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The Effect of Information, Fear, and Risk Perceptions to Pro-Environmental Behavior among University Students in Indonesia

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ABSTRACT

Climate change is a serious threat to human safety and health. Pro-environmental behavior can avoid more serious risks and harm. Pro-environmental behavior is influenced by information, fear, and risk perceptions. As future educators, planners, and policymakers, it is critical to understand the factors influencing students' pro-environmental behavior. This study, therefore, aims to examine the factors influencing students' pro-environmental behavior based on the Protection Motivation Theory. A 77-item questionnaire was completed by 415 students from the Faculty of Arts and Languages, Science, and Education, randomly selected using the cluster sampling method in their last lecture class. Confirmatory factor analysis and structural equation modeling showed that information, fear, and risk perception (reward, perceived severity, and perceived vulnerability) are both directly and indirectly mediated by motivation. In addition, the research identified the indirect and negligible effects of various protection motivation theory factors, including cost, response efficacy, and self-efficiency. Further, an unexpected finding determines that pro-environmental behavior was unrelated to demographic and socioeconomic background. Overall, the study's outcomes offer recommendations to socialize the risks climate change better causes to human health and safety, increasing fear and risk perceptions that may improve pro-environmental behavior. Additionally, stricter environmental behavior regulations are needed to penalize polluters and stop rewarding maladaptive behaviors.

Introduction

Climate change is causing environmental harm and endangering human health and safety [1–3]. According to the National Centers for Environmental Information [4], the Earth's average temperature since 1976 has increased, reaching 1 °C in 2016. Climate change causes rising sea levels, damage to aquatic ecosystems, drought, and high rainfall in tropical countries, all of which trigger floods and landslides [4]. It has various safety and health impacts, including injuries due to disasters, heat stroke due to increased temperatures and heat waves, diarrhea, spread of vector diseases, increased respiratory diseases, and increased mortality [5].

Extreme weather, particularly in Asia, caused a 46% increase in the frequency of natural disasters, which affected 48 million people and claimed 50,000 lives between 1990 and 2016 [5]. By the end of the decade, flood and drought disasters were predicted to rise to 2.3 million and 1.3 million incidents, respectively, following storms and land fires [5]. In 2022, drought disasters will increase by 29% compared with 1951 to 1960 [6]. At least 125 to 175 million adults and children in the US are at risk of the harmful effects of excessive heat, which exacerbates respiratory, cardiovascular, pneumonia, heart, cirrhosis, and renal disorders, resulting in 19,901,511 fatalities between 1990 and 2020 [4,5,7]. The expansion and facilitation of the spread of infectious diseases, including dengue fever, yellow fever, and malaria, have been triggered by climate change. There were 58.4 million cases of dengue fever in 2013, 10,000 fatalities, and a 14% increase in cases by 2020 [5,7]. As estimated by the World Health Organization, there will be an 250,000 annual increase in mortality during 2030 to 2050, and 930 million people will experience morbidity (health complaints) due to

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climate change [8]. Climate change also plays a role in increasing the risk of pandemic. Changes in the movement of humans, plants, and vector organisms increase the risk of disease infection between species, leading to new pandemics. At least 761 million people were infected with COVID-19 between 2019 and 2020, and 220 nations recorded 6,887,000 tragic deaths due to the pandemic. Similar to endemic SARS (2003), MERS (2012), and Ebola (1976; 2014–2016), the COVID-19 pandemic is an acute disease that is accelerated by climate change [8].

Some causes of climate change involve improper human behavior related to urbanization, industrialization, and transportation [1]. The IPCC concurs that anthropogenically caused climate change, especially carbon dioxide (CO_2), accounted for the majority of the temperature increase between 1950 and 2011 [9]. Seventy-eight percent of the greenhouse gas (GHG) increase during 1970 to 2010 was due to carbon dioxide gas from the burning of fossil fuels and industrial processes. A 10 Giga ton CO_2eq increase in GHS emissions occurred between 2000 and 2010, with the contributions of the energy sector (35%), the agricultural, forestry, and land use change sectors (24%), the transportation sector (14%), and the building sector (6%) [9]. Pro-environmental behavior (PEB) can avoid serious risks and harm[10]. PEB includes contributing to a sustainable environment, such as reducing energy use, recycling, using public transportation, participating in environmental demonstrations, and signing pro-environmental petitions. Several countries have implemented pro-environmental practices such as sustainable waste management in Bangkok [11], conservation of water and agricultural land in Indiana and China [12,13], and the adoption of electric vehicles in the Netherlands [14]. In Indonesia, waste generation has decreased by 25.86%, or five million tons per year, at least in waste management. Handled waste accounts for 50.64%, managed waste for 76.5%, and 1,120 tons corresponds to 299,602.4 CO_2eq [1,15].

PEB at various levels of Indonesian society needs to be improved by identifying the factors that influence it. Previous studies have established the possibility that PEB is correlated with and influenced by information, fear, and risk perception. Risk and adaptation assessments are influenced by information on climate change, the health risks it poses, and behavioral adaptations [16]. Accurate and trustworthy information is necessary to influence decisions about PEB and to motivate communities to commit to and support pro-environmental legislation [17,18]. However, inaccurate and insufficient information may make it difficult for people to act in an environment-friendly manner. Information concerning illnesses, fatalities, and stringent regulations associated with climate change is thought to have the potential to provoke anxiety or panic [18]. A person's incentive to make changes is fueled by their feelings of fear, anxiety, and guilt [19].

Fear is a more effective strategy for changing behavior when combined with guidance on how to avoid a perceived threat [20]. The most fearful individual is typically highly motivated to act in a pro-environmental manner [21]. The risk assessment of health concerns caused by environmental degradation in individuals is influenced by fear [17,20]. Pro-environmental attitudes and actions were acquired from a risk assessment [22]. Individuals who perceive higher risk are inclined to pursue energy-efficient and low-pollution items and activities [22]. The drive to eliminate threats to others' health and safety is also stimulated by fear [19]. An individual's altruistic attitude promotes environmental management policies and engagement in PEB [23]. Strict and effective environmental laws that emphasize personal accountability and participation are necessary to improve people's motivation to engage in PEB across national boundaries [9,24]. To protect public health and the environment, policies force people to behave obediently and adaptively out of social expectations to comply with and apprehend punishment to break them.

Protection Motivation Theory (PMT) can clarify the relationship between information, fear, risk perception, motivation, and PEB [17,20]. The PMT explains the fear of threat appeal to the risk assessment process and self-protective decision-making [25]. PMT studies how pro-environmental motivation and behavior are determined by information, fear, perceived severity, perceived vulnerability, response efficacy, self-efficacy, costs, and rewards [17,20]. In behavioral analysis studies, PMT has been used to examine sustainable waste management in Bangkok [11], the environmental behavior of Chinese farmers [12], the environmental behavior of Iranian students [26], energy-saving practices at the household level [3], and the impact of information and communication on the desire to protect themselves from air pollution [27]. Although similar studies are rare, PMT has been applied in Indonesia to compare students' PEB [28]. In general, health, economics, and informatics research are the topics on which PMT are currently applied in Indonesia [29–31]. Students have always been involved in initiatives that encourage environmental awareness, and they will also use resources and have power as educators, planners, and policymakers to manage the environment in the future [32]. Students have privileged knowledge that is important for providing the right solutions to improve the environment [26]. Students are also considered a unique subpopulation that provides insights different

from other subpopulations [33]. Therefore, it is critical to understand the factors that influence student PEB. Thus, the present study aimed to clarify the environmental behavior of Indonesian university students using the PMT framework. The implications of information, fear, perceived severity, perceived vulnerability, rewards, self-efficacy, response efficacy, and costs on students' PEB were examined in this context. The research findings should summarize more successful strategies for promoting PEB that can be applied using the PMT framework.

Methodology

Framework

The fear (F) of threats' appeal to the risk assessment process and self-protective decision-making is explained by PMT [25]. Threat appraisal and response appraisal trigger self-protection motivations that encourage the formation of response behaviors to avoid threats [25,34]. Perceived severity (PS), perceived vulnerability (PV), and reward (R) are threat appraisal variables in PMT, whereas costs (C), self-efficacy (SE), and response-efficacy (RE) are coping variables [20,23,28,37]. They also introduced threat information (I) as a PMT [17,20] and evaluated how the outlined variables impacted PEB and motivation (M). Information is a variable that influences fear, risk perception, and coping efficacy [16]. Information about the threats of environmental damage to health and safety can cause fear and increase perceived severity, vulnerability, and self-efficacy, thereby increasing motivation [11,18,20,35]. Fear is an independent variable that is directly related to motivation [20]. The most fearful individual is typically highly motivated to act in a pro-environmental manner [21]. Fear also influences the perceived severity and vulnerability. The motivation that arises from risk perception generates and directs PEB [19–21].

Perceived severity is the process of measuring the seriousness of a threat [17]. Perceived vulnerability measures potential threats that harm oneself and others. Rewards are the benefits obtained from performing maladaptive actions. Perceived severity and perceived vulnerability significantly affect motivation and behavior in sustainable waste management [11], the use of electric vehicles [14], agricultural land management [12,13], and Iranian students' PEB [26]. Previous research did not directly establish the significance of rewards on PEB but rather accumulated them as a threat appraisal [14]. It has been stated that rewards significantly influence students' PEB [26]. Self-efficacy refers to the belief that individuals can perform recommended actions to eliminate risk, whereas response efficacy refers to the belief that recommended actions will effectively defeat threats. Costs can be in the form of money, time, and energy that must be spent implementing the recommended actions [20]. Self-efficacy significantly affects Iranian students' motivation [26], sustainable waste management behavior [11], and agricultural and land management [12,13]. Response efficacy does not significantly affect student motivation [26] or sustainable waste management behavior [11], but it significantly affects farmers' PEB [12] and the motivation of electric vehicle users [14]. Cost reduces pro-environmental motivation and behavior among students in Italy and farmers in China and Iran [12,26].

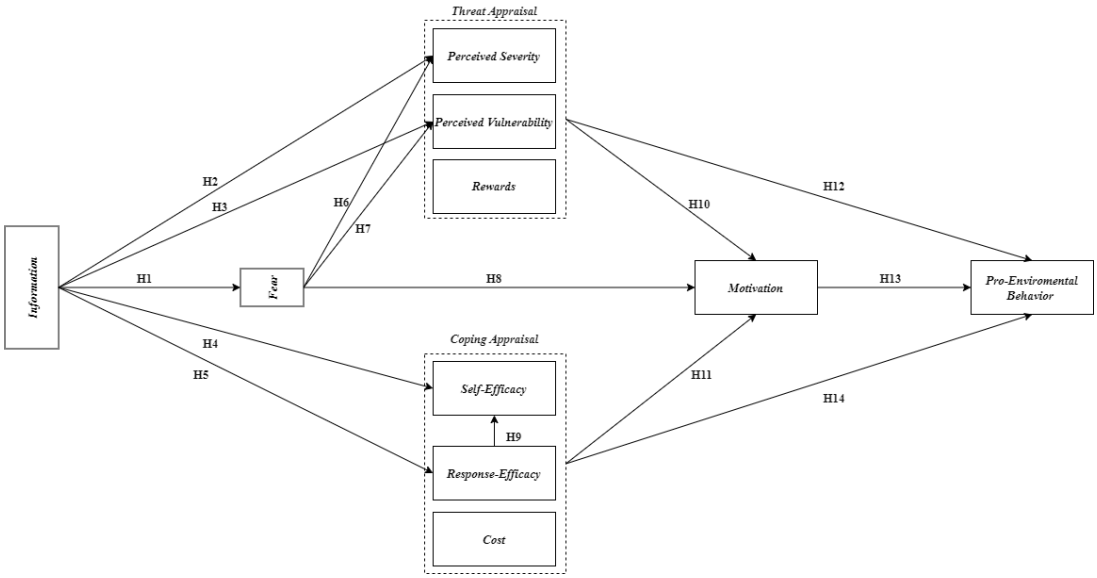

Figure 1. Protection motivation theory on pro-environmental behavior framework.

Based on these recent studies, we adopt the frameworks of [17,20], as shown in Figure 1, and propose the following hypothesis: H1. Information influences fear; H2. Information influences perceived severity; H3. Information influences the perceived vulnerability; H4. Information influences self-efficacy; H5. Information influences response efficacy; H6. Fear influences perceived severity; H7. Fear influences perceived vulnerability; H8. Fear influences motivation; H9. The response efficacy variable influences the self-efficacy variable; H10. The threat appraisal variable influences motivation; H11. The coping appraisal variable influences motivation; H12. The threat appraisal variable influences PEB; H13. Motivation influences PEB; and H14. Coping appraisal influences PEB.

Questionnaire: Variables and Items

The data for this study were collected in August 2023. A questionnaire was created based on earlier research to assess students' PEB and its influencing variables. This process consisted of two parts. The first part inquired about demographic and socioeconomic variables, such as age, gender, faculty, educational grade, parenting education level, monthly income, monthly expenses, and place of residence. The second part inquired about the PMT variables related to information, including PEB (14 items), motivation (8 items), fear (3 items), perceived severity (4 items), perceived vulnerability (5 items), rewards (6 items), self-efficacy (5 items), response efficacy (6 items), and cost (6 items). The questionnaire was answered on a five-point Likert scale [36].

The validity and reliability of the questionnaire were tested using IBM SPSS Statistics 26 software. The validity test confirmed the accuracy of each item in the questionnaire in measuring the research variables, and a reliability test was conducted to ensure the stability and consistency of the questionnaire in producing responses when used repeatedly by researchers. A validity test was performed using the Pearson's correlation test. In the Pearson Correlation Test, a question item was considered valid if the value of the r-count was > r-table. The reliability test was measured based on Cronbach's alpha value, which must be > 0.70, indicating that the question items successfully measured the same variable. Items with a Cronbach's alpha value < 0.7. were excluded from the questionnaire. Thirty-eight samples were used in the pilot study; the r-count value was greater than 0.320, and the Cronbach's alpha coefficients of the variables were 0.820 to 0.923 (Table 1). Ethical approval was obtained from the Research Ethics Committee of the Padjadjaran University, Bandung (450/UN6).KEP/EC/2023 on April 7, 2023.

Table 1. Variables, items, Pearson correlation, and Cronbach's alpha.

Variable	Question item	Rcount	Alfa cronbach
Pro-environmental Behavior	I turn off the fan or air conditioner when I leave the room.	.472**	0.859
	I climb up the stairs to the lecture hall or laboratory.	.526**	
	I drive public transportation or walk to campus.	.639**	
	I bike to the cafeteria, prayer room, and faculty building.	.620**	
	I don't bought delivery food (ShopeeFood, GoFood, and GrabFood).	.495**	
	I bring a bottle or tumbler to buy drinks at the stall, canteen, or café.	.607**	
	If the canteen offers plastic bags, I won't take them.	.681**	
	I collect and reuse crackle or plastic packaging.	.444**	
	I took the empty bottle to the garbage bank.	.645**	
	I separate organic and inorganic waste.	.766**	
	I keep using HVS paper for reuse.	.473**	
	I participate in composting activities.	.807**	
	I follow environmental organizations like Eco Campus, World Cleanup Day, and etc.	.731**	
	I'm not in a hurry to buy new clothes.	.481**	
Information	An extreme increase in air temperature (heat) is a phenomenon of climate change.	.326*	0.845
	Climate change is a natural event caused by human activities.	.321*	
	Carbon dioxide is the biggest cause of climate change.	.593**	
	Burning fuel in motorized engines causes climate change.	.381*	
	Industrial activities are the main cause of climate change.	.382*	
	Cardiovascular (heart and blood vessels)	.705**	
	Pneumonia, tuberculosis	.694**	
	Liver cancer and cirrhosis	.575**	
	Kidney damage	.756**	

Variable	Question item	Rcount	Alfa cronbach
	Diarrhea	.546**	
	Dengue Fever (DB)	.781**	
	Malaria	.443**	
	COVID-19 pandemic	.781**	
	SARS (2003)	.833**	
	MERS (2012)	.820**	
	Ebola (1976; 2014-2016)	.637**	
Fear	I feel insecure knowing the health threats caused by environmental damage.	.821**	0.841
	I am worried that I will contract a deadly disease due to environmental damage.	.904**	
	I feel uncomfortable with so many illnesses these days.	.886**	
Perceive Severity	Environmental destruction has become a serious threat to human health.	.925**	0.908
	Climate change threatens human safety.	.901**	
	Recent extreme weather changes have severely affected activities and health.	.852**	
	The threat to human survival is terrifying.	.864**	
Percieve Vulnerability	I will be seriously ill in life because of the deterioration in the quality of the environment.	.887**	0.923
	I am susceptible to diseases caused by climate change.	.854**	
	My life, family, and even friends can be threatened due to poor environmental conditions.	.855**	
	Deterioration in environmental quality can endanger the health of those around me.	.851**	
	Others can be threatened with disasters due to poor environmental conditions.	.922**	
Reward	I leave the AC or fan on so that the room is cool.	.820**	0.820
	I ride a motorcycle or car to get to my destination faster.	.662**	
	I buy food from delivery (go food, grab food, or shopee food) because it is more practical.	.710**	
	I throw the trash together because it's easier.	.698**	
	Using plastic, crackle, or disposable places to eat and drink is cheaper for me.	.800**	
	I don't need to practice pro-environmental behavior because of my friends either.	.678**	
Self-Efficacy	I know how to sort and recycle waste.	.817**	0.888
	I can prevent climate change by reducing fuel use.	.834**	
	I can protect the health of people around me by preventing climate change.	.871**	
	I know how to prevent environmental damage in everyday life.	.857**	
	I believe I can protect the environment by saving electrical energy.	.789**	
Response-Efficacy	My contribution to protecting the environment has a good impact on my health and that of my family.	.867**	0.868
	I can influence the interest and participation of others in protecting the environment.	.897**	
	My pro-environment behavior can reduce the threat of disease due to environmental damage.	.892**	
Cost	Buying a lunch box is more expensive than using oil paper or Styrofoam from the canteen.	.813**	0.868
	I feel that depositing garbage into the waste bank takes a long time.	.812**	
	Walking or cycling requires more power.	.818**	
	Using stairs to go up and down is more tiring than using an elevator.	.676**	
	Not using plastic or crackers when shopping makes the job less practical.	.849**	
	I feel different than friends who don't care and take care of the environment.	.707**	
Motivation	I feel obliged to improve environmental conditions.	.893**	0.888
	The people closest to me carry out activities to protect the environment.	.746**	
	Good environmental conditions are useful for my health and that of those around me.	.708**	
	It is important for me to leave a healthy environment for my kids.	.664**	
	A healthy environment is very influential on my health condition.	.835**	

Variable	Question item	Rcount	Alfa cronbach
	I save money by walking or riding a bike.	.808**	
	I turn off the air conditioner and fan so that the electricity bill is cheaper.	.661**	
	I feel happy to be able to prevent the destruction of nature.	.817**	

Note: *. Correlation is significant at the 0.05 level (2-tailed), Rtable=0.320; **. Correlation is significant at the 0.01 level (2-tailed), Rtable=0.413.

Participants and Sampling

The inclusion criteria for the population were active students from the faculties of arts, science, and education who were enrolled in 2022, 2021, 2020, 2019, and 2018. A random cluster sampling method was used for each faculty member. After the last lesson, a random selection of students from each faculty member was allowed to complete anonymous, self-administered questionnaires. This technique was used to examine the impact of variations in demographic and socioeconomic background on PEB [18,22,37]. The sample size was determined on the basis of the Krejcie and Morgan Table used in an Iran-related study. A total of 415 students were divided proportionally among the three faculties: 152 students studied the arts and languages, 118 studied science, and 145 studied education.

Results and Discussion

Participants Characteristics

There were 358 (86.3%) female and 57 (13.7%) male respondents. The average age of the respondents was 18 years and the oldest was twenty-five. The Faculty of Language and Arts had 152 respondents (36.6%), the Faculty of Science had 118 respondents (28.4%), and the Faculty of Education had 145 respondents (34.9%). Most respondents were from the 2021-year study, 196 (47.2%), and from the 2020-year study, 142 (34.2%). The remaining respondents were in 2020 (8.4%), 2019 (7.2%), and 2018 (2.9%). Of the respondents, 163 (39.3%) were from urban areas, and 252 (60.7%) were from rural areas. According to Deloitte Southeast Asia's 2015 [38] economic classification of Indonesian residents, 177 (42.7%) respondents made less than three million rupiahs per month, 173 (41.7%) respondents made between three and five million, and only 65 (15.7%) respondents made more than five million. Furthermore, only 0.2% of respondents spent more than 6 million rupiah per month. In contrast, 48 (11.6%) respondents spent between 1.2 and 6 million rupiah per month, 172 (41.4%) respondents spent between 532 and 1.2 million rupiah per month, and 194 (46,8%) respondents spent less than 532 thousand rupiah per month. The majority of the parent respondents (71.3%) had only completed high school, 90 (21.7%) and 17 (4.1%) had bachelor's degrees and diplomas, respectively, and only 12 (2.9%) had a master's degree.

Demographic and Socioeconomic Effects on Students' Pro-Environmental Behavior

As non-parametric tests do not require normally distributed data, they tend to be used with ordinal and nominal data, including the Likert scale [39,40]. In non-parametric tests, ordinal and nominal data can be analyzed by measuring the correlation between variables and combining data ranking and medians [40]. The Mann-Whitney test was used as an alternative to the t-test to measure differences between two groups of data, and the Kruskal-Wallis test was used as an alternative to the one-way test of variance (ANOVA) to test more than two groups. The results of non-parametric tests to determine the influence of demographics and socioeconomics on students' PEB are presented in Tables 2 and 3. Cumulative probability value or asymptote Sig. (2-tailed) < 0.05, indicates that there are significant differences between two or more groups of data at a significance level of 5%, whereas the cumulative probability value, or asymptote Sig. (2-tailed) > 0.05, indicating that there were no significant differences between the two or more groups [41].

As shown in Tables 2 and 3, the asymptotic sig (2-tailed) value of each factor was > 0.05, indicating that the socioeconomic and demographic factors' effect on PEB in this study can be neglected. This finding is consistent with previous research on age [18,26,28], gender, domicile, faculty, education level [18], and faculty [32], while contrary to other studies that proved that economic status significantly affects PEB [42]. In addition to other explanations on the demographic topic, PEB is affected more by external factors, including the distance between facilities and settlements, accessibility of infrastructure, and technological facilities, than by the type of environment [18,26,42]. In addition, larger age range samples should be recruited in future research to examine the significant age effects on PEB as a result of cumulative variations in knowledge as an intervention factor [43].

Table 2. Mann-Whitney test results.

Description	Factors	Mean range	Asymp. Sig.	Conclusion
Students	Gender	9,919.5	0.735	Invalid
	Domicile	20,381	0.895	Invalid

Table 3. Kruskal-Walli's test results.

Description	Factors	Mean range	Asymp. Sig.	Conclusion
Students	Age	8.793	0.268	Invalid
	Faculty	0.829	0.661	Invalid
	Year study	2.275	0.685	Invalid
	Monthly expense	4.858	0.302	Invalid
Parents	Level of education	1.318	0.725	Invalid
	Monthly income	1.005	0.800	Invalid

Information, fear, and risk perception Effects on pro-environmental behavior

The structural equation modeling (SEM) analysis was performed using bootstrapping. The AMOS 22 Bootstrap Bollen-Stine test output shows that 196 bootstrap samples fit the model and 333 models do not fit. Bollen-Stine Bootstrap probability value (p) = 0.667; greater than 0.05 so that the bootstrap sample fits the data and is suitable for use in research model analysis. Subsequently, confirmatory factor analysis (CFA) was performed based on model fit indicators, including the chi-square, minimmum sampel discrepancy function per degree of freedom (CMIN/DF), comparative fit index (CFI), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), Tucker Lewis index (TLI), and root mean square error of approximation (RMSEA). Table 4 presents the CFA results.

As shown in Table 4, the four indicators confirm the goodness of fit of the model. The TLI was 0.988 > 0.090, CFI was 0.989 > 0.90, RMSEA was 0.015 < 0.08, and CMIN/DF was 1.097 < 2, proving that the measurement model had acceptable significance or accuracy and fit the data [26]. Poor chi-square values and GFI, AGFI, and NFI values within the marginal limit can be ignored. As the model fits at least four GOF indicators, it is applicable for use [43]. The main GOF indicators in AMOS that need to be considered are RMSEA, GFI, and CFI [44]. Shafiei and Maleksaeidi [26], applied the CMIN/DF, NFI, GFI, TLI, and RMSEA indicators, whereas Geiger et al. [45] used only CFI and RMSEA indicators. Average variance extracted (AVE) and composite reliability (CR) values are additional metrics used to assess the model fit [46]. As shown in Table 5, each variable has an AVE value greater than 0.5 and a CR greater than 0.70. As a result, each questionnaire item accurately, consistently, and consistently measured the study variables [46].

Table 4. Model fit indicators.

Indicators	Cut off Value	Result	Model evaluation
Chi-Squared	≤ 2412.685 (df = 2,300)	2,523.511	Poor fit
CMIN/DF	≤ 2.00	1.097	Good fit
RMSEA	≤ 0.08	0.015	Good fit
GFI	≥ 0.90	0.860	Marginal fit
AGFI	≥ 0.90	0.849	Marginal fit
TLI	≥ 0.90	0.988	Good fit
CFI	≥ 0.90	0.989	Good fit
NFI	≥ 0.90	0.886	Marginal fit

Table 5. Average variance extracted (AVE) and composite reliability (CR).

Variables	Construct reliability (CR)	Average variance extracted (AVE)
Pro-Enviromental Behavior (PEB)	0.952	0.587
Information (I)	0.954	0.562
Motivation (M)	0.922	0.596
Fear (F)	0.825	0.611
Perceived Severity (PS)	0.858	0.601
Perceived Vulnerability (PV)	0.865	0.562
Self Efficacy (SE)	0.868	0.568
Response Efficacy (RE)	0.794	0.563
Rewards (R)	0.893	0.582
Cost (C)	0.894	0.583

Figure 2 presents the structural results of the model used to analyze the effects of the PMT variables on PEB. The SEM findings demonstrate that rewards and costs directly and negatively affect PEB. However, perceived severity, vulnerability, self-efficacy, response efficacy, and motivation directly and positively affected PEB. Perceived severity, vulnerability, self-efficacy, and response efficacy (0.15–0.19) were the most important variables after motivation (0.29), followed by reward and cost, with standardized regression weight values of –0.08 and –0.13, respectively. Perceived severity, perceived vulnerability, and reward had significant effects on motivation and PEB ($p < 0.05$), whereas self-efficacy, response efficacy, and cost had no significant effect ($p > 0.05$). However, motivation significantly affected PEB, with a probability value of < 0.05. Additionally, fear and information significantly impacted perceived severity, perceived vulnerability, self-efficacy, and response efficacy (0.25–0.60); they also positively affected PEB via motivation, indicating a positive relationship between fear and information (0.58). In general, this result shows that information and fear elevate risk perception, which can encourage self-protection motivations and then generate and direct pro-environmental behavior in response to avoiding threats [19–21,25,34].

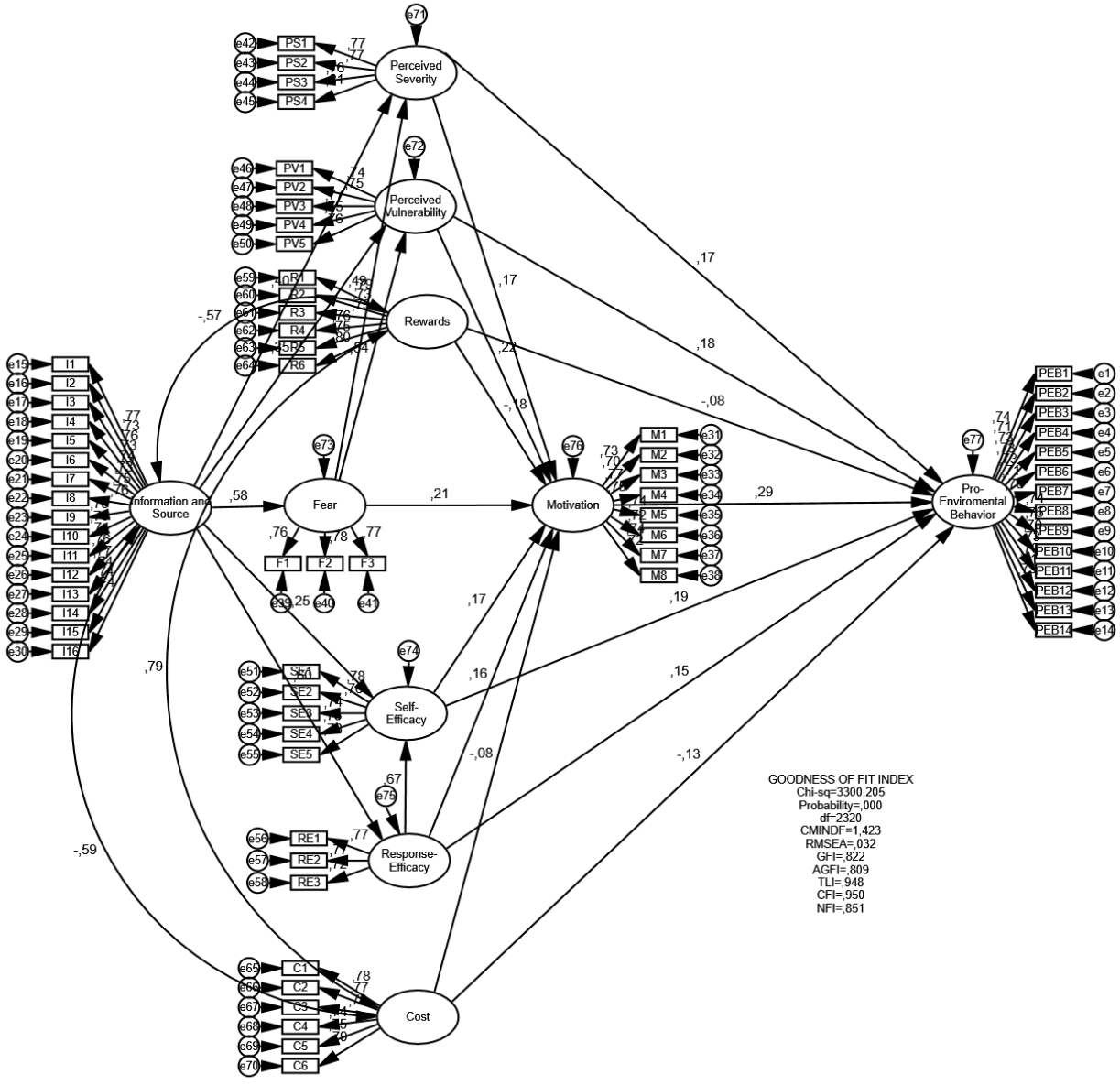

Figure 2. Structural model of student pro-environmental behavior using protection motivation theory.

This study aimed to implement a PMT framework to identify the factors that impact students' PEB. This study demonstrates how students' PEB is affected by information, fear, perceived severity, perceived vulnerability, rewards, self-efficacy, response efficacy, costs, and motivation. Research shows that information and fear significantly increase risk perception owing to exposure to the health and safety risks of climate change. Valid

information can increase vulnerability to severity, generating motivation and behavioral changes. This is in accordance with recent studies suggesting that information increases motivation and behavior towards sustainable waste management and students' PEB [11,18,20]. Clear, accurate, and convincing information about strategies to avoid impacts also increases motivation and behavior toward saving electricity and managing agricultural land [3,12,47].Furthermore, threat appraisal and response appraisal processes can be used to explain how fear and information affect PEB. Perceived severity, perceived vulnerability, and reward contributed to threat appraisal, whereas self-efficacy, response efficacy, and cost contributed to up-response appraisal. According to previous studies [11,18,20], the research results indicate that information influences perceived severity, perceived vulnerability, self-efficacy, and response efficacy.

A person's motivation to use an electric vehicle and a landowner's motivation to manage their land in Indiana are examples of how perceptions of severity, vulnerability, self-efficacy, and response efficacy impact motivation and PEB [12,13]. However, Wang et al and Marquart [12,27], contradicted this finding. Separately, as in the study by Niehoff, Clarke et al, Bockarjova and Steg, and Shafiei and Maleksaeidi [3,13,14,26], perceived severity and vulnerability have a significant effect on motivation and PEB. While self-efficacy and response efficacy had no significant impact, this contradicts the findings of Janmaimool and Wang et al. [11,12]. The relationship between response efficacy and self-efficacy is also significant. Janmaimool [11] explains that information enhances workers' confidence in their own abilities or self-efficacy to be able to behave as suggested and that response efficacy influences self-efficacy and shapes motivation [11]. Shafiei and Maleksaeidi [26], described how information encourages students to believe in the reliability of adaptive behavior in avoiding threats or response efficacy.

Rewards and costs are obstacles to the development of motivation and PEB. Rewards significantly affect PEB, and the costs are negligible. This is in accordance with the statement that comparing the advantages and disadvantages of carrying out environmental behavior inhibits the formation of behavioral changes [11,26,47]. However, Mamady [42], proved that PEB requires greater costs, especially in terms of charges, which determines significant differences in waste management methods (PEB). Finally, the culmination of threat appraisal and response appraisal promotes motivation to protect oneself and directly influences PEB, as well as serving as a mediator for other PMT variables. Motivation is the result of cognitive synthesis and a long process that produces information, fear, and threat appraisal, thus driving behavioral change (PEB) [20]. In general, it can be concluded that PMT variables trigger self-protection motivations that encourage the formation of response behavior to avoid threats, in this case PEB [25,34].

In this regard, it may also be said that to raise students' perceptions of risk and fear, more information on environmental harm, climate change, and its effects must be shared widely among them. Additionally, both students' motivation and pro-environmental conduct were greatly increased. Stricter laws regarding environmentally friendly behavior can eliminate rewards used as convenience for maladaptive behavior. Students who engage in maladaptive behavior may face consequences from policies, which will take away their sense of "reward". In addition, students who practice environmentally friendly behavior should be given more credit to remove the adverse connotation associated with "reward". Future research could examine the impact of combining methods of eliminating rewards and increasing information on PEB and motivation.

Conclusions

The study's findings confirm that a student's or family's educational, demographic, and socioeconomic backgrounds have a negligible effect on students' PEB. Since all the students in the sample were from similar backgrounds, there were constraints on their age, knowledge, and economic standing. Gaps in influence due to educational, demographic, and socioeconomic backgrounds could not be identified because of the sample's generally similar (homogeneous) characteristics. Subsequently, the SEM analysis established that PMT factors impact PEB and motivation. PEB is strongly impacted by information, fear, and risk perception (reward, perceived severity, and perceived vulnerability), and is directly and indirectly mediated by motivation. Furthermore, studies have shown that several PMT parameters such as cost, response efficacy, and self-efficiency have slight and indirect effects. The findings of this study provide suggestions for improving public awareness of the dangers of climate change on human health and safety. This is expected to improve fear and risk perception, which may result in improvement in PEB. Additionally, stricter environmental behavior regulations are needed to penalize polluters and stop rewarding maladaptive behaviors.

Author Contributions

DENF: Conceptualization, Methodology, Software, Investigation, Writing & Editing; **AN**: Methodology, Writing - Review & Editing, Supervision.

Conflicts of interest

There are no conflicts to declare.

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