EXPLORING THE APPLICATION OF THE THEORY OF PLANNED BEHAVIOR TO EXPLAIN UNIVERSITY STUDENTS' ENERGY-SAVING INTENTIONS AND BEHAVIORS: A SYNTHESIS OF CO-KEYWORD AND CONTENT ANALYSIS OF PUBLICATIONS RETRIEVED FROM SCOPUS

The 13th International Conference on Emerging Challenges: Business Dynamics in Disruptive Economy

Toan-VU Le[1*], Nguyen Hoang LAN[1], Xuan Minh Tang[1]

[1]Hanoi University of Science and Technology (HUST), Hanoi, Vietnam

[*]Corresponding author: toan.levu1@hust.edu.vn

Abstract

Energy conservation has emerged as a fundamental component of sustainability transitions, with universities serving a dual function as significant energy consumers and crucial environments for fostering pro-environmental behavior in future leaders. The Theory of Planned Behavior (TPB) has been extensively utilized to examine university students' goals regarding energy conservation; nonetheless, current research is disjointed concerning geographical coverage, methodological frameworks, and theoretical advancements. This study combines bibliometric analysis with content analysis to thoroughly investigate the intellectual and methodological framework of TPB applications in this field. A systematic search of the Scopus database identified 98 qualifying papers, 28 of which directly utilized the TPB. Bibliometric co-keyword analysis emphasized the central role of TPB and Structural Equation Modeling (SEM) in explaining behavioral intentions. Results also showed that energy-saving behavioral tendencies were related to environmental awareness, concern about global warming, and pro-environmental attitudes. Meanwhile, content analysis of 24 full-text reports was found to indicate the role of key variables of TPB in research contexts in different countries. The results of content analysis continued to emphasize the key role of the SEM method. Moreover, the TPB has often been augmented with additional latent variables to improve the explanatory power of the research model. Five groups of additional variables were found, including (1) social norms and influence, (2) personal cognition and perceived control, (3) environmental cognition and affect, (4) policy and external support, and (5) individual or behavioral factors. Research indicates that enhancing the TPB's impact on students' energy-saving behavioral intentions necessitates expanded geographical scope, methodological variety, and comprehensive assessment of model extensions.

Research purpose:
The purpose of this study is to systematically examine how the TPB has been applied to university students' energy-saving intentions by integrating bibliometric analysis and methodological meta-research, thereby mapping intellectual trends, evaluating methodological practices, and synthesizing theoretical extensions to guide future sustainability research..

Research motivation:
Climate change necessitates urgent action on energy conservation, positioning universities as pivotal actors. As both large-scale energy consumers and educators of future leaders, universities shape sustainable practices. University students, increasingly environmentally conscious, represent critical change agents, making their energy-saving behaviors central to sustainability transitions in higher education and beyond.

Research design, approach, and method:
This study employed a mixed bibliometric–qualitative design. A systematic Scopus search identified relevant publications, with 98 papers screened and 28 using the Theory of Planned Behavior. Bibliometric co-keyword analysis mapped intellectual structure, while qualitative content analysis of 24 full texts examined methodological choices, TPB variables, and model extensions across geographical contexts.

Main findings:
The study reveals that TPB-based research on students' energy-saving intentions is geographically concentrated in Asia, methodologically dominated by SEM, and frequently extended with diverse contextual and psychological variables. While these extensions enhance explanatory depth, they also challenge comparability, underscoring the need for broader coverage, methodological diversification, and theoretical coherence.

Practical/managerial implications:
This study integrates bibliometric analysis with methodological meta-research to investigate TPB applications in students' energy-saving intentions. By analyzing 28 studies (2014–2025), it maps intellectual and geographical patterns, evaluates methodological practices, and synthesizes theoretical extensions. The findings enhance conceptual clarity, identify research imbalances, and guide future inquiry into sustainable behavioral transitions.

Keywords: Energy saving, energy-saving intentions, energy-saving behaviors, students, TPB

1. INTRODUCTION

The worldwide issue of climate change has highlighted energy saving as a crucial strategy for sustainable development. Universities, as significant energy consumers and cultivators of future leaders, hold a distinctive role in promoting this goal (Heib et al., 2024). University students, as a significant and increasingly eco-conscious demographic, are essential advocates for energy-saving practices both on campus and in broader contexts (X. Chen & Gou, 2022). Although energy-saving habits are frequently characterized as technical or infrastructural issues, considerable evidence highlights the influence of psychological, social, and contextual factors on behavioral results (Akitsu & Ishihara, 2019; Aktamis, 2011; Zhang et al., 2013). Thus, theory-driven methodologies have become essential for elucidating the intricate reasoning behind students' energy-saving intents.

The Theory of Planned Behavior (TPB) (I. Ajzen, 1991) has become one of the most often utilized frameworks for forecasting pro-environmental intentions and behaviors among these theoretical methods. The Theory of Planned Behavior asserts that behavioral intention is collectively influenced by three elements: attitude toward the behavior, subjective norms, and perceived behavioral control. In the last twenty years, the TPB has been widely utilized to investigate sustainability-related outcomes such as recycling, green consumerism, and energy saving (Z. Chen & Liu, 2020; Duong, 2024; L.-S. Lee et al., 2015). In the setting of university students, the Theory of Planned Behavior provides a systematic framework to examine how evaluative judgments, social influences, and perceptions of control converge to shape energy-saving intentions. Scholars have notably augmented the TPB with further variables—such as moral norms, environmental consciousness, or policy incentives—to enhance its explanatory and predictive efficacy. These additions acknowledge that behavioral intentions are influenced by rational assessments as well as moral(Sharma & Christopoulos, 2021), emotional, and contextual factors (Puiu et al., 2025; Sharma & Christopoulos, 2021).

Notwithstanding its popularity, significant gaps persist in the application of the Theory of Planned Behavior to energy-saving aspirations among university students. Initially, current research is geographically limited, predominantly including China and a select number of Asian nations, which restricts the generalizability of findings across diverse cultural and institutional contexts. Secondly, methodological selections exhibit a significant dependence on structural equation modeling (SEM), with insufficient exploration of other techniques that could address nonlinearities, multilevel effects, or contextual variability. The swift expansion of TPB extensions has enhanced explanatory depth while also prompting questions regarding theoretical parsimony and comparability across studies. Consequently, a thorough synthesis of the operationalization, adaptation, and testing of the Theory of Planned Behavior within this study domain is both timely and essential.

The identified research questions include:

RQ1. What are the core research themes, areas, and trends in the shift in research focus toward university students' energy-saving behavioral intentions?

RQ2. What are the theories integrated with TPB theory to explain university students' energy-saving behavioral intentions?

RQ3. What is the preferred data analysis method of university students' energy-saving behavioral intention studies?

RQ4. What are the additional research variables used in conjunction with the main variables of TPB theory to explain university students' energy-saving behavioral intentions?

This study combines bibliometric analysis with contents analysis to tackle these difficulties. Bibliometric tools offer quantitative analyses of publication trends, knowledge frameworks, and subject clusters, facilitating the mapping of intellectual landscapes over time. The bibliometric method is employed across various disciplines (Hallinger & Kovačević, 2019; Toan-Vu Le et al., 2022; Lim & Kumar, 2024; Nguyen et al., 2023).

Content analysis was performed on 24 studies for which full-text reports were available. By analyzing 24 TPB-based studies published between 2014 and 2025, this research contributes in three ways. First, it offers a comprehensive overview of the intellectual and geographical distribution of the field, identifying dominant contributors and

underexplored contexts. Second, it evaluates the methodological landscape, highlighting the strengths and limitations of prevailing analytical approaches. Third, it synthesizes the diverse extensions of TPB applied to energy-saving intentions, developing a structured taxonomy that underscores theoretical innovation while drawing attention to issues of coherence and comparability. Content analysis also helps to identify geographic concentration trends, key data analysis methods, additional research variables, and key theories integrated with TPB theory in studies of university students' energy-saving behavioral intentions. Through these contributions, the study advances both conceptual clarity and methodological reflexivity, thereby informing future research agendas and practical strategies for promoting sustainable.

2. METHODOLOGY

In this study we combine quantitative bibliometric analysis and content analysis. The integration of bibliometric analysis and content analysis provides a robust framework for synthesizing scholarly developments while critically interrogating theoretical applications. This combined strategy not only advances understanding of research dynamics but also strengthens theoretical generalization, ensuring that both empirical patterns and methodological practices are rigorously examined.

2.1. Data search and screening strategies

A rigorous data search strategy was employed using the Scopus database, which is recognized as one of the most comprehensive and authoritative sources of peer-reviewed literature (Baas et al., 2020). Data retrieval from the Scopus database was performed in July 2025. The search protocol was carefully designed to ensure transparency, replicability, and coverage across relevant domains.The search strategy and data screening were carried out according to the PRISMA process, which includes four stages: (1) identification of records through multiple databases and additional sources; (2) screening of titles and abstracts after removal of duplicates; (3) full-text assessment according to predefined inclusion and exclusion criteria; and (4) selection of eligible studies for inclusion in the analysis. This structured approach ensures that the dataset reflects both the breadth and depth necessary for reliable scientific analysis.

Table 1. The tasks according to PRISMA guidelines

Stage	Tasks	Results
Identification	*Main query string:* TITLE-ABS-KEY("Energy saving behavior" OR "Energy conservation behavior" OR "Electricity conservation behavior" OR "Electricity saving behavior" OR "energy efficiency behavior" OR "Energy saving intention" OR "Energy conservation intention" OR "Electricity conservation intention" OR "Electricity saving intention" OR "energy efficiency intention") AND ABS(student) Limitation criteria: • Document types: article, conference paper. • Language: English	110
Screening	Two researchers independently screened the titles and abstracts, followed by full-text assessment to identify publications regarding energy conservation by university students.	98
Assessment and selection of eligible studies	Two researchers continued to read abstracts and full texts; only publications using TPB theory were retained.	28

The PRISMA protocol was adopted to ensure a rigorous and transparent screening process. An initial pool of 110 records from Scopus was reduced to 98 studies after title and abstract screening based on predefined criteria. These 98 articles were then examined in full, with both abstracts and complete texts carefully reviewed to assess methodological and theoretical relevance. Following this process, 28 studies explicitly employing the TPB were identified and retained for subsequent bibliometric and content analyses, thereby providing a focused dataset for investigating the applications and extensions of TPB in behavioral research.

2.2. Bibliometric analysis

Bibliometric analysis is an advanced method to explore the intellectual structure and research trends within a scientific field. Bibliometric analysis enables the processing of large-scale publication data, extracting keywords, classifying topics, and detecting academic collaboration networks. Through text mining algorithms and citation network analysis, bibliometric analysis identifies seminal works, influential authors, and research gaps. Studies in various fields using bibliometric analysis, such as entrepreneurship (TOAN-Vu Le & Tran, 2021), energy saving (T. Le et al., 2025), and

education (Vuong et al., 2020) show the popularity of this method.
This study employs the co-keyword analysis technique as a bibliometric analysis. Co-word analysis, as a core bibliometric technique, enables the systematic exploration of conceptual structures within a research field by examining the co-occurrence patterns of keywords across publications. By mapping the frequency and strength of keyword associations, this method reveals thematic clusters, intellectual linkages, and emerging research fronts. The approach identifies dominant topics and uncovers latent relationships among subfields, offering insights into knowledge dynamics and scientific evolution (Donthu et al., 2021). VOSviewer software is used to support analysis.

2.3. Content analysis

Content analysis is a widely employed qualitative and quantitative research method designed to systematically examine the content of documents, texts, media messages, or other unstructured data. The primary objective of this approach is to identify, categorize, quantify, and interpret patterns, themes, or latent meanings within the data, thereby deriving insights into the context, trends, and relationships among research concepts (Krippendorff, 2018). Based on 28 retrieved records, 24 full-text articles were identified and included for content analysis. These articles were carefully reviewed, and the data were coded according to a set of standardized and predefined criteria. Content analysis in this study includes the following steps: (1) developing a coding system; (2) coding data according to unified criteria; and (3) analyzing and interpreting the results.

Table 2: Research data coding

Coding content	Coding	Sub_coding
Country/Region where the study was conducted	Countries	
Data analysis methods used	SEM Regression	CB-SEM, PLS-SEM Ordered probit regression, Multiple linear regression, Hierarchical linear model
Testing the main hypotheses of the TPB model ATT -->ESI SN --> ESI PBC --> ESI	Supported Not Supported/Rejected	Positive/Negative effect
Theories integrated with TPB	Theory name (e.g., NAM, TAM, VBN)	
Additional variables	Variable name	

3. RESULTS AND DISCUSSION

3.1. Overview of the research data

Table 3 provides information: the dataset covers publications from 2014 to 2025, including 28 documents drawn from 27 scholarly sources, with 1,921 cited references and contributions from 89 authors. Document types include 26 peer-reviewed journal articles and 2 conference papers. he authors found 24/28 full-text reports.

Table 3. Overview of the research dataset

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2014:2025
Sources (Journals, Books, etc)	27
Documents	28
Full paper	24
References	1921
Authors	89
Co-Authors per Doc	3.56
DOCUMENT TYPES	
article	26
conference paper	2

Table 4 presents the geographical distribution of the 28 reviewed studies on university students' energy-saving intentions, demonstrating a strong concentration in China, which accounts for 14 studies, reflecting both the country's policy

emphasis on energy efficiency and its active academic output. Malaysia and the USA follow with three and two studies respectively, while Germany and Ghana also contribute two each. Other countries, including Pakistan, Kuwait, Vietnam, India, and Slovakia, are represented by single studies. This uneven distribution highlights a regional imbalance, with Asia dominating the research landscape. Broader cross-country investigations would enhance the generalizability and comparative strength of TPB-based insights.

Table 4: Research location

Countries	**Numbers**
China	14
USA	2
Malaysia	3
Germany	2
Ghana	2
Pakistan	1
Kuwait	1
Vietnam	1
India	1
Slovakia	1
Total	27

3.2. Co-keyword analysis

Figure 1 illustrates the co-word network of 74 keywords derived from 28 articles. The co-word network identifies the TPB as the intellectual nucleus, intricately associated with studies on energy-saving behavior. Two primary streams arise: (i) energy-conserving behavior linked to student contexts, SEM/PLS-SEM applications, multigroup analysis, and organizational factors, illustrating the practical application of behavioral theories in education and management; and (ii) energy-saving and energy-utilization behavior associated with environmental awareness, global warming apprehensions, and pro-environmental attitudes.

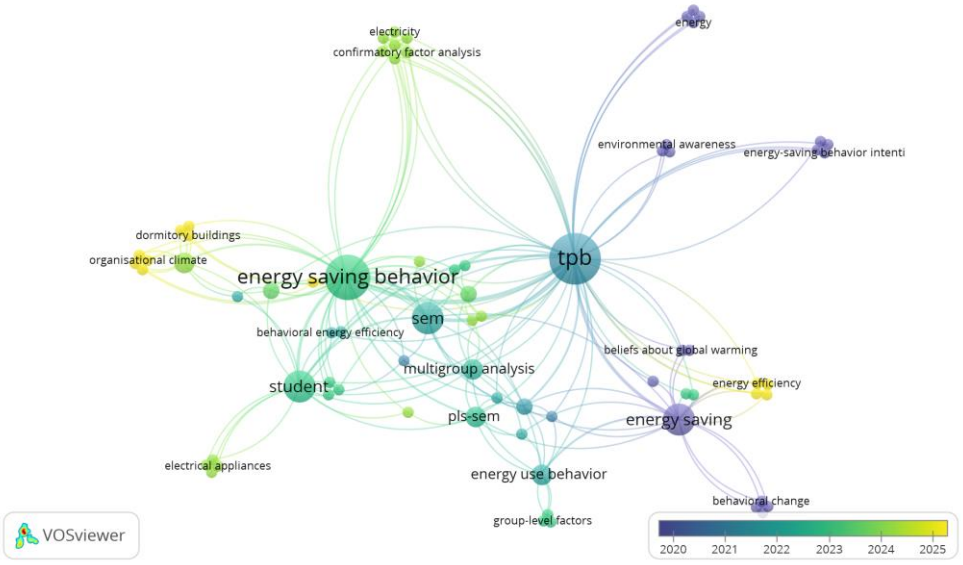


Figure 1. Scientific map of keywords

The co-occurrence network highlights the central role of the TPB in studies on students' energy-saving intentions, with dense linkages to constructs such as energy saving behavior, SEM, and student-related variables. Some studies, although recently published, have received high numbers of citations, such as (X. Chen & Gou, 2022; Du & Pan, 2021; Duong, 2024). The prominence of "energy saving behavior" and its connections with methodological terms like SEM, PLS-SEM, and multigroup analysis reflects the methodological convergence on structural modeling to examine latent constructs. At

the same time, peripheral clusters—such as "dormitory buildings," "organizational climate," and "electrical appliances"—illustrate the contextual diversity of applications, suggesting that TPB has been operationalized across both behavioral and environmental domains. Emerging links with "environmental awareness," "beliefs about global warming," and "behavioral change" indicate that the field is evolving to incorporate broader sustainability and climate-related dimensions. The temporal gradient, with newer terms (e.g., "organizational climate" and "energy efficiency") shown in yellow, suggests a recent emphasis on institutional and contextual factors. This mapping underscores TPB's robustness as a theoretical anchor while also pointing to opportunities for diversification, including multi-level analysis, integration of environmental psychology constructs, and cross-contextual comparisons. Future research should prioritize longitudinal designs to capture behavioral change over time, explore cross-cultural contexts to enhance generalizability, and incorporate mixed methods to strengthen both explanatory and predictive power.

3.3. Overview of data analysis methods:

The analysis of methods employed in studies on university students' energy-saving intentions grounded in the TPB reveals a strong dominance of structural equation modeling (SEM). Out of the 28 eligible studies, 24 applied SEM—either covariance-based or partial least squares—underscoring its suitability for testing complex models with latent constructs such as attitude, subjective norms, and perceived behavioral control. By contrast, only a limited number of studies adopted alternative approaches: two utilized ordered probit regression, one employed multiple linear regression, and another applied a hierarchical linear model. The reliance on SEM reflects both its methodological rigor and its capacity to validate measurement models alongside structural relationships. However, the relative absence of diverse econometric techniques suggests a methodological concentration that may limit analytical perspectives. Expanding beyond SEM could enrich future research by capturing nonlinear effects, multilevel structures, or contextual heterogeneity in behavioral intentions.

Table 5: Synthesis of data analysis methods

Data analysis methods	Statistic
SEM (CB-SEM, PLS-SEM)	24
Regression	
Ordered probit regression	1
Multiple linear regression	2
Hierarchical linear model	1

In contrast to conventional regression methods, SEM provides distinct benefits by concurrently evaluating measurement validity and examining different structural correlations, which is especially advantageous for theory-driven models such as TPB. Its capacity to model latent variables diminishes measurement error and enhances theoretical validation. Nevertheless, regression-based methodologies—such as ordered probit, multiple linear regression, or hierarchical linear modeling—offer complementary advantages, particularly in addressing ordinal outcomes, uncomplicated causal frameworks, or nested data.

3.4. Results of testing the main hypotheses of the TPB model

The Theory of Planned Behavior (Icek Ajzen, 1991) offers a comprehensive framework for elucidating university students' intentions and behaviors about energy conservation initiatives. The Theory of Planned Behavior posits that students' intention to conserve energy is influenced by their attitude towards energy-saving (assessing such actions as advantageous), subjective norms (perceived social pressures from peers, faculty, or institutional culture), and perceived behavioral control (their confidence in adopting energy-efficient practices). These factors collectively determine whether students convert pro-environmental intentions into tangible energy-saving activities on campus, rendering the Theory of Planned Behavior a significant framework for examining sustainable practices in higher education environments. By examining 28 studies, results showed:

Impact of Attitude on Energy Saving Intention: Most studies have indicated that ATT has a positive impact on ESI. However, some studies have rejected this hypothesis, for example (Liu et al., 2023) in the context of dormitories or studies with female students (Du & Pan, 2022). Research by (J. W. C. Lee & Tanusia, 2016) has shown that personal attitudes in specific environments will affect the behavior of that individual differently; specifically, the study has shown that attitudes at home do not affect students' energy saving intentions; however, attitudes on campus do affect students' energy saving intentions.

Impact of subjective norms on energy saving intentions: Although there are studies that also show that subjective norms have a positive impact on energy saving intentions, the role of this research variable is weaker than the impact of ATT and PBC. In addition, studies that reject the hypothesis that subjective norms affect energy saving intentions, for (Du & Pan, 2021; Kwakwa et al., 2024; Liu et al., 2023; Puiu et al., 2025; Wang et al., 2021), or accept it for male students while rejecting it for female students (Du & Pan, 2022). In particular, the study of (Kwakwa et al., 2024) showed that SN negatively impacts energy conservation intention via switching off lights when not needed.

Impact of PBC on energy saving intention: It has the strongest impact on ESI compared to ATT and SN. However, studies with specific energy-saving behaviors show that the role of PBC is different. The research results of (Kwakwa et

al., 2024) show that PBC negatively affects the intention to save energy in the behavior of energy conservation intention via properly closing the refrigerator, turning off and unplugging the laptop charger when the battery is fully charged, or switching off the fan when leaving the room and no one is around. Except for the case study of (Liu et al., 2023) on dormitory students in China, the impact of PBC on ESI was not statistically significant. This result can be explained by the fact that in the dormitory environment, many energy usage conditions are not decided by individuals. Therefore, students feel that they do not have enough actual control to perform energy saving behaviors even if they want to. Additionally, because students are randomly assigned to share rooms, they initially do not clearly understand their roommates' habits, preferences, and acceptance levels. They are not sure whether they can cooperate or adjust their behavior, causing low perceived behavioral control, and PBC is not strong enough to predict energy saving intention.

3.5. The trend of extending TPB theory in studies on energy saving intentions and behaviors of university students

A review of previous studies on university students' energy-saving intentions indicates that the majority of research depended exclusively on the fundamental elements of the TPB—attitude, subjective standards, and perceived behavioral control—to forecast pro-environmental intentions and behaviors. Nonetheless, numerous investigations incorporated supplementary theoretical frameworks to mitigate the acknowledged limits of the TPB.

Extensions including the Norm Activation Model (NAM) and Social Obligation–Based Cognition (SOBC) integrate personal norms and moral obligations, thus enhancing the TPB explanatory capacity regarding the influence of altruistic and ethical motives on sustainable actions. The Comprehensive Action Determination Model (CADM), which integrates the Norm Activation Model (NAM) and the Intention-Behavior models (ITB), offers a holistic perspective by connecting habitual, normative, and deliberate factors influencing energy-saving behavior. Alternative frameworks, such as Stimulus–Organism–Response (SOR) integrated with the TPB, incorporate emotional and contextual inputs in influencing students' reactions. Additionally, the inclusion of Environmental Concern and Beliefs (ECBs) or Pro-Environmental Motivation (PMN) improves our understanding of attitudinal complexity and value-driven factors. Social Cognitive Theory (SCT) and Consideration of Future Consequences (CFC) enhance the TPB by incorporating self-efficacy and future-oriented cognition, respectively.

Theoretical integrations indicate a distinct trend: although the TPB serves as a solid foundation for modeling students' energy-saving intentions, augmenting it with constructs that encompass morality, situational cues, self-regulation, and long-term orientation can enhance predictive validity and yield more practical insights for developing sustainability interventions in higher education. The prevalence of TPB-alone applications while lacking combination with other theories suggests a potential for more varied, sophisticated models that reflect the intricacies of students' decision-making in authentic college environments.

3.6. Additional research variables based on the TPB theory

Although there are limitations in integrating TPB theory and other theories to explain college students' energy-saving behavioral intentions, existing research also shows diversity in examining influencing factors. The articles were carefully read to extract all additional variables integrated into the TPB framework. Each variable was examined for conceptual similarity, thematically coded, and compared across studies. Through successive rounds of refinement, overlapping constructs were merged, ambiguous terms clarified, and broader conceptual patterns identified. Finally, these variables were organized into five coherent groups—social norms and influence, personal cognition and perceived control, environmental cognition and affect, policy and external support, and individual or behavioral factors—providing a structured foundation for synthesizing diverse determinants of energy-saving intentions. Table 6 lists additional variables beyond the core TPB variables that have been included in studies.

Tabel 6: List of additional variables

Groups	Variable Lable
Social Norms and Social Influence	Positive normative feedback (P)
	Negative normative feedback (N)
	Low-intensity normative feedback (L)
	High-intensity normative feedback (H)
	Injunctive social norm
	Descriptive social norm
	Social pressure (SP)
	Group pressure (GP)
	Group interaction
	Personal norms (PN)

	Moral norms (MN) Personal moral norm Personal Value Assessment (PVA) Social Value Assessment (SVA) Ecological Value Assessment (EVA) Energy-conservation value
Personal Cognition and Perceived Control	Perceived responsibility (PR) Perceived self-efficacy Perceived Self-efficacy (PSE) Awareness of consequences (AC) Perceived Benefit (PB) Perceived Cost (PC) Perceived Risk (PR) Perceived Value (PV) Consideration of future consequences (CFC) Value of Energy Saving (VES) Knowledge of Energy Saving (KES) Comfort Preference (CP)
Environmental Cognition and Affect	Positive affect (PA) Negative affect (NA) Emotions (EMO) Environmental Concern (EC) Environmental consciousness (ECO) General Environmental Attitude (GEA) Pro-environmental Identity (PEI) Global Warming Knowledge (GWK) Global Warming Beliefs (GWB)
Policies, Communication, and External Support	Media publicity (MP) Publicity and education (PE) Energy-Saving Promotional Activities (ESPA) Energy-Saving Policy Incentives (ESPI) Policy intervention (PI) Building Energy Consumption Information (BECI) Organizational energy saving climate (OESC) Organizational identification
Behavior and Other Individual Factors	Habitual energy-conservation behaviors Restricted energy-conservation behaviors Interpersonal ECBs Religion (REL)

Social norms and social influence include both descriptive and injunctive norms, varying intensities of normative input (positive/negative, low/high), and collective processes such as group pressure, social contact, and moral or personal norms. The incorporation of value-based judgments (personal, societal, and ecological) signifies an attempt to encompass more profound normative and ethical influences beyond conventional subjective norms.

Secondly, **personal cognition and perceived control** encompass categories including felt responsibility, self-efficacy, awareness of consequences, and perceived rewards or costs. It also emphasizes future-oriented cognition (thinking of

future implications) and value assessments of energy conservation, broadening TPB's perceived behavioral control to include risk–benefit analysis and levels of knowledge.

Third, **environmental cognition and affect** incorporates emotional and identity-related dimensions—positive/negative affect, environmental concern, pro-environmental identification, and climate change knowledge—recognizing the motivational influence of affective and identity components.

Fourth, **policies, communication, and external support** embody structural and institutional factors, including media exposure, educational initiatives, policy incentives, and organizational atmosphere, which address contextual restrictions and facilitators frequently neglected in the individual-level Theory of Planned Behavior.

Ultimately, **behavior and other individual fators** encompass habitual patterns, interpersonal energy-conservation practices, and cultural or religious influences. These additions collectively demonstrate a transition from a solely rational-choice paradigm to a multifaceted framework that incorporates social, emotional, environmental, and habitual factors influencing students' energy-saving goals.

Collectively, these supplementary factors demonstrate the increasing sophistication of TPB applications in the realm of energy conservation. Their incorporation signifies both theoretical advancement and empirical requirement, as scholars endeavor to modify the Theory of Planned Behavior to address the complex nature of sustainability issues. The variety of extensions, however, prompts issues regarding model comparability and parsimony. Future research must emphasize systematic assessment of these constructs in many contexts, utilize multi-group SEM to examine cultural and institutional differences, and investigate the equilibrium between explanatory thoroughness and theoretical consistency. Consequently, TPB-based models can more efficiently identify the factors influencing energy-saving aspirations among students, so aiding with larger sustainability transitions.

4. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

This study provides a comprehensive bibliometric and conceptual synthesis of research applying the TPB to university students' energy-saving intentions. Drawing on 28 publications from 2014 to 2025, the findings illuminate both the evolution and the methodological as well as thematic directions of this field. Several key conclusions can be drawn.

The bibliometric analysis revealed the following main findings:

First, the bibliometric overview underscores the collaborative and journal-centered nature of the research landscape. With an average of 3.56 co-authors per article and only a small fraction of single-authored contributions, scholarship in this domain is characterized by co-production of knowledge, reflecting the interdisciplinary nature of sustainability science. The predominance of journal articles also points to the importance of peer-reviewed outlets in consolidating evidence, while the complementary role of conference proceedings highlights their function as platforms for exploratory debate and the dissemination of emergent findings.

Second, geographical mapping reveals a marked concentration of research in Asia, particularly China, with comparatively fewer contributions from Western or African contexts. While this reflects regional policy priorities and research capacities, it also exposes a critical imbalance that constrains cross-cultural generalizability. Expanding empirical evidence to underrepresented regions remains imperative if TPB-based models are to serve as a global framework for understanding student energy-saving intentions. Future studies should also embrace multi-country and comparative designs to capture cultural heterogeneity and institutional variation.

Third, co-keyword network analysis demonstrates that TPB constitutes the intellectual core of the field, anchoring empirical investigations into student behavior, methodological approaches, and contextual influences. The centrality of constructs such as "energy-saving behavior," "SEM," and "students" reflects the dominance of structural equation modeling and the sustained interest in latent constructs. At the same time, peripheral clusters relating to dormitory contexts, organizational climate, or global warming awareness reveal promising avenues for diversification, including integration with environmental psychology, organizational behavior, and climate communication. The observed temporal shift toward institutional and contextual factors further suggests that TPB applications are evolving beyond individual-level explanations, moving toward multilevel and systemic perspectives.

Based on the content analysis of prior studies, the following conclusions synthesize key findings, including:

Evidence across 28 studies indicates that attitude (ATT) and perceived behavioral control (PBC) generally exert strong positive influences on energy-saving intention (ESI), while the role of subjective norms (SN) is less consistent and often weaker. Contextual differences, such as on-campus versus off-campus settings, gender-specific findings, and the degree of individual control over energy use, explain much of the variation. In particular, students in shared or dormitory environments often experience limited perceived control, reducing the predictive power of PBC even when intentions are present.

At the same time, a clear theoretical evolution emerges. Researchers increasingly expand TPB by integrating normative and moral frameworks (e.g., Norm Activation Model, Social Obligation–Based Cognition), habitual and contextual

influences (e.g., Comprehensive Action Determination Model), and affective or value-based drivers (e.g., environmental concern, pro-environmental identity). Models combining TPB with self-efficacy, long-term future orientation, and situational cues demonstrate stronger explanatory power and practical relevance. These findings suggest that while TPB remains a valuable starting point, hybrid models that integrate moral obligation, affective responses, contextual constraints, and habitual patterns better capture students' complex decision-making. Such enriched frameworks can inform targeted interventions and policy designs in higher education to foster meaningful, sustained energy conservation behaviors

The methodological study reveals a predominant dependence on SEM techniques, which have enabled thorough evaluation of measurement and structural models. SEM's preeminence underscores its appropriateness, although the sparse utilization of supplementary techniques—such as hierarchical models, ordered probit regression, or linear regression—reveals a methodological focus that may limit analytical diversity. Methodological diversification, incorporating mixed-method designs and longitudinal modeling, would improve explanatory robustness and enable researchers to capture temporal dynamics and contextual variability.

Finally, the incorporation of additional variables into TPB frameworks reflects both theoretical innovation and empirical necessity. Beyond the core TPB constructs, researchers have systematically incorporated variables reflecting (1) social norms and social influence, (2) personal cognition and perceived control, (3) environmental cognition and affect, (4) policies, communication, and external support, and (5) behavior and other individual factors. These additions move the TPB framework beyond a purely rational–cognitive model by acknowledging the roles of moral obligation, value assessment, affective responses, institutional context, and habitual practices. Such multidimensional extensions improve the predictive power of TPB, offering a more comprehensive understanding of students' energy-saving decision-making in real-world academic settings. This richer conceptualization provides a robust foundation for future research and targeted interventions, enabling universities and policymakers to design more effective sustainability strategies that address not only attitudes and perceived control but also social dynamics, emotional drivers, contextual enablers, and ingrained behavioral patterns.

Taken together, the evidence suggests that TPB remains a robust and versatile framework for investigating university students' energy-saving intentions. However, its future utility will depend on broadening geographical coverage, diversifying methodologies, and integrating contextual, psychological, and systemic variables without compromising theoretical clarity. By advancing along these lines, TPB-based research can generate deeper insights into the drivers of sustainable behavior among students and contribute more effectively to global sustainability transitions in higher education and beyond.

RESEARCH LIMITATIONS

Restricting the literature search solely to the Scopus database may have excluded high-quality studies on this topic indexed in other academic sources. Moreover, focusing exclusively on university students may limit the generalizability of the findings. Therefore, future research should expand literature retrieval to other reputable academic databases and include broader population groups to achieve a more comprehensive understanding of energy-saving behavioral intentions.

5. ACKNOWLEDGMENTS

This research is funded by Hanoi University of Science and Technology (HUST) under project number T2024-PC-085.

6. 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 (nếu có)

Ajzen, Icek. (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

Akitsu, Y., & Ishihara, K. N. (2019). Energy Literacy Assessment: A Comparative Study of Lower Secondary School Students in Thailand and Japan. *International Journal of Educational Methodology*, *volume-5-2*(volume-5-issue-2-may-2019), 183–201. https://doi.org/10.12973/ijem.5.2.183

Aktamis, H. (2011). Determining energy saving behavior and energy awareness of secondary school students according to socio-demographic characteristics. *Educational Research and Reviews*, *6*(3), 243–250.

Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative Science Studies*, *1*(1), 377–386. https://doi.org/10.1162/qss_a_00019

Chen, X., & Gou, Z. (2022). Bridging the knowledge gap between energy-saving intentions and behaviours of young

people in residential buildings. *Journal of Building Engineering*, *57*(May), 104932. https://doi.org/10.1016/j.jobe.2022.104932

Chen, Z., & Liu, Y. (2020). The Effects of Leadership and Reward Policy on Employees' Electricity Saving Behaviors: An Empirical Study in China. *International Journal of Environmental Research and Public Health*, *17*(6), 2019. https://doi.org/10.3390/ijerph17062019

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Du, J., & Pan, W. (2021). Examining energy saving behaviors in student dormitories using an expanded theory of planned behavior. *Habitat International*, *107*, 102308. https://doi.org/10.1016/j.habitatint.2020.102308

Du, J., & Pan, W. (2022). Gender differences in reasoning energy-saving behaviors of university students. *Energy and Buildings*, *275*, 112458. https://doi.org/10.1016/j.enbuild.2022.112458

Duong, C. D. (2024). Using a unified model of TPB, NAM and SOBC to understand students' energy-saving behaviors: moderation role of group-level factors and media publicity. *International Journal of Energy Sector Management*, *18*(1), 71–93. https://doi.org/10.1108/IJESM-09-2022-0017

Hallinger, P., & Kovačević, J. (2019). A Bibliometric Review of Research on Educational Administration: Science Mapping the Literature, 1960 to 2018. *Review of Educational Research*, *89*(3), 335–369. https://doi.org/10.3102/0034654319830380

Heib, S., Kortsch, T., & Hildebrand, J. (2024). A question of norms and control—factors shaping sustainable energy behavior: a study among various university stakeholders. *Gruppe. Interaktion. Organisation. Zeitschrift Für Angewandte Organisationspsychologie (GIO)*, *55*(2), 141–156. https://doi.org/10.1007/s11612-024-00744-6

Krippendorff, K. (2018). *Content Analysis An Introduction to Its Methodology* (Fourth edi).

Kwakwa, P. A., Alhassan, H., Aboagye, S., & Asale, M. A. (2024). Electricity conservation intention among university students in northern Ghana: An assessment of the drivers for some electrical appliances. In *Cleaner and Responsible Consumption* (Vol. 12). https://doi.org/10.1016/j.clrc.2024.100171

Le, T., Nguyen, H. T., Dung, T., & Ngoc, L. (2025). *Global Scholars ' Interest In Energy Demand And Sustainable Development Goals : A Bibliometric Analysis From The Scopus Database For The Period 1997 To 2024* (Issue Icech 2024). Atlantis Press International BV. https://doi.org/10.2991/978-94-6463-694-9

Le, Toan-Vu, Pham, H.-H., & Tran, V. B. (2022). A Bibliometric Analysis of Studies on 'Start-up Success' Covering the Period 1981-2019. *Journal of Scientometric Research*, *11*(2), 212–225. https://doi.org/10.5530/jscires.11.2.23

Le, TOAN-Vu, & Tran, B.-V. (2021). *Studies on Startup Success in Southeast Asia: a Bibliometrics Analysis with Scopus Dataset Between 2001-2020*. https://doi.org/10.2991/aebmr.k.211119.031

Lee, J. W. C., & Tanusia, A. (2016). Energy conservation behavioural intention: Attitudes, subjective norm and self-efficacy. *IOP Conference Series: Earth and Environmental Science*, *40*(1). https://doi.org/10.1088/1755-1315/40/1/012087

Lee, L.-S., Lee, Y.-F., Altschuld, J. W., & Pan, Y.-J. (2015). Energy literacy: Evaluating knowledge, affect, and behavior of students in Taiwan. *Energy Policy*, *76*, 98–106. https://doi.org/10.1016/j.enpol.2014.11.012

Lim, W. M., & Kumar, S. (2024). Guidelines for interpreting the results of bibliometric analysis: A sensemaking approach. *Global Business and Organizational Excellence*, *43*(2), 17–26. https://doi.org/10.1002/joe.22229

Liu, X., Yang, Y., Guo, L., Liao, L., & Xiao, L. (2023). Research on the factors influencing college students' energy-use behavior in dormitories: group-level factors and time factors. *International Journal of Low-Carbon Technologies*, *18*(July), 836–849. https://doi.org/10.1093/ijlct/ctad071

Nguyen, N. D., Tuyen, N. T., & Le Toan, V. (2023). *Digital Collaboration in Supply Chain: A Bibliometric Analysis from 2000 to 2022* (pp. 555–564). https://doi.org/10.2991/978-94-6463-348-1_43

Puiu, S., Yilmaz, S. E., Udriștioiu, M. T., Raganova, J., Raykova, Z., Yildizhan, H., & Ameen, A. (2025). The expanded theory of planned behavior for energy saving among academics in Romania, Bulgaria, Turkey, and Slovakia. In *Scientific Reports* (Vol. 15, Issue 1). https://doi.org/10.1038/s41598-025-86795-1

Sharma, S., & Christopoulos, G. (2021). Caring for you vs. caring for the planet: Empathic concern and emotions associated with energy-saving preferences in Singapore. *Energy Research & Social Science*, *72*, 101879. https://doi.org/10.1016/j.erss.2020.101879

Vuong, Q., Do, M.-T., Pham, T.-V.-A., Do, T.-A., Doan, P.-T., Hoang, A.-D., Ta, T.-H., Le, Q.-A., & Pham, H. (2020). The Status of Educational Sciences in Vietnam: A Bibliometric Analysis From Clarivate Web of Science Database Between 1991 and 2018. *Problems of Education in the 21st Century*, *78*(4), 644–662. https://doi.org/10.33225/pec/20.78.644

Wang, J., Yi, F., Zhong, Z., Qiu, Z., & Yu, B. (2021). Diversity and causality of university students' energy-conservation behavior: Evidence in hot summer and warm winter area of China. *Journal of Cleaner Production*, *326*(October). https://doi.org/10.1016/j.jclepro.2021.129352

Zhang, Y., Wang, Z., & Zhou, G. (2013). Antecedents of employee electricity saving behavior in organizations: An empirical study based on norm activation model. *Energy Policy*, *62*, 1120–1127. https://doi.org/10.1016/j.enpol.2013.07.036