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Pro-environmental behavior and the theory of planned behavior: a state of the art science mapping

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Abstract

Purpose – This science mapping analysis aims to discern current, emerging and future trends of pro-environmental behavior and the theory of planned behavior (TPB).

Design/methodology/approach – Bibliometric analysis through bibliographic coupling and co-word analysis were used to reveal the progress of this phenomenon. Of the 1,120 documents search in Web of Science (WoS) database, 1,031 were used in this analysis after restricting to journal publications and studies after the year 2000.

Findings – The results show that four themes emerged, namely the fundamentals of TPB for pro-environmental behavior, antecedents of pro-environmental behavior, integration of TPB with the norm activation model and value belief theory and studies of pro-environmental behavior in developing countries. Environmental concern, environmental awareness, environmental knowledge and environmental education were the most commonly integrated variables.

Research limitations/implications – This research is unique in the sense that the integration between TPB and other prominent theories of pro-environmental behavior is vital to predict individual pro-environmental behavior and understand the fundamental scientific importance of the domain. The norm activation model has been integrated with TPB in many pro-environmental behaviors. Mainstream media stakeholders should design and implement a plan for strategic communication and awareness campaigns in the community to encourage consumers to engage in many behaviors that lead to environmental sustainability.

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Originality/value – This study presents a science mapping approach to uncover crucial knowledge structure related to pro-environmental behavior and the theory of planned behavior.

Keywords Pro-environmental behavior, Theory of planned behavior, Theory of reasoned action, Web of science, Science mapping

Paper type Research paper

1. Introduction

Human behavior and activities have negatively impacted ecosystems and biodiversity (Batool *et al.*, 2023). Researchers are increasingly studying underlying human behavior to determine what drives their behavior and its impact on the environment. It is important to understand the psychological variables that correlate with environmental degradation. An important theory in the field of social psychology is the theory of planned behavior (TPB), which was developed to understand and explain human behavior. TPB is considered the most widely used theory for understanding individual behavior (Yuriev *et al.*, 2020). Its explanatory power is based on behavior and intention, and its three main predictors-attitude, subjective norm, and perceived behavioral control (PBC)-can capture the implicit explanation of behavior in a given setting. TPB was originally developed from the theory of reasoned action. Individual execution of behavior is a direct function of intention. Subsequently, intention is determined by attitude and subjective norm (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980). Ensuing that, Ajzen (1991) introduced a third predictor of intention, PBC, defined as volitional control over a behavior. Since then, TPB has been revised to include actual control as a moderating variable for intention, such that intentions tend toward behavioral execution when actual control is high (Ajzen, 2020). The theory is the most popular and widely used theory for predicting human behavior (Setiawan *et al.*, 2020). In the context of pro-environmental behaviors, it has been applied to various behaviors such as general pro-environmental behaviors (Alzubaidi *et al.*, 2021), intention to visit green hotels (Han, 2015; Han *et al.*, 2017; Fauzi *et al.*, 2022), e-waste recycling (Aboelmaged, 2021), alcohol consumption (Cooke *et al.*, 2016), food waste reduction (Russell *et al.*, 2017), and other green behaviors: green transportation, green food, recycling, and sustainable energy/material use (Miller *et al.*, 2015).

This study is driven by two fundamental motivations. First, TPB plays a critical role in environmentally friendly and green behaviors. It explores the determinants of pro-environmental behavior and empirically proposes to influence these predictors to improve people's pro-environmental behavior. There are many studies exploring the fundamental of TPB in respective fields, such as tourism and hospitality (Ulker-Demire and Ciftci, 2020), knowledge management (Nguyen *et al.*, 2019; Fauzi *et al.*, 2023a), and food safety (Lin and Roberts, 2020). TPB noted that individual behavior is guided by beliefs about the potential outcome of the behavior and evaluation of past outcomes, leading to positive or negative attitudes toward the behavior (Vesely and Klöckner, 2018). Subsequently, attitudes depend on beliefs about the perceived cost and benefits of engaging in pro-environmental behavior (Gkargkavouzi *et al.*, 2019). Given the fundamental role of TPB in promoting pro-environmental behaviors, it is extremely important to explore the knowledge structure of the theory to further promote these behaviors in today's highly polluted human world. Second, there is a gap in understanding consumers' pro-environmental behavior from a scientific mapping perspective. Nevertheless, other studies minimally examined the field from the perspective of pro-environmental behavior and TPB, except Tian and Liu (2022) examined the research on pro-environmental behavior by summarizing the theoretical advances. The theoretical development mainly includes theories of psychology, including TPB, that explain and shape pro-environmental behavior.

To the authors' knowledge, there are no studies on current, emerging and future trends of pro-environmental behavior and the theory of planned behavior, except for Li *et al.* (2019), who investigated green behavior by mapping the knowledge domain based on technological text

mining and visualization using bibliometric analysis. One hotspot discovered in this green behavior is the focus on TPB as the underlying theory to explain this behavior. However, the study focused only on green behavior without referring primarily to TPB. In another study, Si *et al.* (2019) conducted a performance analysis based on impact metrics through a bibliometric analysis. However, the study did not conduct a scientific review of current and future trends in this area and did not search for pro-environmental behavior and related terms, but only for the topic area of environmental science in the Web of Science (WoS) database. Yuriev *et al.* (2020) presented a scoping review paper on pro-environmental behavior based on TPB and discovered that studies are lacking in evaluating indirect variables of beliefs. From a theoretical perspective, Han (2021) discovered that common theories in pro-environmental behavior studies in tourism and hospitality are the theory of reasoned action, planned behavior, norm-activation theory, value-belief-norm theory and goal-directed behavior. Another study by Fauzi *et al.* (2023b) examines how pro-environmental behavior studies are implemented in the tourism and hospitality industries. This discussion demonstrates that science mapping analysis is lacking. As a result, the following research objectives were proposed:

(1) To evaluate the current and emerging trends of pro-environmental behavior and the theory of planned behavior, and

(2) To determine and predict future trends of the theory of planned behavior in pro-environmental behavior.

2. Methodology

2.1 Science mapping approach

The approach is a quantitative method that analyzes bibliographic databases such as WoS, Scopus, Dimension, and PubMed using a science mapping technique (Donthu *et al.*, 2021). The analysis aims to represent a research field by structuring the research field (publications, journals, authors, words, institutions, and countries) into groups to capture their classification based on a visual representation (Zupic and Čater, 2015). This approach became popular with the advent of popular bibliometric tools such as Biblioshiny, VOSviewer, and SciMAT (Moral-Muñoz *et al.*, 2020). The method has proven to be a novel approach to study the evolution of a field over time from a multidisciplinary perspective (Tandon *et al.*, 2021). It has enabled understanding the tacit knowledge of a field by mapping past studies based on influential work and suggesting future research directions (Donthu *et al.*, 2021). It has been used in various fields, including marketing (Krishen *et al.*, 2021), entrepreneurship (Maseda *et al.*, 2022), construction management (Araujo *et al.*, 2020), knowledge management (Bernatović *et al.*, 2022; Fauzi, 2023), and in the recent topics of blockchain technology (Rejeb *et al.*, 2021) and the metaverse (Wider *et al.*, 2023). Consistent with the objective, this study performs bibliographic coupling and co-word analysis to capture current and emerging trends and predict future research trends.

2.2 Research design and data collection procedure

This study used the search string presented in Table 1 to identify publications based on relevant keywords. The keywords refer to TPB and its predecessor TRA. In the context of pro-environmental behavior, both theories are fundamental to understanding human behavior in different contexts. Another keyword is pro-environmental behavior and intention with related concepts. Data were captured from the WoS core collection, which is considered the highest quality and most reliable database in the world with more than 21,100 journals indexed (González-Serrano *et al.*, 2020). Specifically, the "TS" search option was used, which means that the keywords were recorded in the title, abstract, and keywords in the thematic

search. There is no restriction in terms of subject area, as pro-environmental behavior can be found in multiple domains, which can occur in multiple domains.

3. Findings and discussion

The search in WoS database was conducted on June 12, 2023. Originally, 1,120 documents were found. After restricting to journal publications and studies before 2000, the total number of documents was finally 1,031. The total number of citations was 37,112 and 31,854 (excluding self-citations). The average number of citations per article is 36, with an H-index of 97. Figure 1 shows the number of publications and citations on this topic. The pattern shows an increasing trend, indicating that researchers are aware of the importance of TPB in understanding people's pro-environmental behavior in different contexts. It is expected that the number of studies will increase in the coming years, which will contribute to a fundamental understanding of human behavior.

3.1 Bibliographic coupling

Bibliographic coupling analyzes the total linkage strength (TLS) between linked documents, which reflects the relationship of the citing document. Of the 1,031 documents, 56 met a threshold of 135 citations. The threshold was set after several experiments with the dataset to obtain the most robust and appropriate clusters in the network visualization. In this analysis,

Table 1. Search string in WoS database

No.	Keywords	Justification
1	"planned behav*r" OR "reason* action" OR "TPB" OR "TRA"	To identify literature related to the theory of planned behavior
2	"pro-environment* behav*r" OR "green behav*r*" OR "sustainab* behav*r*" OR "eco behav*r*" OR "green attitude*" OR "sustainab* attitude*" OR "eco attitude*" OR "pro-environment* attitude*" OR "green intention*" OR "sustainab* intention*" OR "eco intention*" OR "pro-environment* intention*"	To identify literature related to green and pro-environmental behavior

Source(s): Authors' own creation/own work

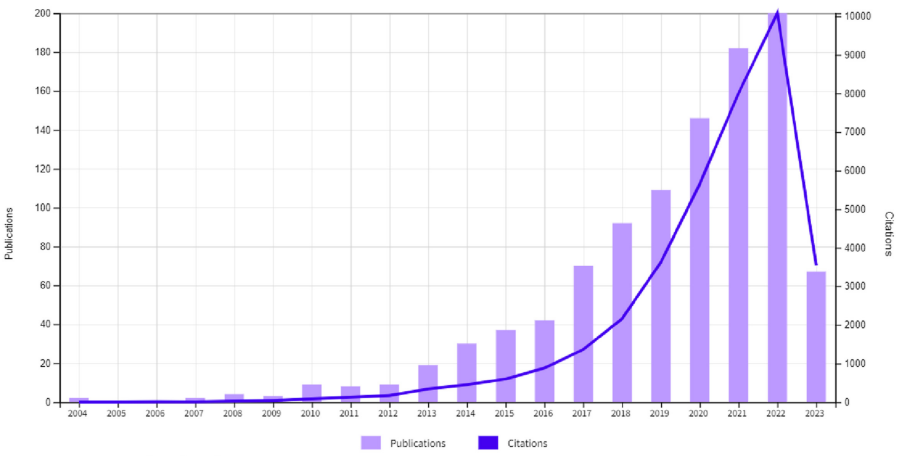


Figure 1. Number of publications and citations on green behavior and TPB

Source(s): Web of Science

the threshold was determined by experimenting with several cutoff values between 130 and 140. The threshold value should be chosen so that it does not undermine the credibility of the network map. For example, a higher cutoff value would lead to over-filtering, increasing the likelihood of missing important clusters and topics, while a lower cutoff value would lead to under-filtering, resulting in redundant clusters and repetition (Geng *et al.*, 2020). The publications with the highest total link strength (TLS) are Wan *et al.* (2017) (372 TLS), Han (2015) (364 TLS), and Han *et al.* (2017) (361 TLS). Table 2 shows the top ten documents in the bibliographic coupling analysis.

Rank	Publication	Journal	Scope	Citation	Total link strength
1	Wan *et al.* (2017)	*Journal of environmental psychology*	Experiential and instrumental attitudes: Interaction effect of attitude and subjective norm on recycling intention	152	372
2	Han (2015)	*Tourism Management*	Travelers' pro-environmental behavior in a green lodging context	532	364
3	Han *et al.* (2017)	*Journal of Travel and Tourism Marketing*	The value–belief–emotion–norm model: Investigating customers' eco-friendly behavior	139	361
4	Verma *et al.* (2019)	*Journal of Business Research*	Values and ascribed responsibility to predict consumers' attitude and concern towards green hotel visit intention	144	339
5	Van Riper and Kyle (2014)	*Journal of Environmental Psychology*	Understanding the internal processes of behavioral engagement in a national park: A latent variable path analysis of the value-belief-norm theory	167	330
6	Turaga *et al.* (2010)	*Annals of the New York Academy of Sciences*	Pro-environmental behavior: Rational choice meets moral motivation	174	324
7	Blok *et al.* (2015)	*Journal of cleaner production*	Encouraging sustainability in the workplace: A survey on the pro-environmental behavior of university employees	244	289
8	Ertz *et al.* (2016)	*Journal of Business Research*	Exploring pro-environmental behaviors of consumers: An analysis of contextual factors, attitude, and behaviors	222	279
9	Bamberg and Möser (2007)	*Journal of Environmental Psychology*	Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behavior	1,908	277
10	Taufique and Vaithianathan (2018)	*Journal of cleaner production*	A fresh look at understanding Green consumer behavior among young urban Indian consumers through the lens of Theory of Planned Behavior	198	265

Source(s): Authors' own creation/own work

Table 2. Top 10 documents in bibliographic coupling analysis

Figure 2 shows the network visualization of the bibliographic coupling, which produced four clusters that are visibly independent of each other based on emerging and future trends of pro-environmental behavior and TPB. The labeling of the clusters is based on an inductive interpretation by evaluating representative articles in the clusters and a synthesis based on common themes and research streams.

(1) Cluster 1 (red): With 24 publications, cluster 1 labeled "*Fundamental of TPB in pro-environmental behavior*". TPB is adopted in many pro-environmental behaviors. This shows it is widely accepted in most environmental behavior, such as recycling, buying green products, and many instances of pro-environmental behavior. For instance, Greaves *et al.* (2013) explore environmental behavior intention within the workplace. TPB variables explained 46 and 61% of the variance in environmental intention and behavior, respectively. In a recycling study, Botetzagias *et al.* (2015) discovered that PBC is the most important recycling intention predictor, while subjective norm and attitude had a significant influence. Donald *et al.* (2014) studied an extended TPB on commuters' use of public transport to commute to work. The TPB variables indirectly impact transport mode through the effect of intention and habit. Russell *et al.* (2017) studied food waste behavior by integrating TPB with the theory of interpersonal behavior and a comprehensive model of environmental behavior. The study discovered that emotion and habits significantly influenced intention and behavior in predicting individual food waste.

(2) Cluster 2 (green): With 11 publications, cluster 2 labeled as "*Antecedents of pro-environmental behavior*". Blok *et al.* (2015) discovered that TPB strongly influences pro-environmental workplace behavior. The study suggests clear differences between factors in households and the workplace. Ertz *et al.* (2016) studied pro-environmental behavior as a multi-dimensional construct by including both the public and private spheres of the behavior. The study examines specific variables of interest to modulate the increment of pro-environmental behavior. Miller *et al.* (2015) studied four categories of pro-environmental behaviors in tourism: green transport use, green food consumption, recycling and sustainable energy/material use. The study also explores five antecedents to

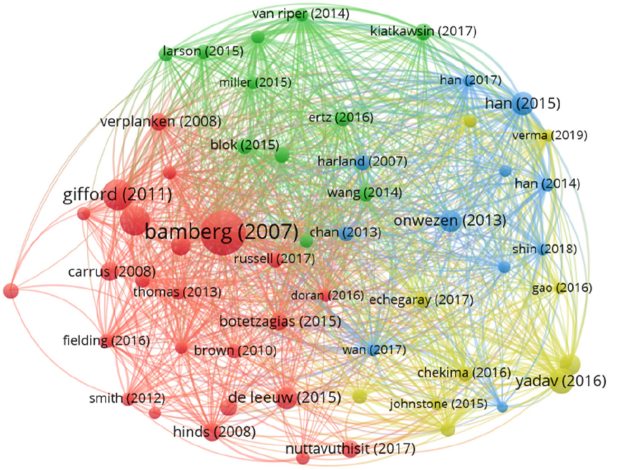


Figure 2.
Bibliographic coupling of pro-environmental behavior and TPB

Source(s): Authors' own creation/own work

the four categories: environmental attitudes, availability of facilities, habitual behaviors, a need to take a break from environmental duties and tourist social responsibility.

(3) Cluster 3 (blue): With 11 keywords, this cluster is labeled "*Integration of TPB with Norm activation model and value-belief norm theory*". The two theories were found to be heavily adapted to TPB in pro-environmental studies. Han (2015) discovered that the unified model of TPB and value-belief-norm theory lead to satisfactory predictive power for pro-environmental intention among travelers toward green lodging. In a fine particulate matter (PM2.5) reduction study, Shi *et al.* (2017) found that all the TPB was significant except for the subjective norm. There was a moderating effect between perceived behavioral control and household moral norm towards PM2.5 reduction intention. In a household waste sorting behavior study, Zhang *et al.* (2019) discovered that the relationship between intention and behavior is weakened after including the influencing path from factors of facilities accessibility and government stimulus of waste sorting. In addition, personal norms were found as the major factor, while subjective norms and PBC were unexpectedly found to have no impact on intention.

(4) Cluster 4 (yellow): With 10 publications, cluster 4 labeled "*Pro-environment behavior studies in developing countries*". This cluster was found to focus on pro-environmental behavior in developing countries. In a study in Brazil, Echegaray and Hansstein (2017) discovered that most respondents developed positive intentions towards recycling electronic appliances. Yadav and Pathak (2017) integrated TPB with a willingness to pay a premium and perceived value on consumer green purchase intention and behavior in India. TPB was found to influence consumers' intention to buy green products. Taufique and Vaithianathan (2018) studied consumers' green behavior among young urban Indians. The study discovered that attitude and perceived consumer effectiveness, in replacement of PBC, predict green behavior, but the subjective norm was insignificant toward intention to engage in green behavior.

Based on the aforesaid discussion, Table 3 summarizes the bibliographic coupling analysis on pro-environmental behavior and TPB.

3.2 Co-word analysis

Table 4 shows the top 15 keywords from the co-word analysis, of which 38 of 4,026 keywords meet 52 thresholds, resulting in four clusters. The most frequently occurring keywords are

Cluster number and color	Cluster label	Number of publications	Representative publication
1 (red)	Fundamental of TPB in pro-environmental behavior	24	Greaves *et al.* (2013), Botetzagias *et al.* (2015), Donald *et al.* (2014), Russell *et al.* (2017)
2 (green)	Antecedents of pro-environmental behavior	11	Blok *et al.* (2015), Ertz *et al.* (2016), Miller *et al.* (2015)
3 (blue)	Integration of TPB with norm activation model and value-belief norm theory	11	Han (2015), Shi *et al.* (2017), Zhang *et al.* (2019)
4 (yellow)	Pro-environment behavior studies in developing countries	10	Echegaray and Hansstein (2017), Yadav and Pathak (2017), Taufique and Vaithianathan (2018)

Source(s): Authors' own creation/own work

Table 3. Bibliographic coupling analysis on pro-environmental behavior and TPB

Rank	Keyword	Occurrences	Total link strength
1	Planned behavior	786	3,054
2	Pro-environmental behavior	548	2,329
3	Attitudes	287	1,306
4	Determinants	234	1,126
5	Model	197	899
6	Theory of planned behavior	187	852
7	Intentions	171	772
8	Values	161	777
9	Intention	138	633
10	Consumption	130	619
11	Sustainability	110	484
12	Knowledge	101	480
13	Attitude	93	434
14	Green	93	429
15	Conservation	84	376

Table 4.
Top 15 keywords in the co-occurrence of keywords analysis

Source(s): Authors' own creation/own work

"planned behavior" (786 occurrences), "pro-environmental behavior" (548 total link strength), and "attitudes" (287 occurrences). The threshold was set between 50 and 55 after several trials until a robust and suitable clustering network was generated.

The four clusters represent four different themes (Figure 3). The clusters are given the appropriate labels according to the author's inductive interpretation. The following clusters are elaborated and discussed:

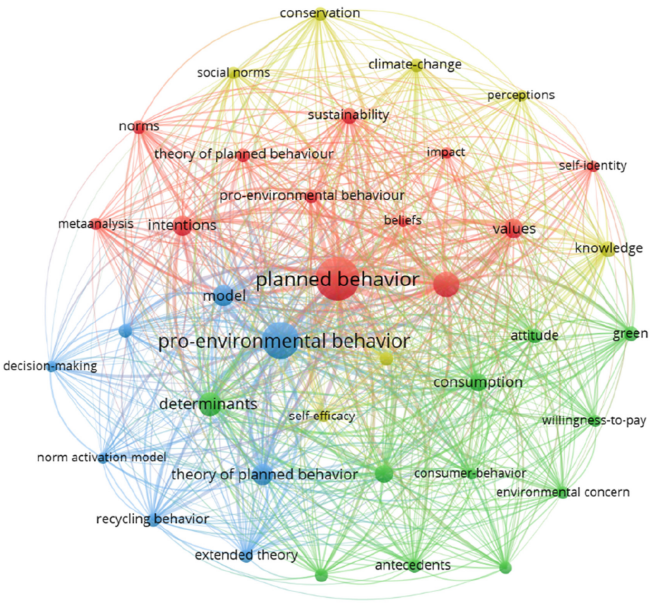


Figure 3.
Co-word analysis on pro-environmental behavior and TPB

Source(s): Authors' own creation/own work

(1) Cluster 1 (red): With 12 keywords, cluster 1 is labeled "*Cultivating Sustainable Values for Positive Environmental Impact*". Graves and Sarkis (2018) stated that environmental attitudes and values contribute to green practices implementation for sustainable development. Understanding sustainable consumer behavior is central to solving environmental problems and transforming society's imparting paradigm shifts (Trudel, 2019). Pro-environmental behavior is a catalyst that can bolster the firm environmental performance through green intellectual capital and top management commitment (Wei *et al.*, 2023). Sustainable values are stronger predicted by certain types of leadership, such as environmental-specific transformational leadership in organizational processes to achieve sustainable performance (Shoaib *et al.*, 2022). These crucial antecedents should be enhanced and cultivated to induce pro-environmental behavior for positive environmental impact.

(2) Cluster 2 (green): This cluster is formed by 11 keywords labeled "*Theory of Planned Behavior in Consumer Decision-Making*". TPB was long adapted as a theory to explain decision-making behavior. TPB was considered an appropriate theory for the organization's green management decision-making (Arslan and Şar, 2018; Sung *et al.*, 2021). The TPB comprises a crucial component of rational choice to explain one decision-making process, together with volitional factors. Most green behavior involves monetary commitment, where explaining these behaviors is complex due to multiple factors that influence decision-making (Varah *et al.*, 2021). Among these variables, willingness to pay a premium and environmental concern are the most crucial consumer green product purchase predictors (Cheng *et al.*, 2022), including energy-saving behavior (Qalati *et al.*, 2022), visiting green hotels (Fauzi *et al.*, 2022) and using renewable energy (Nketiah *et al.*, 2022).

(3) Cluster 3 (blue): With 8 keywords, this cluster is labeled "*Extension and integration of TPB*". There has been a plethora of evidence where TPB has been adopted in model extension and integration. This cluster primarily centered on how TPB is extended and integrated with other theoretical foundations, primarily the norm activation model and value-belief-norm theory. Researchers extend TPB by adding new variables to increase the explained variance in behavioral intention (Wan *et al.*, 2021). Further, Badsar *et al.* (2022) discovered that through the integration of TPB and self-motivation theory, the variables of attitude, PBC and subjective norm were able to predict a higher variance of intention and behaviors. Through the integration of TPB and social capital theory, Liu *et al.* (2022) discovered that all the TPB variables lead to recycling intention, while environmental concern and social capital influence a community's recycling intention through subjective norms and attitudes.

(4) Cluster 4 (yellow): This cluster is formed with 7 keywords, labeled "*Climate Change Knowledge for Effective Conservation Management*". Individuals with knowledge of climate change are the ones who accept that climate change is happening (Zerva *et al.*, 2018; Sammie *et al.*, 2021; Tan *et al.*, 2023; Arabatzis and Malesios, 2013). This knowledge would subsequently lead to pro-environmental behavior. It has been discovered that possessing the nature knowledge, causes, and impacts of climate change would have a significant subjective impression on the risks climate change poses (Xie *et al.*, 2019). Climate change knowledge underlies the perspective of an individual's risk perception that leads to enhanced psychological adaptation and response efficacy related to climate change, ultimately toward pro-environmental behavior (Bradley *et al.*, 2020).

Table 5 summarizes the co-word analysis on pro-environmental behavior and TPB based on the aforementioned discussion.

Table 5. Summary of co-word analysis on pro-environmental behavior and TPB

Cluster number and color	Cluster label	Number of keywords	Representative keywords
1 (red)	Cultivating Sustainable Values for Positive Environmental Impact	12	Planned behavior, attitudes, pro-environmental behavior, intentions, values
2 (green)	Theory of Planned Behavior in Consumer Decision-Making	11	Consumption, willingness-to-pay, environmental concern, consumers
3 (blue)	Extension and integration of TPB	8	Theory of planned behavior, norm activation model, recycling behavior, extended theory, personal norms, model
4 (yellow)	Climate Change Knowledge for Effective Conservation Management	7	Conservation, climate-change, knowledge, management, perceptions

Source(s): Authors' own creation/own work

4. Implications of the study

4.1 Theoretical implications

The theoretical implications are multi-fold based on the integral structure of TPB. The integration between TPB and other prominent theories of pro-environmental behavior is vital to predict individual pro-environmental behavior and understand the fundamental scientific importance of the topic (Sulaiman *et al.*, 2022). Basic theories such as the norm activation model (Schwartz, 1977), the value-belief-norm theory (Stern *et al.*, 1999), the theory of interpersonal behavior (TIB) (Triandis, 1979), the theory of protective motivation (Rogers, 1983), and the technology acceptance model (TAM) (Davis, 1989) serve as fundamental explanations for pro-environmental behavior. This Science mapping analysis discovered that the norm activation model has been integrated with TPB in many pro-environmental behaviors (Shi *et al.*, 2017; Zhang *et al.*, 2019). In a later study, Setiawan *et al.* (2020) adapted TPB with norm activation theory to estimate pro-environmental behavior in a waste separation context that incorporates social pressure as a moral obligation, while Fauzi *et al.* (2022) integrated TPB with VBN to predict tourists' intention to visit green hotels. These theories have provided crucial perspective on understanding the predictors of individuals' pro-environmental behavior. It has provided different perspective with regard to different context and situation. For instance, Yuriev *et al.* (2020) asserted that pro-environmental behavior can difference for individual at work and home. Pro-environmental behavior at work is fostered by certain values such as management support, internal culture, peers' attitude and organizational value. The findings correlate with other reviews on pro-environmental behavior (Grilli and Curtis, 2021; Lange and Dewitte, 2019).

In addition, several studies have extended the original TPB model with other variables to improve the prediction of pro-environmental behavior (Alzubaidi *et al.*, 2021; Chwialkowska *et al.*, 2020; Harun *et al.*, 2022; Si *et al.*, 2019). Chwialkowska *et al.* (2020) have considered environmental awareness in their study of pro-environmental behaviors in different cultures. Harun *et al.* (2022) extended the TPB model to include environmental factors and energy-efficient behavior to understand the role of different environmental factors and generic energy-efficient behavior on intention and behavior to purchase energy-efficient appliances. Alzubaidi *et al.* (2021) extended the TPB model to include materialism and innovativeness to understand the influence of early adopters and confirm the influence of values on consumer purchase intention and green behavior, respectively. Overall, the most commonly integrated variables are environmental concern, environmental awareness, environmental knowledge, and environmental education. According to Ajzen (2020), the TPB is open in principle to the inclusion of other predictors to increase its predictive power, but researchers should be

cautious in including these variables in the original TPB for reasons of parsimony. One of the most important criteria is that the proposed variable can be defined and measured in the context, action, goal, and time frame in which the behavior was defined.

4.2 Managerial implications

Mainstream media stakeholders should design and implement a plan for strategic communication and awareness campaigns in the community to encourage them to engage in many behaviors that lead to environmental sustainability. They play an important role in conveying the crucial message about the role of consumers in pro-environmental behaviors. Liu and Li (2021) emphasized that the media play a crucial role in environmental communication through personal norms as intrinsic and subjective norms as external factors. In today's environmental context, Lima *et al.* (2023) suggested that green advertising combines the cognitive process through persuasive messages and the value-belief norm of environmental protection to raise awareness and promote sustainable behaviors. Green advertising helps to explicitly or implicitly promote environmental awareness by suggesting behaviors that help minimize environmental problems. It is associated with commercial, for-profit, or nonprofit businesses where effective green marketing content and strategies promote more pro-environmental behaviors by appealing to individual values related to nature (Fowler III and Close, 2012; Peterson *et al.*, 2021).

Social media should be used to create socially responsible consumers who are aware and vigilant about environmental issues and their harmful effects. Social media can trigger emotional and cognitive responses and help socially normative information become a moral obligation (Han *et al.*, 2022). It is effective when pro-environmental behavior is easy to achieve and costs little money. Exploring social media in the context of pro-environmental intentions and behaviors is critical because it serves as a means of constructing one's identity to present an expanded self (Wallace and Buil, 2023). Although posting about climate change on social media is not necessarily related to their offline pro-environmental behaviors, social media provides a platform for communicating environmental issues. Previous studies suggest that social media plays a critical role in promoting pro-environmental behaviors such as recycling (de Fano *et al.*, 2022), green shopping behaviors (Zafar *et al.*, 2021), and food waste prevention (Jenkins *et al.*, 2022).

Government agencies and environmental non-governmental organizations (NGOs) should use social media influencers to engage the public on environmental issues as an innovative marketing strategy (Makijenko *et al.*, 2016). These influencers have been shown to elicit pro-environmental behavior, especially among younger generations (Dekoninck and Schmuck, 2022). Since they are one of the most influential consumer groups, the use of social media influencers would enable better consumer engagement. Studies have documented the effectiveness of social media influencers on consumer attitudes and behaviors (Hudders *et al.*, 2021). In addition, Boerman *et al.* (2022) introduce greenfluencers to promote consumers' green behavior on social media. Greenfluencers raise awareness of environmental issues related to climate change and environmental degradation caused by human activities (Dekoninck and Schmuck, 2022). Stakeholders and government agencies could use the influence of greenfluencers to spread messages about the critical impacts of pro-environmental behavior.

5. Limitations of the study

This systematic review has some limitations that provide directions for future research. One relates to TPB, as a theory can only measure one behavior at a time (Yuriev *et al.*, 2020). Since there are many pro-environmental behaviors, such as purchasing environmentally friendly products, recycling behaviors, reducing food waste, and others, these behaviors cannot be measured simultaneously. Many studies evaluate pro-environmental behaviors in isolation, resulting in theoretical impacts based on a specific behavior. In addition, TPB studies use self-

reported measures of actual behavior, leading to biased responses (de Leeuw *et al.*, 2015). Because pro-environmental behavior is individualistic, researchers have been unable to measure behavior using multilevel models that account for the study's contextual relationships, interactions, and interdependencies at different levels of analysis (Huo *et al.*, 2016). Studies on pro-environmental behaviors could not be derived from multilevel modeling, which could exclude model bias when observing data in a nested model structure (Fauzi, 2022).

6. Future research avenues

Future studies are recommended to integrate TPB with other known behavioral and social psychological theories to better explain pro-environmental behavior, apart from NAM and VBN. Additionally, future studies should incorporate the emotional and irrational aspects of consumer behavior as TPB is not able to predict human emotions, which complicates the detailed understanding of pro-environmental behavior. One of the theories is the stimulus-organism response (SOR) model, which incorporates emotions into the measurement of human behavior. Environmental stimuli can elicit emotional states in humans that trigger certain responses or approaches to pro-environmental behaviors. Information about environmental conditions and identification of environmental terms (stimulus) can influence environmental (organism) trust, which ultimately leads individuals to take sustainable actions (response). Indeed, more studies on the application of TPB in specific industries could lead to a significant knowledge gap. People behave differently depending on the industry, as the people-centeredness of the industry influences their pro-environmental behaviors. Assessing industry-specific behaviors will reveal underlying factors and provide measures for intervention and mitigation strategies to overcome challenges and barriers to pro-environmental behaviors. Further research is also needed on the different categories of pro-environmental behavior, as they have different characteristics and properties depending on the context of pro-environmental behavior.

7. Conclusion

This study has provided a critical foundation for the application of TPB to pro-environmental behavior and examined its knowledge structure. Through bibliographic coupling and co-word analysis, this study discovered four themes that correspond to emerging trends and future predictions for the application of TPB in studies of pro-environmental behavior, such as the integration of several theories and the extension of TPB, as well as the communication of pro-environmental behavior to the community and the public. The finding of this study complements past reviews of pro-environmental behavior and TPB (Yuriev *et al.*, 2020) by presenting a deep analysis of the knowledge structure by presenting the topological and temporal network of the phenomenon based on empirically scientific findings and discoveries of past studies. In intervening with pro-environmental behavior, Grilli and Curtis (2021) have suggested that behavioral changes are crucial in determining the success of environmental mitigation activities. It involves treatment control, including social influence, outreach and relationship building, education and awareness, incentives, nudges, and behavioral insights. A deep understanding of the theories would lead to intervention and mitigation strategies to promote pro-environmental behaviors to the public.

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