reliability results showed that Cronbach's alpha was 0.894 for behavioral attitude, 0.895 for subjective norm, 0.895 for perceived behavioral

control, 0.881 for collective identity, and 0.883 for carbon reduction behavior. The overall Cronbach's alpha for the 30 measurement items was 0.924.

The construct-level coefficients ranged from 0.881 to 0.895, while the overall coefficient was 0.924. These results indicate strong internal consistency among the measurement items and support the use of the scales in the subsequent validity and structural analyses (Tavakol & Dennick, 2011).

Table 3.1 Questionnaire Reliability Results

Test	Value
Number of respondents	30
Number of items	30
Cronbach's Alpha	0.938

3.3 Data Analysis Methods

The collected data were analyzed using SPSS and AMOS. First, descriptive statistics were used to summarize the respondents' demographic characteristics and the overall levels of the research variables. Frequencies and percentages were reported for categorical variables, while means and standard deviations were calculated for the measurement items and constructs.

Second, Cronbach's alpha was used to evaluate internal consistency. The Kaiser–Meyer–Olkin measure and Bartlett's test of sphericity were then applied to determine whether the data were suitable for factor analysis. Confirmatory factor analysis was conducted to evaluate the measurement model through standardized factor loadings, composite reliability, average variance extracted, and discriminant validity (Cheung et al., 2024; Fornell &

Larcker, 1981).

Third, structural equation modeling was used to test the direct effects of behavioral attitude, subjective norm, perceived behavioral control, and collective identity on carbon reduction behavior. Model fit was assessed using χ^2/df , GFI, CFI, TLI, RMSEA, and other fit indices. Model fit was evaluated using multiple indices, including χ^2/df , GFI, CFI, TLI, and RMSEA. The adequacy of an SEM model should be judged by considering several absolute and incremental fit indices together rather than relying on a single statistic (Iacobucci, 2010).

Finally, the Bootstrap method with 5,000 resamples was used to examine the mediating role of collective identity. An indirect effect was considered significant when its 95% Bootstrap confidence interval did not include zero (Cheung, 2009).

4. Results and Discussion

4.1 Demographic Characteristics of Respondents

After data screening, 347 valid questionnaires were retained for analysis. The respondents came from 13 universities in Thailand, which increased the diversity of the sample. Mahidol University contributed the largest proportion of respondents (17.9%), followed by Chulalongkorn University (15.0%) and Bangkok University (11.5%).

Regarding gender, 190 respondents were female (54.8%) and 157 were male (45.2%). Most respondents were aged between 18 and 21 years, accounting for 74.6% of the sample. The distribution

across academic years was relatively balanced, with each group representing between 18.2% and 21.6% of the sample.

A total of 245 respondents (70.6%) had participated in environmental or sustainability-related courses, while 260 respondents (74.9%) had joined environmental organizations or volunteer activities. In addition, 71.1% of respondents reported that they were familiar with or had a good understanding of carbon reduction behavior. These results indicate that most respondents had relevant educational exposure or practical environmental experience.

Table 4.1 Descriptive Statistical Analysis

Variable	Options	Frequency	Percentage
University	Mahidol University	62	17.9
	Chulalongkorn University	52	15.0
	Bangkok University	40	11.5
	Dhurakij Pundit University	34	9.8
	Krirk University	33	9.5
	Thammasat University	22	6.3
	Kasetsart University	21	6.1
	Bangkok Thonburi University	19	5.5
	Stamford International University	18	5.2
		17	4.9
	Srinakharinwirot University	13	3.7
	Silpakorn University	11	3.2
	Assumption University		
	Rajamangala University of Technology Rattanakosin	5	1.4
Participation in Environmental or Sustainability-related Courses	No	102	29.4
	Yes	245	70.6
Participation in Environmental Groups or Volunteer Activities	No	87	25.1
	Yes	260	74.9
Gender	Male	157	45.2

	Female	190	54.8
	18	57	16.4
	19	67	19.3
	20	72	20.7
	21	63	18.2
	22	23	6.6
	23	16	4.6
Age	24	27	7.8
	25	14	4.0
	26	8	2.3
	Freshman	63	18.2
	Sophomore	73	21.0
	Junior	75	21.6
Academic Year	Senior	73	21.0
	Graduate Student	63	18.2
Nationality	Thailand	139	40.1
	China	208	59.9
	Science/Engineering	84	24.2
	Business	92	26.5
	Sports/Arts	32	9.2
Major Type	Humanities	91	26.2
	Medicine	48	13.8
	A. Very familiar with it	89	25.6
	B. Have a good understanding of it	158	45.5
Are you familiar with carbon reduction behaviors?	C. I've heard of it, but I don't know the specifics.	54	15.6
	D. Never heard of it before	46	13.3
	A. School Curriculum/Classroom Learning (Reading, Textbooks, Teacher Lectures)	188	19.5%
	B. Campus Publicity/Regulations (Posters, Notices, Waste Sorting and Energy Saving Tips, etc.)	180	18.7%
What are the main channels for learning about carbon emission reduction efforts? (Multiple selections allowed)	C. Social Media/Short Video Platforms (e.g., Facebook/Instagram/TikTok, etc.)	83	8.6%
	D. Forums/Communities/Online Communities (e.g., Reddit, Line Groups, School	163	16.9%

Community, etc.)		
E. Environmental Protection Clubs/Volunteer	172	17.8%
Activities/Campus Greening Activities		
F. Communication with Family/Friends/Peers	83	8.6%
G. News Media/Government or Institutional Publicity	96	9.9%

4.2 Descriptive Statistics of Research Variables

Descriptive statistics were calculated for the five research variables using a seven-point Likert scale. As shown in Table 4.2, the mean scores ranged from 4.257 to 4.456, and all values were above the scale midpoint of 4. This indicates that respondents generally demonstrated positive environmental attitudes, perceived social support, perceived behavioral control, collective identity, and actual carbon reduction behavior.

Pro-environmental attitude had the highest mean score ($M = 4.456$, $SD = 1.330$), suggesting that respondents generally considered carbon reduction

meaningful and beneficial. Perceived green behavioral control ranked second ($M = 4.356$, $SD = 1.315$), indicating that students generally believed that they had the ability and conditions to perform low-carbon behavior.

Collective identity had the lowest mean score ($M = 4.257$, $SD = 1.280$). Although this value remained above the midpoint, it suggests that respondents' group-based identification with carbon reduction was weaker than their individual environmental attitudes. Carbon reduction behavior recorded a mean of 4.323, indicating a moderate-to-positive level of actual low-carbon action.

Table 4.2 Descriptive Statistics of Measurement Items and Dimensions

Dimension	Item	Item Mean	Item Std. Deviation	Dimension Average Mean	Average Std. Deviation
Pro-environmental Attitude (ATT)	ATT1	4.401	1.646	4.456	1.330
	ATT2	4.524	1.626		
	ATT3	4.409	1.597		
	ATT4	4.519	1.601		
	ATT5	4.380	1.744		
	ATT6	4.504	1.661		
Subjective Norms (SN)	SN1	4.245	1.678	4.312	1.336
	SN2	4.334	1.699		
	SN3	4.320	1.545		
	SN4	4.300	1.630		

	SN5	4.329	1.702		
	SN6	4.346	1.647		
	PBC1	4.392	1.621		
	PBC2	4.380	1.625		
Perceived Green	PBC3	4.323	1.571	4.356	1.315
Behavioral Control	PBC4	4.360	1.683		
	PBC5	4.329	1.631		
	PBC6	4.352	1.610		
	CI1	4.262	1.625		
	CI2	4.280	1.543		
Collective Identity	CI3	4.228	1.601	4.257	1.280
(CI)	CI4	4.173	1.676		
	CI5	4.349	1.651		
	CI6	4.251	1.596		
	CRB1	4.435	1.607		
	CRB2	4.317	1.635		
Carbon Reduction	CRB3	4.176	1.588	4.323	1.268
Behavior (CRB)	CRB4	4.329	1.540		
	CRB5	4.380	1.571		
	CRB6	4.300	1.638		

4.3 Reliability and Validity Analysis

4.3.1 Reliability Analysis

Cronbach's alpha was used to assess the internal consistency of the measurement scales. As shown in Table 4.3, the alpha values of the five

constructs ranged from 0.881 to 0.895, while the overall scale achieved an alpha value of 0.924. These coefficients indicate strong internal consistency among the measurement items (Tavakol & Dennick, 2011).

Table 4.3 Reliability Results

Construct	Number of items	Cronbach's alpha
Pro-environmental attitude	6	0.894
Subjective norm	6	0.895
Perceived green behavioral control	6	0.895
Collective identity	6	0.881
Carbon reduction behavior	6	0.883
Overall scale	30	0.924

These results demonstrate that the questionnaire had satisfactory internal consistency and was appropriate for subsequent factor analysis and structural equation modeling.

4.3.2 KMO and Bartlett's Test

The Kaiser–Meyer–Olkin value was 0.926, exceeding the recommended threshold of 0.90. Bartlett's test of sphericity was also statistically

significant, $\chi^2 = 5,635.064$, $df = 435$, $p < .001$. Therefore, the correlations among the measurement items were sufficient for factor analysis.

Table 4.4 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	0.926
Approx. Chi-Square	5635.064
Bartlett's Test of df	435
Sphericity Sig.	0.000

4.3.3 Confirmatory Factor Analysis

Confirmatory factor analysis was conducted to assess convergent and discriminant validity. The standardized factor loadings ranged from 0.723 to 0.805. Composite reliability values

ranged from 0.882 to 0.895, while AVE values ranged from 0.554 to 0.588. Taken together, these results provide evidence of satisfactory construct reliability and convergent validity (Cheung et al., 2024; Fornell & Larcker, 1981).

Table 4.5 Convergent Validity Results

Construct	Loading range	CR	AVE
ATT	0.758–0.772	0.894	0.584
SN	0.723–0.805	0.895	0.586
PBC	0.746–0.778	0.895	0.588
CI	0.725–0.760	0.882	0.554
CRB	0.728–0.778	0.883	0.557

Discriminant validity was assessed using the Fornell–Larcker criterion. The square roots of AVE ranged from 0.744 to 0.767 and were greater than the inter-construct correlations, which ranged from 0.369 to 0.457. These results confirm that the five constructs were statistically distinct.

4.4 Structural Model and Direct-Effect Testing

Structural equation modeling was conducted after the measurement model demonstrated satisfactory reliability and validity. The structural model showed good overall fit, as presented in Table 4.6.

Table 4.6 Structural Model Fit

Fit Index	Criterion	Value
χ^2	-	453.268
df	-	395
χ^2/df	<3	1.148
GFI	>0.9	0.921
RMSEA	<0.10	0.021
CFI	>0.9	0.989
NFI	>0.9	0.922
RFI	>0.9	0.914
TLI	>0.9	0.988
AGFI	>0.9	0.907
IFI	>0.9	0.989

The χ^2/df value was 1.148, while GFI, AGFI, CFI, TLI, NFI, RFI, and IFI all exceeded 0.90. RMSEA was 0.021. Considering these fit indices jointly, the proposed structural model demonstrated a satisfactory fit to the observed data (Iacobucci, 2010).

The direct-effect results showed that all four predictors had significant positive effects on carbon reduction

behavior. Collective identity produced the strongest direct effect ($\beta = 0.183$, $p = .005$), followed closely by pro-environmental attitude ($\beta = 0.182$, $p = .007$) and subjective norm ($\beta = 0.178$, $p = .007$). Perceived green behavioral control also had a significant effect, although its coefficient was comparatively smaller ($\beta = 0.140$, $p = .035$).

Table 4.7 Direct-Effect and Hypothesis-Testing Results

Hypothesis	Path	Standardized coefficient	p-value	Result
H1a	ATT → CRB	0.182	.007	Supported
H1b	SN → CRB	0.178	.007	Supported
H1c	PBC → CRB	0.140	.035	Supported
H2	CI → CRB	0.183	.005	Supported

The significant ATT → CRB relationship indicates that students with more favorable evaluations of carbon reduction were more likely to perform low-carbon actions. The significant SN → CRB relationship shows that support and expectations from important others contributed to students' behavior. The significant PBC → CRB relationship suggests that perceived ability and behavioral feasibility also encouraged carbon reduction. Most importantly, collective identity showed the strongest direct effect, demonstrating that students

were more likely to act when carbon reduction was understood as part of their shared group values and responsibilities.

4.5 Bootstrap Mediation Analysis

The mediating role of collective identity was examined using 5,000 Bootstrap resamples and 95% confidence intervals. An indirect effect was considered significant when its confidence interval did not include zero (Cheung, 2009). As shown in Table 4.8, none of the confidence intervals included zero; therefore, all three mediation hypotheses were supported.

Table 4.8 Bootstrap Mediation Analysis Results of Collective Identity

Hypothesis	Indirect path	Indirect effect	95% confidence interval	p-value	Result
H3a	ATT → CI → CRB	0.044	[0.013, 0.096]	.002	Supported
H3b	SN → CI → CRB	0.043	[0.014, 0.091]	.002	Supported
H3c	PBC → CI → CRB	0.029	[0.005, 0.073]	.016	Supported

The indirect effect of pro-environmental attitude was the strongest at 0.044. Its confidence

interval ranged from 0.013 to 0.096 and did not contain zero. The direct effect remained statistically significant;

therefore, collective identity partially mediated the relationship between pro-environmental attitude and carbon reduction behavior.

The indirect effect of subjective norm was 0.043, with a confidence interval from 0.014 to 0.091. Since both its direct and indirect effects were significant, collective identity also partially mediated this relationship.

The indirect effect of perceived green behavioral control was 0.029, with a confidence interval from 0.005 to 0.073. In the Bootstrap analysis, its direct-effect confidence interval included zero, indicating that perceived behavioral control primarily influenced

carbon reduction behavior through collective identity. Thus, collective identity transmitted the effect of perceived behavioral control more fully than the effects of attitude and subjective norm.

These findings demonstrate that collective identity serves as an important psychological bridge between individual cognition and actual low-carbon action. Positive attitudes, social expectations, and perceived behavioral capacity were more likely to result in carbon reduction behavior when students internalized low-carbon practices as shared group values.

4.6 Summary of Hypothesis Testing

Table 4.9 Summary of Hypothesis Testin

Hypothesis	Proposed relationship	Result
H1a	Behavioral attitude positively affects carbon reduction behavior	Supported
H1b	Subjective norm positively affects carbon reduction behavior	Supported
H1c	Perceived behavioral control positively affects carbon reduction behavior	Supported
H2	Collective identity positively affects carbon reduction behavior	Supported
H3a	Collective identity mediates ATT → CRB	Supported
H3b	Collective identity mediates SN → CRB	Supported
H3c	Collective identity mediates PBC → CRB	Supported

Overall, all proposed hypotheses were supported. The results confirm that carbon reduction behavior is influenced by both individual-level psychological factors and group-based identity mechanisms. Among the direct predictors, collective identity had the strongest effect. It also significantly mediated all three relationships between the planned behavior variables and carbon reduction behavior.

5. Conclusion, Discussion, and Recommendations

5.1 Conclusion

This study examined the formation of carbon reduction behavior among university students in Thailand by integrating the Theory of Planned Behavior and Social Identity Theory. Behavioral attitude, subjective norm, and perceived behavioral control were

treated as individual-level psychological factors, while collective identity was introduced as a group-based mediating mechanism.

The results showed that behavioral attitude, subjective norm, perceived behavioral control, and collective identity all had significant positive effects on carbon reduction behavior. Among these variables, collective identity had the strongest direct effect. This finding indicates that students are more likely to engage in carbon reduction behavior when they regard low-carbon action as part of the shared values and responsibilities of the university student community.

The Bootstrap results further showed that collective identity significantly mediated the relationships between behavioral attitude, subjective norm, perceived behavioral control, and carbon reduction behavior. Therefore, carbon reduction behavior is shaped not only by personal evaluation, social expectations, and perceived ability, but also by the extent to which students internalize low-carbon behavior as part of their group identity.

Overall, the findings support all proposed hypotheses and demonstrate that collective identity serves as an important psychological bridge between individual cognition and actual low-carbon action.

5.2 Discussion

5.2.1 Behavioral Attitude and Carbon Reduction Behavior

The results showed that behavioral attitude had a significant positive effect on carbon reduction behavior. Students who believed that low-carbon behavior was beneficial, meaningful, and socially

responsible were more likely to practice energy conservation, green consumption, and low-carbon transportation.

This finding is consistent with the Theory of Planned Behavior, which proposes that favorable behavioral evaluations increase the likelihood of performing the corresponding behavior (Ajzen, 1991). It also supports previous evidence that positive environmental attitudes contribute to pro-environmental action (Bamberg & Möser, 2007; Steg & Vlek, 2009).

However, the effect of attitude was not dominant. This suggests that recognizing the value of carbon reduction alone may be insufficient to ensure stable action. Students may still require social encouragement, practical conditions, and identity-based motivation.

5.2.2 Subjective Norm and Carbon Reduction Behavior

Subjective norm had a significant positive effect on carbon reduction behavior. This result indicates that expectations and support from classmates, friends, teachers, families, and universities influence students' low-carbon practices.

The finding is consistent with previous studies showing that social norms shape environmental behavior by communicating what is socially expected and approved (Cialdini et al., 1990; Farrow et al., 2017). In the university context, students are constantly exposed to peer behavior and institutional messages. When important social groups support carbon reduction, students are more likely to act consistently with these expectations.

This result also highlights the

importance of the campus social environment. Low-carbon behavior is more likely to develop when it is visible, encouraged, and socially recognized.

5.2.3 Perceived Behavioral Control and Carbon Reduction Behavior

Perceived behavioral control also had a significant positive effect on carbon reduction behavior. Students who believed that they had sufficient knowledge, resources, opportunities, and ability were more likely to perform low-carbon actions.

This finding supports Ajzen's (1991) argument that behavior becomes more likely when individuals consider it feasible and controllable. For university students, practical factors such as access to public transportation, recycling facilities, affordable green products, and energy-saving infrastructure may determine whether environmental beliefs can be translated into action.

Compared with the other direct effects, perceived behavioral control had a relatively weaker coefficient. Nevertheless, its significant indirect effect through collective identity suggests that perceived feasibility may strengthen students' belief that low-carbon behavior can become a realistic and shared group practice.

5.2.4 Collective Identity and Carbon Reduction Behavior

Collective identity had the strongest direct effect on carbon reduction behavior. This result demonstrates that students are more likely to maintain low-carbon practices when they perceive such behavior as part of the shared identity and responsibility of their group.

The finding supports Social Identity Theory, which proposes that individuals partly define themselves through group membership and tend to align their behavior with the values and norms of salient identity groups (Hornsey, 2008). It is also consistent with environmental identity research showing that group identification can promote pro-environmental action by linking environmental responsibility with the meaning of "who we are" (Fielding & Hornsey, 2016; Fritzsche et al., 2018).

This result extends the individual-level explanation of the Theory of Planned Behavior. It suggests that carbon reduction behavior becomes more stable when it is transformed from "a behavior I personally support" into "a behavior that people like us should perform."

5.2.5 Mediating Role of Collective Identity

The Bootstrap results confirmed that collective identity mediated all three relationships between the planned behavior variables and carbon reduction behavior.

First, positive behavioral attitude strengthened carbon reduction behavior partly because favorable evaluations encouraged students to accept low-carbon values as part of their group identity. Second, subjective norm influenced behavior partly because external expectations were internalized as shared group responsibilities. Third, perceived behavioral control influenced behavior through collective identity because feasible low-carbon practices were more likely to be regarded as realistic group standards.

These findings indicate that collective identity is not merely another direct predictor. It explains how individual cognition and external social influence are converted into more stable action. Therefore, the integration of the Theory of Planned Behavior and Social Identity Theory provides a more complete explanation of carbon reduction behavior than either theory alone.

5.3 Answers to the Research Questions

5.3.1 Answer to RQ1

RQ1 asked how behavioral attitude, subjective norm, and perceived behavioral control influence the carbon reduction behavior of university students in Thailand.

The results showed that all three variables had significant positive effects on carbon reduction behavior. Behavioral attitude had a standardized effect of $\beta = 0.182$, subjective norm had an effect of $\beta = 0.178$, and perceived behavioral control had an effect of $\beta = 0.140$.

These results indicate that students are more likely to engage in carbon reduction behavior when they regard it positively, perceive support from important others, and believe that they have the ability and conditions to perform it.

5.3.2 Answer to RQ2

RQ2 asked what role collective identity plays in shaping carbon reduction behavior.

The results showed that collective identity had a significant positive effect on carbon reduction behavior, with $\beta = 0.183$. It was the strongest direct predictor among the variables included

in the model.

This means that students who regard carbon reduction as part of the shared values, responsibilities, and identity of the university community are more likely to perform actual low-carbon behavior.

5.3.3 Answer to RQ3

RQ3 asked how collective identity explains the transformation of behavioral attitude, subjective norm, and perceived behavioral control into carbon reduction behavior.

The Bootstrap results showed that collective identity significantly mediated all three relationships. The indirect effects were 0.044 for behavioral attitude, 0.043 for subjective norm, and 0.029 for perceived behavioral control. None of the 95% confidence intervals included zero.

Therefore, collective identity functions as a psychological bridge. It helps transform personal evaluation, social expectations, and perceived ability into actual low-carbon action by internalizing carbon reduction as a shared group value.

5.4 Theoretical Implications

This study provides three theoretical contributions.

First, it extends the Theory of Planned Behavior by incorporating collective identity into the explanation of actual carbon reduction behavior. The findings show that individual-level psychological factors remain important, but their effects can be strengthened through group identification.

Second, the study links the Theory of Planned Behavior with Social Identity Theory. The integrated model explains both the cognitive foundations of

behavior and the identity-based process through which these foundations become internalized.

Third, the study provides empirical evidence from the context of universities in Thailand. The results show that group-based psychological processes are particularly relevant in a campus environment characterized by frequent peer interaction, shared activities, and institutional influence.

5.5 Practical Recommendations

Universities should not rely solely on environmental knowledge campaigns. Although education can improve attitudes, stable carbon reduction behavior also requires social support, practical opportunities, and collective identification.

First, universities should strengthen low-carbon campus identity by presenting carbon reduction as a shared student responsibility. Sustainability messages can emphasize collective expressions such as “our campus” and “our shared responsibility.”

Second, universities should use peer influence more effectively. Student leaders, environmental clubs, and volunteer groups can demonstrate low-carbon practices and create visible behavioral norms.

Third, universities should improve the practical conditions for carbon reduction. Convenient public transportation, recycling facilities, energy-saving equipment, and accessible green products can increase students’ perceived behavioral control.

Finally, low-carbon activities should encourage continuous participation rather than one-time involvement. Green challenges, campus

competitions, recognition programs, and group-based projects may help transform temporary participation into stable habits.

5.6 Limitations and Future Research

This study has several limitations. First, the cross-sectional design measured variables at one point in time and therefore cannot establish long-term causal relationships. Future research may use longitudinal or experimental designs to examine how collective identity and carbon reduction behavior change over time.

Second, convenience sampling was used, and the sample included university students from selected institutions in Thailand. Therefore, the findings may not be fully generalizable to all university students or other social groups. Future studies may apply probability sampling and include participants from different regions and countries.

Third, the data were collected through self-reported questionnaires. Respondents may have overreported socially desirable environmental behavior. Future studies may combine questionnaires with behavioral observations, electricity-use records, transportation data, or other objective indicators.

Fourth, this study focused on behavioral attitude, subjective norm, perceived behavioral control, and collective identity. Other variables, such as environmental knowledge, personal values, collective efficacy, institutional support, and environmental concern, may also influence carbon reduction behavior and should be examined in

future research.

References

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, 27(1), 14–25. <https://doi.org/10.1016/j.jenvp.2006.12.002>
- Cheung, G. W., Cooper-Thomas, H. D., Lau, R. S., & Wang, L. C. (2024). Reporting reliability, convergent and discriminant validity with structural equation modeling: A review and best-practice recommendations. *Asia Pacific Journal of Management*, 41, 745–783. <https://doi.org/10.1007/s10490-023-09871-y>
- Cheung, M. W.-L. (2009). Comparison of methods for constructing confidence intervals of standardized indirect effects. *Behavior Research Methods*, 41(2), 425–438. <https://doi.org/10.3758/BRM.41.2.425>
- Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, 58(6), 1015–1026. <https://doi.org/10.1037/0022-3514.58.6.1015>
- Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1–4. <https://doi.org/10.11648/j.ajtas.20160501.11>
- Farrow, K., Grolleau, G., & Ibanez, L. (2017). Social norms and pro-environmental behavior: A review of the evidence. *Ecological Economics*, 140, 1–13. <https://doi.org/10.1016/j.ecolecon.2017.04.017>
- Fielding, K. S., & Hornsey, M. J. (2016). A social identity analysis of climate change and environmental attitudes and behaviors: Insights and opportunities. *Frontiers in Psychology*, 7, Article 121. <https://doi.org/10.3389/fpsyg.2016.00121>
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39–50. <https://doi.org/10.1177/002224378101800104>
- Fritsche, I., Barth, M., Jugert, P., Masson, T., & Reese, G. (2018). A social identity model of pro-environmental action (SIMPEA). *Psychological*

- Review*, 125(2), 245–269.
<https://doi.org/10.1037/rev0000090>
- Hornsey, M. J. (2008). Social identity theory and self-categorization theory: A historical review. *Social and Personality Psychology Compass*, 2(1), 204–222.
<https://doi.org/10.1111/j.1751-9004.2007.00066.x>
- Iacobucci, D. (2010). Structural equations modeling: Fit indices, sample size, and advanced topics. *Journal of Consumer Psychology*, 20(1), 90–98.
<https://doi.org/10.1016/j.jcps.2009.09.003>
- Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, 8(3), 239–260.
<https://doi.org/10.1080/13504620220145401>
- Sedgwick, P. (2014). Statistical Question Cross sectional studies: advantages and disadvantages. *BMJ-British Medical Journal*, 348,g2276.
<https://doi.org/10.1136/bmj.g227>
- 6
- Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, 29(3), 309–317.
<https://doi.org/10.1016/j.jenvp.2008.10.004>
- Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*, 56(3), 407–424.
<https://doi.org/10.1111/0022-4537.00175>
- Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, 2, 53–55.
<https://doi.org/10.5116/ijme.4dfb.8dfd>
- Wright, K. B. (2005). Researching Internet-based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. *Journal of Computer-Mediated Communication*, 10(3), Article JCMC1034.
<https://doi.org/10.1111/j.1083-6101.2005.tb00259.x>