

Enhancing water conservation behavior: the role of knowledge, attitude and environmental concerns

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Abstract

Purpose – Water resources are fundamental to achieving sustainable development. Households play a critical role in global water conservation efforts, directly supporting the attainment of several Sustainable Development Goals (SDGs). This study expands the knowledge–attitude–behavior (KAB) model to explore how knowledge about water conservation, environmental concern and concern about water scarcity influence residents' attitudes and their water-saving behavior.

Design/methodology/approach – Data were collected through an interviewer-administered survey of 503 respondents in Vietnam and analyzed using covariance-based structural equation modeling.

Findings – The findings reveal that concern about water scarcity significantly shapes attitude and water conservation behavior, whereas general environmental concern has no significant effect. Additionally, knowledge about water conservation positively influences attitude, which drives water-saving behavior. Moreover, the research results provide evidence for the mediating effect of attitude toward water conservation on the relationships between knowledge about water conservation and water conservation behavior, as well as between concern about water scarcity and water conservation behavior.

Originality/value – These results enrich the literature on pro-environmental behavior and water conservation, particularly in emerging markets, and offer practical insights for policymakers, environmental organizations, and utility companies to design targeted communication strategies and campaigns to encourage water conservation.

Keywords Environmental concern, Knowledge, Sustainability, Water conservation behavior, Water scarcity

Paper type Research paper

1. Introduction

Water resources are fundamental to human life and ecosystem health (Li *et al.*, 2023). However, growing populations, climate change and pollution are putting unprecedented pressure on global freshwater resources. Water scarcity can have severe consequences, including water shortages, compromised food security, ecosystem degradation and increased social tensions (Postel *et al.*, 1996). Recognizing these challenges, the United Nations established Sustainable Development Goal 6 (SDG6) (Clean water and sanitation) as one of its 17 SDGs. This goal is interconnected with others including SDG13 (Health and well-being)

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and SDG12 (Responsible consumption and production), reflecting how water access impacts food security, health and poverty alleviation. The forecast for future water accessibility is concerning, as projections indicate that over two billion people risk losing access to fresh water, with at least 25% of the global population facing severe water shortages by 2050 (Singha *et al.*, 2022). To address these challenges, countries have developed two primary approaches: supply-side and demand-side management (Xiong *et al.*, 2015). While supply-side strategies focus on developing new water resources through investment and technology, demand-side approaches aim to reduce consumption. Even when supply-side options do exist, their implementation faces substantial hurdles due to escalating environmental, monetary and regulatory costs (East and Grant, 2023). Demand-side management has gained particular attention for its effectiveness in residential settings, where studies show potential water savings of 30–70% (Lahlou and Colyer, 2000). Household water conservation primarily involves reducing daily water usage (Addo *et al.*, 2018) and curtailment behavior, the consistent effort to save water is a key component of residential conservation strategies (Russell and Fielding, 2010).

The search for determinants of water conservation behavior has gained substantial scholarly attention (Singha *et al.*, 2022; Muenrath and Nguyen, 2023; Addo *et al.*, 2019). However, the literature reveals two notable gaps. First, studies on water conservation behavior in emerging economies remain scarce, despite these regions experiencing the most severe water stress in their urban centers (Kookana *et al.*, 2020). Due to these nations' unique socioeconomic and environmental conditions, water management solutions from developed countries may not be directly transferable because of political, economic and environmental barriers. This highlights the need for context-specific research in emerging markets. For example, water conservation training programs developed in advanced economies and staffed by personnel from developing nations risk being irrelevant to local conditions (Pigram, 2001). Second, previous research on green consumption suggests that individuals respond differently to various environmental concerns (Gökşen *et al.*, 2002). General environmental concern measures may not accurately capture specific concerns (Brechtin and Kempton, 1994), and not all ecological issues influence consumer behavior equally (Tan *et al.*, 2017). Current research on residential water conservation behavior has typically focused on either general environmental concern (Aprile and Fiorillo, 2017) or specific concern about water scarcity (Clark and Finley, 2007). Therefore, studying these two types of environmental concern is crucial for capturing disparities in consumer responses and developing effective strategies to promote water-saving behavior. Furthermore, while existing literature has thoroughly investigated the mediating role of attitude in the relationship between knowledge, environmental concern and water conservation behavior (Duong *et al.*, 2022; Li *et al.*, 2019), there remains insufficient understanding of how attitude toward water conservation mediates the specific relationship between concern about water scarcity and water conservation behavior.

Motivated by the research gaps stated above, this study incorporates general environmental concerns and specific concern about water scarcity into the knowledge–attitude–behavior (KAB) framework to examine their impact on consumers' water conservation attitude and behavior. Additionally, it seeks to explore the mediating mechanism of attitude toward water conservation behavior in the link between knowledge about water conservation, environmental concern, concern about water scarcity and water conservation behavior. The conceptual model is validated using data from Vietnam, an emerging economy, and this research makes several important contributions to sustainable development. First, it addresses the need for more research on water conservation behavior in lower to middle-income countries (Kookana *et al.*, 2020). Second, a key contribution of this study is its distinction between two types of environmental concerns: the first, general environmental concern; and the second, specific concern about a particular environmental issue and its consequences (e.g. concern about water scarcity). This distinction aims to clarify the complex and sometimes inconsistent effects of consumers' environmental concerns on their attitudes and behavior

(McDonald *et al.*, 2015; Rhead *et al.*, 2015; Akehurst *et al.*, 2012). By examining attitudinal mediation in water conservation behavior, this research enhances theoretical understanding of how knowledge, environmental concern and concern about water scarcity shape environmentally-friendly behavior. These insights offer valuable guidance for academic researchers, policymakers and utility companies in developing strategies to enhance a positive attitude toward water conservation and behavior through knowledge and environmental concerns.

This paper is structured in four main sections: the following section presents a comprehensive literature review and develops the hypotheses; the methodology and data collection process are then described; this is followed by an analysis of the findings; and the paper concludes by outlining the theoretical contributions to water conservation literature, providing actionable recommendations for policymakers and practitioners, and identifying avenues for future research.

2. Theoretical background and hypothesis development

2.1 Knowledge–attitude–behavior model

Kollmuss and Agyeman (2002) propose that a widely-recognized framework for understanding pro-environmental behavior is the KAB model. This model suggests that knowledge about environmental issues fosters a positive environmental attitude, which subsequently encourages pro-environmental actions. According to the KAB model, individuals must possess adequate knowledge or be willing to learn about environmental issues before engaging in pro-environmental actions. This capacity for environmental learning and awareness varies significantly across individuals (Thøgersen and Ölander, 2003). The United Nations (UN) adopted the 17 SDGs in 2015 as part of the 2030 agenda for sustainable development, aiming to address pressing global challenges such as poverty, inequality, climate change and environmental degradation. The United Nations Educational, Scientific and Cultural Organization (UNESCO) plays a vital role in advancing these goals, mainly through its emphasis on Education for Sustainable Development, which equips individuals with knowledge, competencies and mindsets needed to address worldwide sustainability issues (Lee *et al.*, 2022). As a result, the KAB model has served as the foundation for numerous environmental behavior studies aimed at raising awareness and promoting sustainable practices (Lee *et al.*, 2022; Nguyen *et al.*, 2017). Empirical works have further validated the suitability of the KAB model in explaining both pro-social and pro-environmental behaviors (Recio-Román *et al.*, 2024; Zhang *et al.*, 2023).

Enhancing public knowledge and awareness of water conservation and management has been key in fostering positive attitudes and behaviors about sustainable water use (Xiong *et al.*, 2015; Addo *et al.*, 2019). Therefore, the KAB model provides a theoretical basis for this study, while the research expands on the model by investigating the direct influence of knowledge on water conservation behavior. To better understand household water conservation, the study examines the extended KAB model with environmental concern and concern about water scarcity, which have been critical in predicting pro-environmental attitudes and behaviors in both developed and developing economies (Nguyen *et al.*, 2019; Li *et al.*, 2019).

2.2 Knowledge about water conservation

Environmental knowledge generally refers to an individual's ability to identify various ecological issues, understand their causes and effects, and recognize behaviors linked to environmental protection (Mostafa, 2007). Knowledge about water conservation, in particular, can be reflected in an individual's awareness of water-related challenges (e.g. water scarcity), water-saving actions and their associated benefits. Research indicates that both subjective knowledge (what individuals believe they know) and objective knowledge (what

they actually know) are crucial in influencing pro-environmental decision-making (Dursun *et al.*, 2019).

The KAB model supports the positive relationship between knowledge and attitude. Typically, individuals with greater environmental knowledge are more inclined to develop positive attitudes toward pro-environmental behavior (Nguyen *et al.*, 2017). Fielding *et al.* (2013) emphasized that equipping individuals with knowledge about water conservation can improve their attitudes and practices related to water-saving. Similarly, Dolnicar *et al.* (2012) found that individuals actively seeking information about water-related issues, such as conservation, tend to engage more in water-saving practices. The discussions above provide a rationale for the following hypotheses:

- H1. Knowledge about water conservation positively influences attitude toward water conservation.
- H2. Knowledge about water conservation positively influences water conservation behavior.

2.3 Environmental concern

Environmental concern plays a crucial role in shaping sustainable attitude and behaviors. According to Dunlap *et al.* (2000), environmental concern encompasses awareness of environmental problems and willingness to contribute to their solutions. These concerns manifest in general environmental and specific issue-focused concern (Fransson and Gärling, 1999). The present study incorporated both types of environmental concerns in a unified model, focusing on general environmental concern and specific concern about water scarcity.

Environmental concern is an essential determinant of attitude and behavior toward green consumption and resource conservation (Li *et al.*, 2019; Nguyen *et al.*, 2019). Research has indicated that individuals with greater environmental concern are more inclined to develop pro-environmental attitude (Trumbo and O'Keefe, 2001) and participate in water conservation efforts (Aprile and Fiorillo, 2017). Willis *et al.* (2011) revealed that households exhibiting greater environmental and water conservation concerns typically achieve lower overall water consumption. Based on these discussions, the following hypothesis is proposed:

- H3. Environmental concern positively influences attitude toward water conservation.
- H4. Environmental concern positively influences water conservation behavior.

2.4 Concern about water scarcity

According to Mekonnen and Hoekstra (2016), approximately four billion people, representing two-thirds of the global population, experience water scarcity for at least one month annually. In developing countries, urban areas face increasing water insecurity due to multiple interconnected challenges, including rapid population growth, limited access to quality water sources, inadequate infrastructure and poor waste management practices (Kookana *et al.*, 2020). Water scarcity has become a critical global challenge, occurring when the water demand across all sectors, including environmental needs, exceeds the available supply or when water quality deteriorates to unusable levels (Liu *et al.*, 2017). The growing strain on freshwater resources serves as a key situational factor driving water conservation efforts. Research demonstrates that heightened awareness of drought impacts can lead to positive water conservation attitude (Brownlee *et al.*, 2014). Residents engage in water conservation activities when they know water is scarce (Addo *et al.*, 2018; Clark and Finley, 2007). Hence, we develop the following hypotheses:

- H5. Concern about water scarcity positively influences attitude toward water conservation.

2.5 Attitude toward water conservation

Attitude represents an individual's psychological tendency to evaluate an object favorably or unfavorably (Eagly and Chaiken, 2007). According to several theoretical frameworks, particularly the well-known theory of planned behavior and KAB, a more positive attitude toward a specific behavior increases the likelihood of performing that behavior (Ajzen, 1991). This relationship between attitude and behavior has been well-documented in consumer research (Nguyen *et al.*, 2019). In the environmental context, attitude refers explicitly to how individuals evaluate environmental protection actions (Taufique *et al.*, 2016). Recent empirical evidence strongly confirms the positive relationship between environmental attitudes and pro-environmental behaviors (Hossain *et al.*, 2022). In accordance with the KAB model, this study posits that attitude toward water conservation behavior will translate into water conservation practices. Prior work by Tong *et al.* (2017) has shown that attitude toward conservation behaviors, including water conservation, strongly predicts household water-saving practices. Consumers who hold positive attitude toward water conservation practices consider saving water to be a beneficial choice. Thus, the hypothesis below is formulated:

H7. Attitude toward water conservation positively influences water conservation behavior.

The conceptual model and hypothesized relationships between variables are synthesized in Figure 1.

2.6 Mediating role of attitude toward water conservation

The KAB model supports the mediating effect of attitude toward water conservation on the relationship between knowledge about water conservation and water conservation behavior. According to this model, consumers' pro-environmental behavior is the outcome of a sequential process moving from acquiring knowledge to forming attitudes and adopting behaviors (Kollmuss and Agyeman, 2002). Studies have demonstrated that environmental knowledge shapes consumers' attitude toward green products (Mostafa, 2009). In a similar vein, Li *et al.* (2019) found that environmental knowledge influences consumers' attitude toward energy-efficient appliances, which in turn affects their purchase intention. Based on these aforementioned discussions, we propose the following hypothesis:

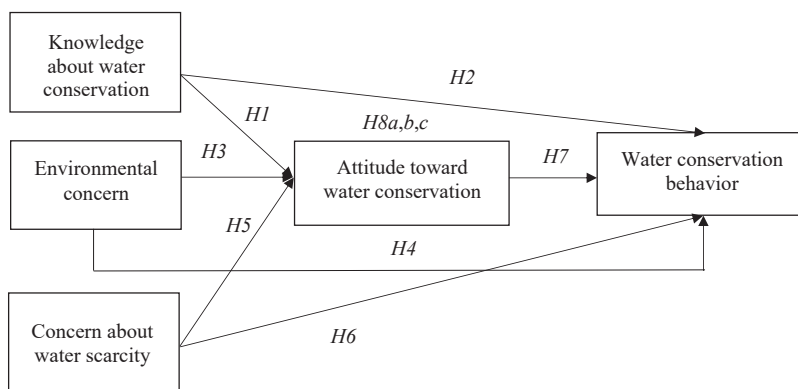


Figure 1. Proposed conceptual framework. **Source:** Authors' compilation

H8a. Attitude toward water conservation positively mediates the relationship between knowledge about water conservation and water conservation behavior.

Previous studies have provided empirical evidence to confirm that attitude toward pro-environmental behavior mediates the relationship between environmental concern typologies and consumers' sustainable consumption behavior. [Duong et al. \(2022\)](#) discovered an internal mechanism where environmental concern activates attitude toward green purchases, which then influences consumers' intention to purchase green products. However, these studies were limited to examining general concerns about ecological conditions. Beyond investigating the direct relationships between environmental concern, concern about water scarcity and consumers' water conservation behavior, this study proposes that attitude toward water conservation mediates the effect of environmental concern and concern about water scarcity on water conservation behavior. Specifically, environmental concern and concern about water scarcity influence attitude toward water conservation, which in turn affects water conservation behavior. Therefore, the following hypotheses are proposed:

H8b. Attitude toward water conservation positively mediates the relationship between environmental concern and water conservation behavior.

H8c. Attitude toward water conservation positively mediates the relationship between concern about water scarcity and water conservation behavior.

3. Research methodology

3.1 Research context

Vietnam was chosen as the research site for this study because of its unique water resource challenges. Located in Southeast Asia, Vietnam is a tropical country with intensive rainfall and a dense river network of 2,360 rivers across eight large river basins ([Ngo et al., 2018](#)). The country's average annual rainfall and river discharge exceed global averages, suggesting abundant water resources ([Harrigan et al., 2020](#)). However, two-thirds of its water resources originate outside the country, making it highly dependent on transboundary water systems. This vulnerability is heightened by prolonged droughts, and the impacts of climate change have exacerbated water stress across the country. Water levels have plummeted in many regions, with the dry season becoming increasingly drier and the rainy season experiencing more intense rainfalls ([Cosslett and Cosslett, 2014](#)). The situation is further complicated by deteriorating water quality and rapidly rising water demand driven by socioeconomic development, population growth and improving living standards ([Pham and Rambo, 2003](#)). Despite the severity of Vietnam's water crisis, research on water conservation behavior in the country remains limited. Current studies have only scratched the surface by examining Vietnamese consumers' general perceptions of conservation behavior, leaving gaps in our understanding of what motivates water conservation. Given the critical food-energy-water security nexus ([Ningi et al., 2021](#)), a comprehension of consumers' water conservation behavior drivers is vital for Vietnam's sustainable development.

3.2 Measures

The survey instrument was developed to assess respondents' knowledge, concerns, attitude and behavior relating to water conservation. As illustrated in [Table 1](#), all measurement items to operationalize the constructs were carefully selected from previously validated scales in existing literature. The original questionnaire was developed in English and then translated into Vietnamese using the back-translation techniques recommended by [Tyupa \(2011\)](#) to ensure translation accuracy. The translation and cross-validation were conducted by a specialized team comprising two linguistic experts and bilingual researchers with expertise in pro-environmental behavior. Following this, a comprehensive pre-test was conducted with

Table 1. Constructs and items

Constructs	Items and sources
Knowledge about water conservation	Nguyen et al. (2017) and Willis et al. (2011) 1. I am knowledgeable about opportunities to save water 2. I am knowledgeable about the environmental benefits of water conservation 3. I am knowledgeable about water conservation practices in household
Environmental concern	Yadav and Pathak (2016) 1. The balance of nature is very delicate and can be easily upset 2. Human beings are severely abusing the environment 3. Humans must maintain the balance with nature in order to survive 4. Human interferences with nature often produce disastrous consequences
Concern about water scarcity	Clark and Finley (2007) 1. I am worried about the water shortage in my area 2. The consequences of water scarcity concern me 3. Water scarcity is my major concern
Attitude toward water conservation	Dolnicar et al. (2012) and Lapinski et al. (2007) 1. I think it is important that we conserve water 2. I think water conservation is necessary because of water scarcity 3. I think reducing water consumption is a good idea 4. I think conserving water reflects civilization and good behavior
Water conservation behavior	Fielding et al. (2016) 1. I make sure that taps do not drip 2. I use minimal water in the kitchen 3. I take shorter showers 4. I use half flush or minimize toilet flushing where possible 5. I only do full loads of washing 6. I turn off taps when brushing teeth

Source(s): Authors' explanation

four marketing professors and 12 volunteers to check the questionnaire for clarity, relevance and consistency before distribution. Their feedback was used as inputs to enhance item wordings and contextual relevance.

Knowledge about water conservation was operationalized by adapting three items from [Nguyen et al. \(2017\)](#) and [Willis et al. \(2011\)](#). Four items to measure environmental concern were adopted from [Yadav and Pathak \(2016\)](#). Three items to measure concern about water scarcity were adapted from [Clark and Finley \(2007\)](#). For attitude toward water conservation, four items were adapted from [Dolnicar et al. \(2012\)](#) and [Lapinski et al. \(2007\)](#). Finally, six items to measure self-reported water conservation behavior were referenced from [Fielding et al. \(2016\)](#). All measurements used a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree), except for water conservation behavior, where respondents indicated their frequency of engagement in water conservation practices over the past three months with 1 representing “never” and 7 representing “always”. The questionnaire consisted of three sections: an introduction with research purposes and two screening questions (age of respondents and their past water conservation behavior), the main measurement items and demographic questions covering gender, age, education and household income.

3.3 Sample and data collection

The study participants were Vietnamese adults (18 years and above) who reported implementing water conservation practices in their households during the three months before data collection. Hanoi, the capital city of Vietnam, was intentionally selected as the

research site because this city has been facing water shortages, which likely motivates its residents to conserve water. Additionally, urban consumers in Hanoi tend to endorse sustainable movements and have proven to be appropriate subjects in studies of green purchases and conservation behavior (Le and Nguyen, 2024; Nguyen *et al.*, 2016). Given the lack of a sampling frame, data were collected from eligible participants through convenience and volunteer sampling methods (Saunders *et al.*, 2015). The target sample size was 500, which meets the requirement for multivariate data analysis (Kline, 2011). Eight trained interviewers approached respondents in two popular shopping centers and two public parks in Hanoi. The interviewers explained the research purpose to eligible participants and assured their confidentiality and anonymity. Participants were informed that there was no right or wrong and that their responses would be used solely for scientific research. After reviewing and signing an informed consent statement, participants completed face-to-face interviews voluntarily. Upon completing each survey, respondents received VND 50,000 as an appreciation token. The survey was conducted from November 2018 to January 2019, collecting 519 responses. After the data-cleaning process, 16 responses containing multivariate outliers were eliminated, resulting in 503 valid responses for further analysis.

3.4 Analysis method

This study employed SPSS 24.0 and AMOS 24.0 for data analysis. SPSS was used for data screening, descriptive statistics and reliability testing. Following a two-stage approach suggested by Anderson and Gerbing (1988), AMOS was used to examine validity and test hypotheses through structural equation modeling (SEM), generating both measurement and structural model to assess goodness-of-fit. The model's goodness-of-fit was evaluated using multiple indices as recommended by Hair *et al.* (2010): chi-squared/df, CFI, TLI, IFI and RMSEA (2019). The model demonstrates a good fit with the data when chi-square/df is less than 3, RMSEA is less than 0.05, and CFI, TLI and IFI values exceed 0.90 (Hair *et al.*, 2010).

4. Results and discussion

4.1 Demographic profile

Table 2 shows the respondents' characteristics. There were slightly more females (50.3%) than males (49.7%). The percentage of respondents aged 18–24, 25–34, 35–44, 45–54 and 55+ was 26.6%, 25.6%, 24.1%, 14.3% and 8.5%, respectively. Moreover, it is worth noting that most of the respondents were married (55.6%) and university graduates with undergraduate degrees (44.7%). In terms of monthly income, the sample was dominated by consumers having a household monthly income ranging from VND 10 to less than 20 million (27.8%), followed by consumers earning from VND 20 to less than 30 million (20.9%) and from VND 30 to 40 million (10.5%).

4.2 Common method bias

Given that this study collected self-reported responses, a common method bias (CMB) analysis was conducted. Harman's one-factor test showed that the cumulative percentage of the first component was 31.610%, below the recommended threshold of 50% (Podsakoff *et al.*, 2012); thus, it is reasonable to conclude that CMB was not a severe issue. In addition, we conducted a common latent factor test to assess common method bias. This involved adding a first-order factor with all measures as indicators to the confirmatory factor analysis (MacKenzie *et al.*, 1993). The presence of common method variance was evaluated by examining differences in factor loadings with and without the common latent factor (Podsakoff *et al.*, 2003). Our test revealed minimal differences in regression weights (<0.200), confirming that common method variance was not a major concern in our data (Gaskin, 2012).

Table 2. Demographic information of the sample

Variables	Frequency	Percentage
<i>Gender</i>		
Female	253	50.3
Male	250	49.7
<i>Age</i>		
18–24	134	26.6
25–34	129	25.6
35–44	121	24.1
45–54	76	14.3
55 and above	52	8.5
<i>Marital status</i>		
Single	175	34.8
Married	280	55.6
Widowed	27	5.4
Divorced	21	4.2
<i>Educational level</i>		
High school	65	12.9
Professional and college degree	131	26.1
University undergraduate	225	5.4
Postgraduate	82	4.2
<i>Household monthly income</i>		
< VND 5 million VND	39	7.8
VND 5 - less than 10 million	95	18.9
VND 10 - less than 20 million	140	27.8
VND 20 - less than 30 million	105	20.9
VND 30 - less than 40 million	53	10.5
VND 40 - less than 50 million	38	7.5
≥ VND 50 million	33	6.6
<i>Total</i>	<i>503</i>	<i>100</i>
Note(s): \$ = 23,130 at the time of the survey		
Source(s): Authors' explanation		

4.3 Validity and reliability test

A confirmatory factor analysis (CFA) was performed on all the dependent and independent variables to verify the fitness, reliability and validity of the measurement model. The CFA results revealed a good model fit as all the goodness-of-fit indices of the measurement model (i.e. $\chi^2/df = 1.668$, GFI = 0.949, NFI = 0.939, CFI = 0.975, RMSEA = 0.036) met the recommended criteria (Hair *et al.*, 2010).

Table 3 shows the mean, standard deviation and Cronbach's alpha values for each construct. Notably, the mean score for respondents' knowledge about water conservation was 3.967, the lowest among all measured constructs. This score falls below the midpoint of 4.0, suggesting that respondents have a limited understanding of water conservation practices and their environmental benefits. As can be seen from Table 3, Cronbach's alpha coefficients for all five variables were greater than the threshold of 0.70, ranging from 0.773 to 0.877, confirming the good reliability of the measures in this study. Table 3 also showed that the factor loadings of each item were greater than the cutoff value of 0.60, the composite reliability (CR) values were greater than 0.70, and the average variance extracted (AVE) values were above 0.50 (Hair *et al.*, 2010). Thus, the convergent validity of all constructs was satisfactory.

Following Fornell and Larcker (1981), discriminant validity was established by confirming that the square roots of AVE exceeded all inter-construct correlations. Based on Table 4, this

Table 3. Items, construct reliability and convergent validity

Construct	Items	Mean	SD	FLs	α	CR	AVE
Knowledge about water conservation	KNO1	3.867	1.112	0.730	0.773	0.773	0.531
	KNO2			0.734			
	KNO3			0.722			
Environmental concern	ECO1	4.702	1.191	0.766	0.832	0.832	0.553
	ECO2			0.769			
	ECO3			0.714			
	ECO4			0.723			
Concern about water scarcity	COW1	4.693	1.283	0.799	0.844	0.845	0.644
	COW2			0.811			
	COW3			0.798			
Attitude toward water conservation	ATT1	4.880	1.050	0.743	0.813	0.815	0.524
	ATT2			0.770			
	ATT3			0.670			
	ATT4						
Water conservation behavior	WCB1	4.846	1.115	0.744	0.877	0.878	0.544
	WCB2			0.725			
	WCB3			0.719			
	WCB4			0.766			
	WCB5			0.744			
	WCB6			0.728			

Note(s): *Abbreviation:* M: Mean; SD: Standard deviation; FL: Standardized factor loadings; α : Cronbach's alpha; CR: Composite reliability; AVE: Average variance extracted

Source(s): Authors' explanation

Table 4. Bivariate correlations and discriminant validity

Constructs	KNO	ECO	COW	ATT	WCB
KNO	<i>0.729</i>				
ECO	0.281	<i>0.743</i>			
COW	0.217	0.544	<i>0.803</i>		
ATT	0.443	0.344	0.505	<i>0.724</i>	
WCB	0.276	0.315	0.425	0.517	<i>0.738</i>

Note(s): The italic diagonal elements are the square root of AVE

Abbreviation: KNO: Knowledge about water conservation behavior; ECO: Environmental concern; COW: Concern about water scarcity; ATT: Attitude toward water conservation; WCB: Water conservation behavior

Source(s): Authors' explanation

requirement was satisfactory for all constructs, demonstrating adequate discriminant validity across all constructs. Furthermore, the highest bivariate correlation value between constructs was 0.544, below the threshold of 0.70 (Grewal *et al.*, 2004), suggesting that multicollinearity did not adversely affect the estimated relationships between the constructs.

4.4 Hypothesis testing

SEM was used to assess the hypothesized model. The results indicated an acceptable model fit to the data: χ^2/df , GFI, NFI, CFI and RMSEA were 2.534, 0.925, 0.906, 0.941 and 0.055, respectively. The proposed model amounted to 31.9% of the variance in attitude toward water conservation and 26.8% of the variance in water conservation behavior. Table 5 summarizes the hypothesis test results. Knowledge significantly impacted attitude toward water conservation behavior ($\beta = 0.364$, $p < 0.001$), supporting H1. However, H2 was not

Table 5. Hypothesis test results

Hypotheses	β	t-value	p-value	Results
H1: KNO $\rightarrow$ ATT	0.364	6.463	***	Supported
H2: KNO $\rightarrow$ WCB	0.055	0.982	0.326	Not supported
H3: ECO $\rightarrow$ ATT	0.083	1.706	0.088	Not supported
H4: ECO $\rightarrow$ WCB	0.091	1.905	0.057	Not supported
H5: COW $\rightarrow$ ATT	0.424	7.819	***	Supported
H6: COW $\rightarrow$ WCB	0.187	3.329	***	Supported
H7: ATT $\rightarrow$ WCB	0.376	5.557	***	Supported

Note(s): *** $p < 0.001$

Abbreviation: KNO: Knowledge about water conservation behavior; ECO: Environmental concern; COW: Concern about water scarcity; ATT: Attitude toward water conservation; WCB: Water conservation behavior

Source(s): Authors' explanation

supported, since knowledge was not significantly related to water conservation behavior ($\beta = 0.055, p = 0.326$). Environmental concern showed no significant effect on either attitude ($\beta = 0.083, p = 0.088$) or water conservation behavior ($\beta = 0.091, p = 0.057$), leading to the rejection of H3 and H4. As hypothesized, concern about water scarcity was positively related to both attitude ($\beta = 0.424, p < 0.001$) and water conservation behavior ($\beta = 0.187, p < 0.01$), supporting H5 and H6. Attitude toward water conservation behavior was positively associated with water conservation behavior ($\beta = 0.376, p < 0.001$), confirming H7.

To test for mediation, this study followed Preacher *et al.* (2007) by conducting a bootstrap analysis with 5,000 samples and 95% confidence interval. As shown in Table 6, the results revealed that the indirect effect of knowledge about water conservation on consumers' water conservation behavior through attitude toward water conservation was statistically significant ($\beta = 0.137, p < 0.01$); thus, H8a was supported. The indirect effect of environmental concern on consumers' water conservation behavior through attitude toward water conservation was not significant ($\beta = 0.031, p > 0.05$), rejecting H8b. However, the indirect effect of concern about water scarcity on consumers' water conservation behavior through attitude toward water conservation was statistically significant ($\beta = 0.159, p < 0.001$), supporting H8c. However, since the direct effect of knowledge about water conservation on water conservation behavior was not significant, attitude fully mediates this relationship. In contrast, since the direct effect of concern about water scarcity on consumers' water conservation behavior was significant, attitude toward water conservation partially mediates the effect of concern about water scarcity on water conservation behavior (Zhao *et al.*, 2010).

Table 6. The mediating tests

Hypothesis	Indirect paths	Indirect effects	p-value	95% confidence interval	
				Lower bound	Upper bound
H8a	KNO $\rightarrow$ ATT $\rightarrow$ WCB	0.137	0.001	0.068	0.228
H8b	ECO $\rightarrow$ ATT $\rightarrow$ WCB	0.031	0.203	-0.015	0.099
H8c	COW $\rightarrow$ ATT $\rightarrow$ WCB	0.159	0.000	0.088	0.263

Note(s): **Abbreviation:** KNO: Knowledge about water conservation behavior; ECO: Environmental concern; COW: Concern about water scarcity; ATT: Attitude toward water conservation; WCB: Water conservation behavior

Source(s): Authors' explanation

5. Discussion and implications

5.1 Discussion of main findings

Drawing on the KAB model, this research examines the integrative effects of knowledge about water conservation, environmental concern and concern about water scarcity on consumers' attitude toward water conservation behavior, which in turn leads to water conservation behavior. A conceptual model was proposed and validated using data collected from Vietnam, an emerging market. The research results offer fresh insights into the water-saving practices of Vietnamese consumers.

First, the findings show that consumers with good knowledge of water conservation behavior are more likely to develop a positive attitude toward this pro-environmental act, in line with existing literature on green consumption behavior by [Nguyen et al. \(2017\)](#) and [Lee et al. \(2022\)](#). Thus, knowledge about water conservation is a prerequisite for the formation of an attitude toward water conservation. The mediation test reveals that attitude toward water conservation behavior fully mediates the relationship between knowledge and actual conservation behavior, indicating that knowledge is a distant determinant of water conservation behavior. This aligns with the KAB model, which describes how people first acquire knowledge, then develop positive feelings and, finally, take action based on those feelings ([Kollmuss and Agyeman, 2002](#)).

Second, attitude demonstrates a strong association with consumers' water conservation behavior. The positive relationship between attitude toward water conservation behavior and consumers' active water conservation behavior builds on the findings of green purchase research by [Cheung and To \(2019\)](#) and [Ogiemwonyi et al. \(2023\)](#). Another important finding is that two types of environmental concern exhibit different influences on consumers' water conservation behavior. General environmental concern does not necessarily translate into either attitude toward water conservation behavior or committed water conservation behavior. In Vietnam, this phenomenon may be attributed to the country's multiple environmental challenges as an emerging nation ([Chu, 2018](#)) and that, while broad environmental concerns raise awareness of ecological degradation, they may not sufficiently motivate specific water conservation actions. A similar weak effect of environmental concern on pro-environmental behavior was reported in Malaysia by [Tan et al. \(2017\)](#). However, a specific concern about water scarcity has the opposite effect, specifically a concern about water scarcity exerts a positive impact on attitude toward water conservation behavior, which in turn significantly drives conservation behavior. This finding corroborates other research showing that individuals who express specific concerns about water availability are more inclined to implement water conservation practices ([Addo et al., 2019](#); [Clark and Finley, 2007](#)).

The mediation analysis revealed that attitude toward water conservation behavior fully mediates the link between knowledge about water conservation on water conservation behavior and partially mediates the link between concern about water scarcity and water conservation behavior. Building upon previous research by [Li et al. \(2019\)](#) and [Duong et al. \(2022\)](#), our findings reinforce attitude's essential role in driving pro-environmental behavior, while providing new perspectives on how knowledge about water conservation and concern about water scarcity influence water conservation practices. The results indicate that, while concern about water scarcity operates through both direct and indirect pathways, knowledge about water conservation manifests its influence exclusively through indirect channels.

5.2 Theoretical implications

This study makes several key contributions to the field of environmental science and conservation behavior literature. First, to the authors' best knowledge, it is the first study to incorporate two distinct dimensions of environmental concern: general environmental concern and specific concern about water scarcity into one unified model. Previous studies limited to either general environmental concern ([Aprile and Fiorillo, 2017](#)) or concern over future shortages ([Clark and Finley, 2007](#)), leaving an incomplete picture of how these two types of

environmental concerns collectively influence consumer responses. Therefore, this study validates and extends the KAB model's application to water conservation behavior. This dual approach enhances the model's explanatory power and its applicability to environmental decision-making.

Second, the study reveals an important theoretical insight: individuals respond differently to various environmental issues. Specifically, it shows that concerns about a particular problem, such as water scarcity, drives water conservation behavior more strongly than general environmental concern. Third, this study shows that, while knowledge about water conservation is essential, it does not directly translate into actual behavior and this finding reinforces evidence from previous studies in related fields (Li *et al.*, 2019; Taufique *et al.*, 2016). Knowledge initiates a process that increases consumer awareness of water conservation's importance, shapes attitudes and ultimately encourages water-saving practices.

Fourth, the findings of this study shed a new light on the mediating mechanism of attitude toward water conservation in the link between knowledge about water conservation, concern about water scarcity and consumers' water conservation behavior. Unlike previous studies which narrowed their scope to general environmental concern about the ecology, this study advanced the body of literature about the impact of knowledge about water conservation and concern about water scarcity on consumer attitude which in turn influences water saving behaviors.

Finally, this study addresses a crucial research gap, as developing countries face increasing water shortage risks yet have limited research on water conservation behavior. By proposing and validating a model of water conservation in Vietnam, it provides valuable theoretical framework and empirical evidence for researchers studying conservation practices in developing countries.

5.3 Practical implications

Water conservation behavior is integral to reducing overall water consumption and a vital initiative to achieve several SDGs. This study offers potential implications for policymakers and utility companies to encourage consumers' water conservation behavior, especially those in emerging markets. First, given the vital role of knowledge about water conservation in shaping positive attitude toward water conservation behavior and later water conservation practices, focused water education programs should emphasize the advantages of reducing water consumption, including lower utility bills and environmental benefits. These programs could also highlight the interconnectedness of water conservation with food security, energy production and climate resilience, fostering a holistic understanding of its importance. Additionally, more resources should support high-quality media content that educates consumers about water-saving techniques as consumers acquire knowledge through both formal education and mass media (Pham and Rambo, 2003). Social media campaigns, influencer partnerships and interactive online platforms could be leveraged to reach a broader audience, particularly younger generations who are highly engaged with digital content. For example, water-saving tips for household residents can be presented in the form of interactive digital context instead of the traditional text of image forms.

Second, since concern about water scarcity directly translates into water saving practices, education and communication programs should inform households about the global and local water crises, while emphasizing their environmental and societal consequences. For instance, programs could showcase case studies of regions that have successfully mitigated water scarcity through community-driven conservation efforts, inspiring collective action. The research results underscore the importance of addressing context-specific environmental issues when designing interventions to promote pro-environmental behaviors. Therefore, education and communication initiatives should focus on raising awareness about water scarcity and demonstrating how conservation contributes to well-being and sustainability. Incorporating local cultural values and traditions, such as long-term orientation or man-nature

orientation, into these programs can enhance their relevance and effectiveness, as people are more likely to adopt behavior that resonate with their cultural identity (Leonidou *et al.*, 2010).

Third, to help consumers achieve their water conservation goals, utility companies should provide smart meters or mobile applications for monitoring daily or monthly water consumption and conduct regular inspections to identify potential water leaks. These tools could be complemented with personalized feedback and tips for reducing usage, such as adopting water-efficient appliances (Tsai *et al.*, 2011). Furthermore, incentive programs, such as rebates for installing water-saving devices or tiered pricing structures that reward low consumption, could motivate behavioral change (Maas *et al.*, 2024).

5.4 Limitations and future research

This study has several limitations. First, the survey data were collected at a single time and relied on self-reported responses, which may be subject to social desirability bias. Future research should incorporate observational data or conduct a longitudinal study to assess water conservation behavior better. Second, qualitative research methods could provide deeper insights into how, when and where consumers conserve water. Third, Vietnam's unique cultural and socioeconomic characteristics may limit the generalizability of these results globally, and future research should examine this model in different cultural settings. Fourth, this study focused on daily water-saving actions, leaving the purchases of water-saving appliances overlooked; however, as consumer behavior is dynamic and evolves, future scholars can contemplate studying consumer purchases of water-saving appliances. Additionally, future studies could explore variables from other theoretical perspectives, such as social identity theory (Brewer, 1991) or the theory of planned behavior (Ajzen, 1991). Moreover, the relationship between environmental concern and concern about water scarcity warrants further exploration, as it may reveal the underlying mechanisms through which environmental concern affects consumer responses. Finally, researchers should examine how water conservation behavior varies across various demographic groups, as previous studies have shown important differences. For instance, Clark and Finley (2007) found that older residents reported a stronger intention to save water.

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Further reading

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