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Environmental intentions and attitudes and their influence on pro-environmental behavior in engineering students and practicing engineers

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Abstract— This study focuses on the critical relationship between human activities and climate change, with a particular emphasis on the instrumental role of environmental education in mitigating environmental damage. While environmental education is a globally significant research area, its impact in Mexico is hampered by a lack of comprehensive guiding documents. This study introduces a structural equation model (SEM) to investigate the influence of environmental intention (EBI), environmental attitudes (EA), private pro-environmental behaviors (PPEB), and public pro-environmental behaviors (PPC) among engineering students and professionals in the Mexican maquiladora industry. With 1449 questionnaire responses from Ciudad Juarez, the study validates six hypotheses. The findings highlight the significant influence of EBI on EA and PPEB, and the positive impact of high EBI levels on EA, PPEB, and PPC. The study underscores the pivotal role of environmental education in fostering pro-environmental attitudes and behaviors in educational and industrial settings. The recommendations include promoting individual actions among students and engineers through educational programs and providing incentives to cultivate a pro-environmental culture, thereby offering practical solutions to the environmental challenges we face.

Keywords— Environmental knowledge, attitude, intentions, Pro-environmental behavior, Mexican universities, Mexican maquiladora industry

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Intenciones y actitudes ambientales y su influencia en el comportamiento pro ambiental en estudiantes de ingeniería e ingenieros en ejercicio

Resumen— En este estudio se abordó la relación entre las actividades humanas y el cambio climático, destacando el papel de la educación ambiental como herramienta para mitigar el daño ambiental. Aunque la educación ambiental es un tema de investigación prominente a nivel mundial, en México sigue siendo limitada debido a la falta de documentos orientadores. La investigación presenta un modelo de ecuaciones estructurales (SEM) que examina la intención ambiental (EBI), las actitudes ambientales (EA), los comportamientos proambientales privados (PPEB) y los comportamientos proambientales públicos (PPC) entre estudiantes de ingeniería y profesionales de la industria maquiladora mexicana. Con 1449 respuestas de cuestionarios de Ciudad Juárez, el estudio valida seis hipótesis. Los hallazgos revelan que EBI influye en EA y PPEB, mientras que niveles altos de EBI afectan positivamente a EA, PPEB y PPC. El estudio sugiere que fomentar las intenciones ambientales en entornos educativos e industriales conduce a actitudes y comportamientos proambientales. Se recomienda promover acciones individuales entre estudiantes e ingenieros mediante programas educativos e incentivos para cultivar una cultura proambiental.

Palabras clave: actitud, comportamiento proambiental, conocimiento ambiental, intenciones, universidades mexicanas, maquiladora mexicana.

1 Introduction

Since the Industrial Revolution, human progress has led to neglecting nature's limits, causing ecosystem deterioration and resource depletion [1]. Socioeconomic, institutional, and geographical factors primarily influence climate change. Abbas declares that environmental pollution causes increased temperatures, changes in rainfall and storm patterns, and glacier retreats.

Climate change negatively impacts biodiversity, human lives, and economic development because it is linked to air pollution, health, natural resources, and economic and social concerns, particularly inequality and education [2]. Therefore, analyzing this environmental phenomenon from social, economic, and political perspectives is crucial. Environmental Education (EE) promotes lifestyle changes and behaviors that decelerate environmental degradation [3] and has been recognized since the World Environment Conference in 1972. The Official Journal of the Mexican Federation [4] defines EE as a training process to promote integrated environmental perception and rational social and environmental development behaviors.

Moreover, EE focuses on understanding the relationship between natural and built environments, addressing social problems caused by industrialization, restoring links with nature, and educating future generations on encouraging positive environmental change seems increasingly important [5]. Thus, EE aims to develop pedagogical strategies to raise awareness of human responsibility and critical thinking in environmental problems [6]. The interdependence of the modern world is evident as decisions and activities in different countries can have global repercussions.

Thus, EE in educational institutions must address global environmental culture, lifestyles, and resource challenges and build knowledge, attitudes, skills, and values for life [7]. Studies have examined environmental behavior (EB), environmental attitudes (EA), and public and private pro-environmental behavior to understand the level of Environmental knowledge (EK) in societies.

However, behavioral intention (BI) is crucial for adopting sustainable lifestyles, as it helps understand pro-environmental behavior and conditioning factors. Intention can predict behavior based on previous beliefs, social norms, and motivations. Predictive norms, habits, and values influence today's behavior by forming behavioral impulses [8]. Understanding these factors is essential for designing socio-environmental intervention programs.

Personal norms represent moral obligation, while subjective norms represent specific behavior patterns. Personal norms influence pro-environmental behavior better than subjective beliefs [9], and research has shown their relationships [10]. Additionally, community social capital and personal motives positively affected pro-environmental intentions. Economic gains and precautionary norms are related to intentions, highlighting the trending topics of environmental and behavioral intentions of the scientific community [11].

A positive relationship between EA and BI is vital for EK measurement [12]. EAs are influenced by media exposure, and individuals with greater exposure are more motivated and environmentally friendly. Therefore, to promote a better society, environmental communication should focus on disseminating environmental information to promote a better society [13].

Therefore, pro-environmental behavior (PEB) can be classified as deliberate, purposeful, or compulsory actions undertaken to minimize adverse environmental impacts or enhance positive effects. Depending on the circumstances, these actions may be habitual or intentional [14]. Social and individual requirements can also influence this behavior to ensure environmental protection [15]. Schultz [16] highlighted the connection between environmental issues and human behavior, stating that modifying behavior to promote sustainability is related to individual variables such as values, attitudes, beliefs, and reasons.

Additionally, some authors have highlighted the impact of environmental behavior on society, with both individual and collective actions influencing public behavior. PEB is linked to tourism because destinations can use environmental images to reduce negative impacts [17].

The inaugural intergovernmental conference on environmental education, held in Tbilisi, Georgia, on April 20, 1997, underscored the pivotal role of environmental education in comprehending and addressing global environmental issues [18].

EE is crucial for training new human resources, such as engineers, graduates, administrators, and personnel. Countries such as the US, China, and the UK recognize the importance of ED in preparing them for civilian and executive roles [19]. For this reason, some countries have focused on EE for students, mainly because they have the commitment and responsibility to manage environmental problems as future business executives. Some researchers report the experience from some countries; for example, Salehi, et al. [20] in Iran and Japan; Tofighi and Jackson [21] in the United States; Saracli, et al. [22] in Turkey, Piyapong [23] and Janmaimool and Khajohnmanee [24] in Thailand, and Higuchi, et al. [25] in Brazil, among other works.

Regarding EE research in Mexico, only 24 documents were found, and only one was associated with higher education (Business Administration) [26]. Others have focused on elementary education or specific issues, such as specific attitudes associated with waste recycling [27] and environmental consumption attitudes [28]. In addition, Mexico has constantly grown its manufacturing industry and has trade agreements, such as the North American Free Trade Agreement. Therefore, it would be interesting to understand the impacts generated by this industry because it opens opportunities for companies to improve their environmental management systems.

According to the National Institute of Statistics and Geography (INEGI), Mexico's Manufacturing, Maquiladora, and Export Service Industry (INMEX) comprise 5,160 companies in 2022. Of these, 322 were in Ciudad Juarez, accounting for 6.2 % of the national total and 66.25 % of the state's total. These companies contribute to the country's economy by generating 2,938,160 direct jobs and significantly creating social welfare [29].

Industrial growth has increased urban solid waste, which requires urgent attention [30]. EE can help address this issue, particularly for those with greater environmental responsibility in public or managerial positions. This study investigates EI, attitudes, and PEB among engineering students and engineers in Ciudad Juarez's industry. It aims to understand students' EK and promote an environmental culture in educational institutions and workplaces.

Section two delivers a literature review, section three explains the methodology, and section four presents a structural equation model illustrating the relationships between the studied variables. Finally, section five offers the findings and their interpretations.

2. Literature review and hypotheses

2.1 Environmental Behavioral Intention (EBI)

Behavioral intention is an interactive process that develops before lifestyle adoption and is influenced by cultural and educational factors and contextual and attitudinal variables [31], affecting environmental behavior and disposition. Previous studies have explored EBI in various countries; for example, Gkargkavouzi, et al. [32] in Greece explored the association between intentions and environmental motives using structural equation models (SEM) and Liu, et al. [12] in China found that positive and significant associations between behavioral intentions and environmental behavior.

2.2 Environmental Attitudes (EA)

Environmental attitudes (EA) have assumed an imperative role in environmental psychology, and various measurement instruments have been developed to explore the interconnection between attitudes and other factors [33].

In addition, experts agree that attitudes are influenced by beliefs, feelings, and behavioral intentions with stable interactions [34]. Thus, over the years, the EBI has been involved in scientific studies to represent and measure how intention to act influences attitudes toward environmental problems. The following hypothesis was formulated to assess the influence of EBI on EA.

H_1: Environmental Behavioral Intention has a direct and positive effect on Environmental Attitudes.

2.3 Private Pro-Environmental Behavior (PPEB)

As indicated by Junot, et al. [35], it is assumed that environmental issues and human behavior are related to how people's behavior is modified to make it more pro-environmental, thus promoting a more sustainable environment. Research on environmental issues primarily examines individual variables, such as values, attitudes, beliefs, and reasons for pro-environmental behavior [16]. The following hypothesis aims to demonstrate the influence of EBI on PPEB.

H_2: Environmental behavioral intentions directly and positively affect private pro-environmental behavior.

Recent research suggests that attitudes toward environmental care and conservation must change as they influence individual and collective behaviors toward environmental protection and resource conservation [36]. Individuals using these strategies have improved knowledge, attitudes, intentions to change lifestyles, and collaboration to improve and protect the environment. This study aimed to investigate the proposition that fluctuations in EA may be linked to PPEB, according to the following hypothesis.

H_3: Environmental attitudes directly and positively affect private pro-environmental behavior.

2.4 Public Pro-Environmental Performance (PPC)

Some studies mention the origin of behavior as a behavioral intention determined by attitudes towards the environment [35], and it is vital to identify whether behavior remains favorable to the environment inside and outside the home. Higher education levels have been linked to increased environmental awareness, but a complete picture of the factors contributing to this is not yet available [37].

Attitudes and intentions are strongly linked to human activity, such as encouraging protective behaviors like using public transportation, reducing energy consumption, and donating income to environmental care [12]. This study examined the relationship between EBI and PPC and proposed the following hypothesis:

H_4. Environmental behavioral intentions directly and positively influence public pro-environmental behaviors.

A favorable attitude toward an object or environment leads to good behavior. The behavioral component is a direct, measurable element that aids in evaluating attitudes. Studies suggest links between attitudes and environmental behaviors, enabling the identification of behaviors related to environmental issues and modifying attitudes that promote behavioral change [38].

In addition, EA and behavioral interactions are crucial for encouraging environmentally friendly activities [39], and the following hypothesis is proposed.

H_5. Environmental attitudes directly and positively affect public pro-environmental behaviors.

Zheng, et al. [40] mention that environmental behavior develops differently in public because it impacts people's behaviors when members observe. It is widely acknowledged that individual and collective behaviors play a critical role in promoting environmental sustainability. Common pro-environmental behaviors, such as recycling materials and using public transportation, can be differentiated individually and collectively. Adopting these behaviors often involves associations and may require higher levels of engagement and investment. Additionally, collective actions can involve participating in associations for environmental care, participation in demonstrations, or any activity that suggests a higher cost and relationship with people [41]. The hypothesis proposed in this study posits that PPC significantly influences PPEB.

H_6. Public pro-environmental behavior (PPC) directly and positively affects private pro-environmental behavior (PPEB).

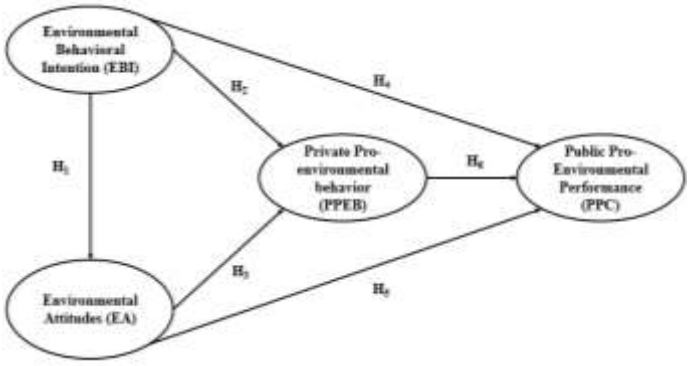

Figure 1. Proposed hypotheses.
Source: own elaboration (2023)

3 Methodology

3.1 Questionnaire design

The research project employed a questionnaire to collect data from engineering students and experienced engineers using a comprehensive literature review in Science Direct and Scopus databases. The findings of this literature review represent a rational validation [42]. The questionnaire consists of three sections: demographic information, knowledge, attitudes, and risk. It also includes the benefits respondents can achieve by fulfilling their environmental knowledge. Section 1 is optional, while sections two and three are mandatory to avoid missing values. The questions are answered on a five-point Likert scale.

3.2 Validation by Judges

The questionnaire was validated by judges, including six engineering academics and five managers, to understand Mexico´s industrial environment, and it was finalized after three rounds. The Judges evaluate consistency, relevance, sufficiency, scale and structure.

3.3 Operationalization of variables

The operationalization of variables identifies items measuring four latent variables and describes data collection activities from a selected population [43]. The latent variables and their items appear as supplementary material; however, the latent variables and authors' sources are as follows: Environmental behavioral intention [12], [32] and [44]; Environmental attitudes [45] and [46]; Private pro-environmental behavior [12], [45] and [44]; Public pro-environmental behavior [12], [45] and [44].

3.4 Application of the questionnaire

The Research Ethics Committee of the Universidad Autónoma de Ciudad Juarez reviewed the research proposal and adhered to the Declaration of Helsinki [47]. A questionnaire was administered online to university students and active engineers in the Maquiladora industry in Ciudad Juarez, which required permission from educational institutions. A questionnaire was emailed to practicing engineers and students, with responses ranging from 15 days to three days. If no response was received, the patient was discarded. The questionnaire remained open until December 2022, and the CVS extension database was downloaded for analysis.

3.5 Debugging of information

Before the database analysis, it was debugged using the following procedure [48]: The study identifies uncommitted respondents by obtaining the standard deviation for every questionnaire and discarding cases with lower values. Outliers are denoted by standardizing all items in sections two and three, where absolute values surpassing four are replaced with the median, as such values are extreme.

3.6 Statistical validation of variables

The statistical validity of variables refers to their ability to measure what they are designed to measure [49], and the following indices were used to validate them [50]:

- Parametric predictive validity was assessed using adjusted R^2 and R^2 values, with the expected values exceeding 0.02.
- Q^2 measures nonparametric predictive validity, expecting values similar to R^2 and greater than zero.
- Cronbach´s alpha and composite validity index measure internal validity, expecting values exceeding 0,7.
- The average variance extracted (AVE) measures convergent validity, with factor loadings on latent variables also reported. The desired value must be bigger than 0,5.
- The variance inflation index (VIF) measures collinearity within latent variables and must be less than five.

3.7 Structural Equation Model

The hypotheses presented in Fig. 1 were verified using a structural equation model (SEM), which establishes connections between latent variables and their independent and dependent roles [51]. The partial least squares (PLS) approach was utilized, as it is commonly recommended when a small sample size, Likert scale data, or non-normal data distribution is present [52]. Before model interpretation, the following efficiency indices were analyzed with a confidence level of 95% for predictive validity: the average path coefficient (APC), average R-squared (ARS), and adjusted average R-squared (AARS). Multicollinearity was measured using the average block VIF (AVIF) and average full collinearity VIF (AFVIF), with values below five being better. Data fit was assessed using the Tenenhaus index (GoF), with values above 0,36 being better.

3.7.1 Direct, indirect, and total effects

Three distinct effects between latent variables were estimated using WarpPLS V.8 software. Direct effects were employed to validate the hypotheses, with a standardized β value as a measure of dependence. The null hypothesis, H_0: $\beta=0$, was tested against the alternative hypothesis, H_1: $\beta\neq0$, to determine the existence of a relationship between variables. If $\beta=0$, no relationship exists; however, if $\beta\neq0$, the variables are interconnected. A p-value was assigned to each β value, allowing for the determination of its statistical significance at a confidence level of 95 %. The indirect effects between variables involving one or more mediating variables were also reported. The total effects are the aggregate of direct and indirect effects, and each beta estimated is gauged by effect size (ES) such that the sum of all ES in a dependent variable equals R^2.

3.7.2 Sensitivity analysis

A sensitivity analysis of the proposed model is presented in Table 6. The probability values corresponding to the high scenario are denoted by the symbol "+" in each latent variable. At the same time, the sign "-" is used to represent the probability values associated with the low scenario. Furthermore, the sign "&" is used to represent joint probabilities, whereas the term "if" is employed to denote conditional probabilities. As an illustration, the co-occurrence probability of EBI+ and EA+ was 0.087. Nevertheless, the conditional likelihood of EA+, given the occurrence of EBI+, was 0.536. Similarly, the likelihood of EA transpiring, given the prior occurrence of EBI-, was determined to be 0.472. This finding implies that when EBI has negative results, the prospects for fostering pro-environmental aspirations are unlikely to be positive or

actualized. Similarly, the remaining connections can be viewed similarly.

4 Results

Descriptive analysis of the sample. A questionnaire was used to gather data from university engineering students and engineers in the Ciudad Juarez maquiladora industry. The results showed decreased gender gaps in engineering, but the male gender still dominated. The automotive sector has the highest participation, followed by the medical and electronics sectors. Industrial and systems engineering had the highest participation, followed by mechatronics and manufacturing engineering.

Statistical validation of variables. The seven indices shown in Table 1 through R^2, modified R^2, and Q^2 verify the latent variables' necessary parametric and nonparametric predictive validity. Figures showed internal validity for Cronbach's alpha and composite reliability, both above 0.7. Collinearity issues were eliminated, VIF values were below 3.3, and AVE values demonstrated convergent validity.

Table 1
Validation of the survey.

Index	PPC	BI	EA	PEB
R^2	0.366		0.349	0.399
Adj. R^2	0.365		0.349	0.398
Composite Reliability	0.901	0.905	0.878	0.901
Cronbach's alpha	0.862	0.86	0.825	0.853
Avg. Var. Extract. (AVE)	0.646	0.705	0.59	0.872
VIF	1.561	1.964	1.604	2.002
Q^2	0.366		0.35	0.4

Source: Author

Structural Equation Model**.** The validation indices in Table 3 demonstrate that the integration of variables into the SEM is valid, as indicated by the p-values < 0.05 for APC, ARS, and AARS; therefore, the model has sufficient predictive validity and can be interpreted with 95 % confidence.

Table 2
Model fit and quality of fit indices.

Index	Value	Best if
APC	0.326 (p<0,001)	p<0.05
ARS	0.371(p<0,001)	p<0.05
AARS)	0.371(p<0,001)	p<0.05
AVIF	1.642	<5
AFVIF	1.783	<5
GoF	0.511	>0.36

Source: own elaboration

Collinearity problems were absent; the AVIF and AFVIF values were less than 3.3, while the GoF index was 0.511, indicating good data fit, and these values collectively suggest that the model can be interpreted with confidence. Fig. 2 displays the model's performance, including the β values for each relationship, the associated p-value, and the R^2 values for the dependent variables, which measure the variance.

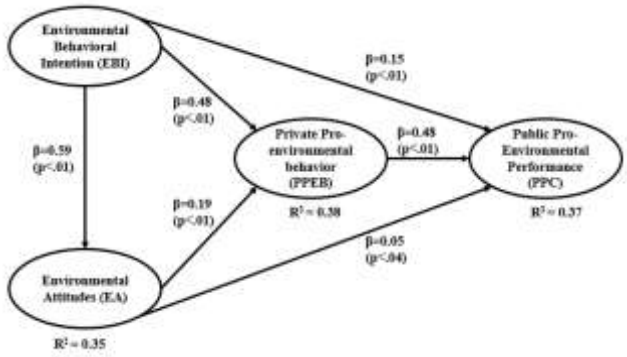

Fig 2. Evaluated model.
Source: own elaboration

Direct Effects. Fig. 2 illustrates the direct effects in the model, with p-values indicating statistical significance. For instance, there is a positive and direct effect between EBI and EA, with β=0.59 (p < 0.01) suggesting that an increase in the standard deviation of EBI by one unit leads to an increase in EA by 0.59 units. Additionally, Fig. 2 shows the R^2 values associated with each latent dependent variable. For example, EBI accounted for 35 % of the variation in EA due to an R^2 value of 0.35.

Table 3.
Hypotheses validation.

Hyp	Independent variable	Dependent Variable	β	P-value	ES	Conclusion
H_1	EBI	EA	0.59	<0.01	0.349	Accept
H_2	EBI	PEB	0.48	<0.01	0.287	Accept
H_3	EBI	PPC	0.15	<0.01	0.069	Accept
H_4	EBI	PEB	0.19	<0.01	0.091	Accept
H_5	EBI	PPC	0.05	<0.04	0.017	Accept
H_6	PPEB	PPC	0.48	<0.01	0.286	Accept

Source: own elaboration

Table 3 summarizes the conclusions drawn from the beta values and p-values, detailing the acceptance or rejection of the hypotheses. Indirect effects. Table 4, shows three statistically significant indirect effects were observed among the latent variables at the 95 % confidence level.

Table 4
Sum of indirect effects.

To → From	β	P-value	ES
EA →PPC	0.092	<0.001	0.034
EBI→PPC	0.260	<0.001	0.120
EBI→PPEB	0.113	<0.001	0.067

Source: own elaboration

Total effects. Table 5 shows the total effects of the latent variables. Several total effects are identical to direct effects, as the relationships between the variables have no indirect impact. The greatest total effect was related to the EBI with EA and EA with EBI.

Table 5.
Total effects.

	EA	EBI	PPEB
PPC	0.138 (p<0,001) ES=0.050	0.464 (p<0.001) ES=0.215	0.483 (p<0.001) ES=0. 286
EA		0.591(p<0.001) ES=0.349	
PPEB	0.191 (p<0.001) ES=0.091	0.596 (p<0.001) ES=0.355	

Source: own elaboration.

Sensitivity analysis**.** Table 6 displays the formal sensitivity analysis of the model assumptions. The probabilities associated with high and low scenarios for each latent variable are denoted by the symbols "+" and "-" respectively. Moreover, "&" denotes joint probabilities and a "if" denotes conditional probabilities. As an illustration, the likelihood that EBI+ and EA+ will occur together is 0.087, yet the likelihood that EA+ will occur after EBI+ has occurred is 0.536. Similarly, if EBI is negative, there is a 0.472 chance that EA will occur, given that EBI has already occurred, indicating that pro-environmental objectives will not be favorable or achieved. Other relationships may be interpreted similarly.

Table 6
Sensitivity Analysis.

	Probability	BI+	BI-	EA+	EA-	PEB+	PEB-
		0.162	0,150	0.182	0.132	0.170	0.168
EA+	0.182	&=0.087 if=0.536	&=0.004 if=0.028				
EA-	0.132	&=0.007 if=0.043	&=0.071 if=0.472				
PPEB+	0.170	&=0.080 f=0.494	&= 0.003 f=0.018	&=0.074 if=0.407	&=0,003 f=0.026		
PPEB-	0.158	&=0.005 f=0.030	&=0.071 f=0.472	&=0.011 f=0.061	&=0.058 f=0.440		
PPC+	0.155	&=0.064 f=0.396	&=0.004 f=0.028	&=0.063 f=0.346	&=0.005 f=0.037	&=0.093 f=0.549	&=0.006 f=0.039
PPC-	0.168	&=0.012 f=0.077	&=0.064 f=0.427	&=0.019 f=0.109	&=0.050 f=0.382	&=0.006 f=0.037	&=0.083 f=0.524

Source: own elaboration.

5. Discussion of results

5.1 Structural Equation Model

This study utilized a structural equation model to evaluate the correlations between EBI, EA, PPEB, and PPC variables among engineering students and active engineers operating within the Mexican Maquiladora sector. Six hypotheses were developed for this purpose. The obtained results provide a basis for subsequent discussion. The relationship between Environmental Behavior Intention (EBI) and EA was positive and direct (H_1). Specifically, an increase in the standard deviation by one unit led to a corresponding increase in EA by 0.59 units. The findings of Alsaad, et al. [53] support the notion that individuals' engagement in environmental conservation reflects a sense of concern and accountability, thereby enhancing their inclination to engage in ecologically responsible behaviors. Furthermore, a study by Liu, et al. [12] indicated a clear and positive relationship between environmental views and environmental goals. In summary, students and practicing engineers demonstrated a shared inclination to reduce consumption and preserve resources as part of their commitment to environmental stewardship. In the forthcoming months, there is a strategic intention to curtail the squandering of natural resources through initiatives to preserve the environment.

Moreover, the results indicate that EBI has a direct and beneficial impact on PPEB (H_2), as there is evidence that an increase in pro-environmental intentions is associated with enhanced private behaviors. This conclusion is consistent with that of Carfora, et al. [54], who found a connection between the intention to engage in pro-environmental acts and individual behaviors. Furthermore, Fang, et al. [55] determined that there is no direct correlation between the EBI and pro-environmental behavior due to the inconsistency between the beliefs and behaviors of students. We examine the associations between behavioral intentions and private pro-environmental behavior to discern the factors and obstacles that impede the adoption of pro-environmental actions.

Therefore, the Mexican maquiladora business demonstrates that proactive engineers place high emphasis on implementing initiatives such as public transit, water conservation, and environmental awareness. Hence, it is imperative for universities and industries to actively encourage behavioral intent through training programs, seminars, and informative sessions that elucidate the environmental advantages of both students and employees. Furthermore, it can be shown that EAs have a positive and direct effect on PPEB (H_3), because when the first variable corresponds to increments in its standard deviation, the second variable increases by 0.19 units. The findings indicate that it would be beneficial to implement initiatives such as promoting activities, offering educational courses, and providing incentives to foster a sense of motivation toward environmental conservation. Additionally, it is important to focus on changing individuals' views towards the environment into tangible actions that support pro-environmental behaviors in university and workplace settings. Corraliza and Berenguer [56] provide empirical evidence supporting the correlation between individuals' environmental views and their engagement in pro-environmental actions,

specifically in the context of recycling practices within domestic settings.

Based on the available statistical evidence, it can be confidently asserted that there is a direct and positive correlation between EBI and PPC (H_4). Specifically, when the standard deviation of the first variable increased by one unit, the second variable increased it by 0.15 units. These findings agree with Liu, et al. [12], who mentioned that environmental and behavioral intentions positively affect pro-environmental behaviors, and with Carfora, et al. [54], who analyzed whether people with stronger intentions are likely to engage in pro-environmental behaviors, suggesting that intentions are related to present and past pro-environmental behaviors.

In addition, Wu, et al. [57] showed a lack of correspondence between pro-environmental intentions exhibited during vacations and the subsequent manifestation of pro-environmental behaviors. Hence, the results obtained from our research and the existing body of literature provide empirical evidence that substantiates the association between behavioral intentions and pro-environmental conduct. Despite the lack of beneficial outcomes in certain studies, these findings provide valuable insights into the identified challenges. Therefore, there are distinct behavioral patterns between students and engineers in public settings, and educational institutions have the potential to foster programs and activities aimed at disseminating knowledge about the advantages that might incentivize students' intentions and actions.

The findings suggest significant statistical support for the assertion that EA has a direct and beneficial impact on PPC, as stated in hypothesis H5, since when the standard deviation of the first variable is increased by one unit, the second one increases by 0.050 units. Despite its relatively low magnitude, this effect is important in examining the behavioral shifts of engineers and students in public settings. Nevertheless, it is worth considering other factors that can be analyzed and strategies implemented to facilitate the utilization of EA in meetings or work teams, as highlighted by Bleidorn, et al. [15], who revealed that there is a positive correlation between pro-environmental beliefs and pro-environmental consumer actions. This relationship persists over time among individuals with varying demographic and psychological characteristics.

Our results are similar to those reported by those who found that nursing students have positive environmental attitudes, but their behavior is not always reflected. They proposed improving environmental training in the last two academic semesters when students have developed maturity and environmental awareness.

Finally, the statistical data show a direct and positive relationship between PPEB and PPC (H6), wherein a one-unit increase in the former leads to a 0.483-unit increase in the latter. This indicates that a PPEB fosters a PPC, repeating habits learned at home in public social settings that require EBI and EA.

Our study's findings align with those of Aronsson et al. [59], which indicates that nursing students have favorable environmental views. However, it is important to note that there may be discrepancies between their beliefs and actual behavioral practices. The authors suggest enhancing environmental education during the last two academic semesters when students cultivate greater maturity and environmental consciousness.

Ultimately, there is sufficient statistical data to assert that PPEB has a direct and favorable impact on PPC (H6). This is evident, as an increase of one unit in the former variable corresponds to a 0.483 unit rise in the latter variable. This suggests that PPEB contributes to the manifestation of PPC, as individuals replicate environmentally conscious behaviors acquired in their lives in public social contexts. This phenomenon necessitates the presence of EBI and EA.

Our study's findings align with those of Wan and Du [60], as they indicate a positive correlation between adherence to social norms and the level of social engagement and a greater inclination to embrace both individual and collective pro-environmental actions. According to Kulin and Johansson Sevä [58], people with environmental consciousness are inclined to participate in pro-environmental actions within both private and public domains, particularly in nations characterized by equitable, efficient, and unbiased governmental structures.

Consequently, educational institutions offer several suggestions, including encouraging public transportation, providing extra environmental education classes, employing eco-friendly materials, and encouraging recycling different goods. They may also reduce the amount of paper and energy used in the industrial sector and use environmentally friendly equipment. Managers may also encourage pro-environmental behavior by offering incentives, such as movie tickets, meal coupons, and visual recognition.

5.2 Sensitivity analysis

The findings indicate that managers of educational institutions and companies should encourage EBI+ as precursors of EA+, PPEB+, and PPC+ since the conditional probabilities of occurrence are 0.536, 0.494, and 0.396, respectively. Furthermore, the efforts of managers and directors to encourage EBI+ will not be in vain, as EBI+ is poorly associated with EA, PPEB, and PPC, with conditional probabilities of 0.043, 0.030, and 0.077, respectively, which are very low. This implies that when students and active engineers in the maquiladora industry put environmental behavioral intentions into practice, public and private pro-environmental attitudes and behaviors will benefit.

However, EBI- is a risk for managers and executives because it promotes the occurrence of EA-, PPEB-, and PPC-, with probabilities of occurrence of 0.472, 0.472, and 0.427, respectively. In addition, EBI − was only weakly associated with EA+, PPEB+, and PPC+, as the conditional probabilities of occurrence were 0.028, 0.018 and 0.028, respectively. Thus, managers and directors should generate environmental intentions to promote their workers' and students' public and private attitudes and behaviors.

In addition, the results show that EA+ is a precursor of PPEB+ PPC+ because the conditional probabilities of occurrence were 0.407 and 0.346, respectively. Similarly,

university managers and directors achieve better results by fostering EA+ because it is only weakly associated with PPEB- and PPC-, as the conditional probabilities of occurrence are 0.061 and 0.109, respectively. Therefore, as Nieves Mendoza and Morales Cely (2022) mentioned, attitude formation is a complex process influenced by several factors and affirms that affective, cognitive, and intentional dimensions conspire to generate this mental structure. Thus, pro-environmental attitudes should be included as a fundamental part of higher education to help young people develop positive attitudes toward the environment [59].

However, EA- presents unfavorable scenarios for industry executives and managers because it encourages the occurrence of PPEB- and because the probabilities of occurrence are 0.440 and 0.382, respectively. Attitude is a fundamental part of an individual's personality, and emotion is sufficient to trigger action, even if it is influenced by social norms, roles, values, or beliefs [60].

Therefore, it is essential to mention that promoting environmental attitudes in classrooms and workplaces will improve both private and public pro-environmental behaviors. It also generates benefits, such as savings in the use of materials, reduction in the cost of utility bills (water and electricity), and a more significant relationship with international clients who are interested in creating ties with companies that are socially responsible for the environment.

In addition, the results indicate that those in charge of the Maquiladora industry and universities should encourage PPEB+ because it is a precursor of PPC+, given that its probability of occurrence is 0.549. In addition, PPEB+ had a weak relationship with PPC, with a probability of occurrence of 0.37. As previously mentioned, a more sustainable environment will be promoted as people's behavior is modified to be more pro-environmental. Therefore, it is essential to redirect the individual behavior of students and engineers in the maquiladora industry.

Foster, et al. [61] mentioned that employees interested in environmental concerns would participate in pro-environmental activities and influence other employees to participate. Once oriented, they would voluntarily perform pro-environmental behaviors daily without being instructed by managers. However, PPEB- may present unfavorable scenarios in universities and maquiladora industries because the probability of PPC- is 0.524, and human behavior is known to be the root cause of environmental problems. Pro-environmental behaviors are more likely to occur only when stimulated by Liu, et al. [12]. This indicates that if private pro-environmental behavior is not encouraged, public pro-environmental behavior will not result.

6 Limitations and future research

Environmental education is dynamic and incorporates several factors, including attitudes, behaviors, and intentions toward future behaviors. However, the most significant constraint was the difference in behavior between engineering students and practicing engineers in private and public settings. Although the two groups are connected, the effect that one has on the other is relatively small. Therefore, it is essential to consider the elements responsible for this transformation. Subsequent studies might incorporate factors such as the amount of knowledge, values, or advantages achieved, whether environmental, economic, or social.

Data availability

Data used in this paper is available at https://doi.org/10.17632/jj7ks3kf8x.1

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