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Original Research

Reducing Single-Use Plastic Bags to Combat Pollution: Analyzing Drivers and the Role of Environmental Policy Among Chinese Millennials

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Abstract

Environmental pollution is a widespread issue with significant implications for ecological health, environmental quality, and biodiversity. Plastic pollution has become one of the most pressing environmental issues as the rapidly increasing production of disposable plastic products overwhelms the world's ability to deal with them. Moreover, plastics have become an integral part of human life, and the use of single-use plastic bags has increased in recent times, creating severe environmental pollution and global sustainability problems. Therefore, a reduction in single-use plastic bags is necessary to control environmental pollution and decrease its carbon footprint. Therefore, this study used partial least squares structural equation modeling to analyze data collected from 567 Chinese millennials to investigate the drivers of single-use plastic bag reduction to improve environmental quality in China. Moreover, the study also analyzed the moderating role of environmental policy perception between environmental concerns and single-use plastic bag use reduction to assist policymakers in improving environmental quality. The results showed that environmental knowledge, carbon footprint reduction awareness, and environmental concerns significantly affected the single-use plastic reduction attitudes of citizens. The results also indicated that environmental policy promotion assists in decreasing plastic pollution by decreasing the use of single-use plastic bags. A pro-environmental attitude was also found to positively affect single-use plastic bags. Therefore, environmental policies and awareness about the carbon footprints of individual actions should be created to control plastic pollution and improve environmental quality globally.

Keywords: environmental pollution, pro-environmental behavior, plastic waste, single-use plastic, carbon footprints

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Introduction

Environmental pollution is one of the most prominent issues faced by the current generation in the era of climate change. Single-use plastic waste has significant environmental impacts, which have severe implications for ecological health, environmental quality, and sustainable development. A synthetic organic polymer, now known as plastic, was first created for public use over a century ago [1]. The use of plastic bags (PBS) worldwide ranges from five hundred billion to five trillion PBS annually [2]. The use of PBS in China is nearly three billion per day [3], and it may take more than 100 years for each PBS to biodegrade [3, 4]. Moreover, the production of PBS is expected to increase two-fold over the next 20 years, exceeding our ability to handle plastic waste pollution [5]. The multifunctional properties of plastics have markedly improved over the last three decades in almost all facets of life. Dump and landfill sites, which are conventional methods of waste disposal, have almost reached their full potential [6]. Hence, efforts to minimize or avoid plastics have become an important global issue for improving environmental sustainability [7].

Plastics have become an integral part of daily life, and their production has risen annually over the last 70 years [8]. Plastic is an issue for recycling because the carbon bonds in plastic are not similar to the chemical bonds in traditional raw materials, which are relatively easy and inexpensive to break down [9]. Some plastic materials never decompose but fragment into smaller particles, which may find their way into humans and animals [10]. Therefore, plastic pollution is an emerging environmental problem [11], resulting in detrimental effects on the environmental sustainability of living organisms. In addition, they cause chemical pollution and the formation of microplastics that pollute water, soil, and human health [12]. Plastic pollution is an international issue because water bodies transport it from inland to the seas and oceans, decompose it, or transport it to other nations' shores in international waters [10]. The socio-ecological impacts of plastic waste and plastics are bound to continue because globally, only a small proportion of plastic is recovered for recycling, while a greater part is buried in landfills, burned, or becomes litter [13].

Municipal and traditional plastics are produced from fossil fuels. If these plastics are produced at the current rates, the oil consumption rate will increase by 20% by 2050 [14]. Moreover, if existing waste management practices are not changed, approximately 12 billion tons of plastic will end up in landfills and the environment by 2050 [15]. PBS should be reused and recycled to reduce environmental pollution and improve environmental quality [16]. Despite continuous efforts, plastic recycling rates remain very low worldwide. These low recycling rates are associated with non-existent recycling systems and the unprofitability of plastic recycling [15]. This is a highly sensitive issue that is multi-layered; therefore, ensuring that the problem is well addressed will require research and other strategies. Therefore, countries discourage the use of PBS and make efforts to eliminate or make single-use plastics as well as biodegradable plastics to improve environmental quality [17]. Bio-based plastics are made completely or partially from renewable raw materials, and almost all bio-based plastics are biodegradable [15]. Degradation is defined as the action of degradation by the activity of living microbes. Biodegradable plastics are plastics that are decomposed by living organisms [18]. Consequently, compostable plastics transform through composting to yield CO2, water, inorganics, and biomass, similar to compostable plugs, and have no leftover visibly recognizable fragments or toxicity, thereby improving environmental sustainability [19].

China is the most populated country in the world and is among the largest consumers of single-use PBS [20]. Supermarkets and vegetable markets are the two preferred shopping destinations for Chinese people. Confronted with the overuse of single-use PBS by the population, the country has implemented policies to decrease plastic use to control environmental pollution [20]. The government introduced two laws with the primary objective of reducing single-use shopping bags. For instance, thin PBS that cannot be reused and are generally within 25 μm have not been permitted to be produced or used since 2008, whereas thicker bags greater than 25 μm can be used [20]. In addition, the 2008 policy made it mandatory for all retailers to pass the cost of plastic carrier bags used at the point of sale to their consumers. However, this policy exempts free inner plastic packaging bags used in supermarkets from being charged, as has been observed in other nations [21]. In 2020, the government established a new law stating that not all supermarkets in large cities should utilize non-recyclable PBS by the end of the year [22].

Analyzing people's behavioral intentions towards the single use of PBS is essential to help reduce their usage and improve environmental quality and ecological sustainability. This stems from human intentions and behaviors throughout the process of manufacturing, using, and disposing of PBS [7]. Nonetheless, public environmental consciousness and concerns about plastic risks remain blind spots in the literature on PBS usage reduction [23]. Being environmentally friendly or pro-environmental is a form of prosocial behavior. In this case, it is defined as people who are doing something regarding the protection of the environment or environmental problems. Using fewer PBS is a good pro-environmental behavior.

At present, behavior change research that seeks to find solutions to the plastic problem can be divided into two categories. First, studies have considered policies and regulations as influential factors in manipulating community single-use plastic consumption behavior. For example, Wang et al. [24] discussed the feasibility of reducing plastic waste through environmental regulations. Similarly, Adeyanju et al. [25] stated

that public policies and legislation play a significant role in the adoption of biodegradable products and environmentally friendly actions in daily life. Arriagada et al. [26] investigated the individuals' preferences regarding regulations barring the use of PBS. Second, studies that consider PBS use behavior can be changed through voluntary actions such as education and persuasive information dissemination by raising awareness of individuals' actions regarding carbon footprints [27, 28]. Kurokawa et al. [29] and Situmorang et al. [30] stated environmental education significantly affects ecological knowledge and excites concern about plastic waste problems. Zhou et al. [31] found that policy promotion is one of the key factors influencing consumers' willingness to reduce the use of PBS.

While previous studies have emphasized the role of public policies and legislation as well as voluntary action of individuals in plastic waste reduction behaviors, there is limited integration of these dimensions with behavioral drivers, such as environmental knowledge, carbon footprint reduction, attitudes, and concerns. Moreover, the moderating role of environmental policy perception in shaping behavioral intentions to reduce PBS usage remains underexplored, particularly in the context of China. This study addresses this gap by examining these drivers and their interactions to advance the understanding of sustainable behavior and the influence of environmental policies on reducing PBS usage. Thus, the main objective of this study was to investigate the drivers of behavioral change, such as environmental knowledge (EKN), carbon footprint reduction (CFR), environmental attitudes (ENA), and environmental concerns (ENC) to reduce the use of single-use PBS. The study also aimed to explore the moderating role of environmental policy perception (EPP) between ENA and single-use PBS reduction behavioral intentions (PBRI) to improve environmental sustainability.

Literature Review and Hypotheses Development

Some studies have pointed to a positive correlation between ENA and environmentally friendly practices [32]. These studies have proven that people with favorable ENA towards certain issues are likely to promote environmentally friendly intentions. Piao and Managi [33] stated that ENA positively influences the pro-environmental behavior of consumers. Hall et al. [34] stated that positive ENA is useful in determining that people with stronger pro-environmental attitudes tend to be more likely to engage in pro-environmental behaviors. The above literature proves a strong connection between ENA and PBRI. Therefore, the first hypothesis (H1) of this study is as follows:

H1: ENA significantly affects the PBRI.

EKN is one of the key predictors of pro-environmental behavior, which reflects the level of awareness regarding environmental problems and a general understanding of facts, concepts, and relations concerning the natural environment and its major ecosystems. In its classical meaning, EKN contains factual knowledge equal to the structures, functions, and processes of ecosystems [35]. Liu et al. [36] asserted that general ecological knowledge could predict pro-environmental attitudes. The literature also proves that consumers with long-term EKN are inclined to spend more money on green products and are willing to purchase environmentally friendly products [37]. Such a decision cannot be made if one lacks or possesses incorrect knowledge. Nekmahmud et al. [38] also strongly believed in alignment that consumers' attitudes towards green products are likely to change with increased information on green products. Knowledge has been found to be a key determinant in different theoretical models that explain the connection between attitudes and intentions. Therefore, the second hypothesis (H2) of this study is as follows:

H2: EKN positively affects ENA.

ENC is among the factors that may be used to estimate consumers' environmentally friendly behavior [39]. Previous research on environmental issues is mainly rooted in the ENC. Recent research indicates that when a person is more environmentally concerned, more will be done concerning the environment to protect it [40]. In the case of the planned use of PBS, it may be hypothesized that an individual with a high level of ENC, believing that the use of PBS is environmentally wrong, will not develop the intention to use it or will have a low intention to use it. This implies that ENC has a negative relationship with attitudes towards the use of PBS. In addition, those who are afraid of environmental problems will have a negative attitude towards the use of PBS because PBS are perceived as non-environmentally friendly. The above-discussed literature indicates a strong association between ENC and ENA. Based on this, we propose the third hypothesis (H3) as follows:

H3: ENC has a significant positive effect on the ENA.

Perceived personal self-responsibility regarding personal carbon emissions influences the intention to reduce single-use PBS. When people make a connection between the emissions of carbon and plastics, they move toward the use of better alternatives, such as reusable bags (RB). This suggests that when policymakers provide consumers with an understanding of the environmental impacts of plastics, such as greenhouse gas emissions, they are more willing to embrace sustainable behavior reduction in the single use of plastics [41]. Campaigns aimed at reducing plastic use focus on encouraging individual behavioral changes in daily life, highlighting the crucial role of these changes in achieving environmental sustainability [42]. This discussion shows a strong relationship between CFR awareness and ENA. Therefore, the fourth hypothesis (H4) of this study is as follows:

H4: CFR awareness significantly affects ENA.

Environmental policy promotion (EPP) is an essential tool in environmental governance worldwide. Another important consideration in EPP is the environmental policy instruments that refer to different measures and approaches the government uses to extend its control over society to bring about a change in attitudes and behaviors regarding environmental policy objectives [43]. As the Chinese government becomes more concerned about environmental problems, better environmental laws and policies are continuously being developed and updated, proving China's clear and strong commitment to improving the quality of the environment [44]. To enhance environmental performance, further attention to environmental policies has begun to shift toward the modification of people's behavior in the environmental sector [45]. This implies that policymakers require this insight to understand the structural link between policy measures and environment-friendly behavior and structural pathways from the viewpoint of citizens [46]. Subsequently, researchers have gone ahead and tried or have proposed that the level to which individuals comprehend, acknowledge, and afford environmental policies might influence their environmentally friendly behavior [47]. Another study suggested that individuals with pro-environmental attitudes may cope with them based on policy support as their inner pro-environmental needs. Likewise, those who support public environmental policies may participate in environmentally friendly behavior [48]. EPP has been identified as a moderator between ENA and PBRI in the literature. Thus, the fifth hypothesis (H5) of this study is as follows:

H5: EPP has a significant moderating role between ENA and the PBRI.

Materials and Methods

Study Area and Econometric Technique

A comparative study of the current usage among millennials showed that PBS are the most frequently used plastic products in Nanjing, accounting for more than half of the plastic products. Nanjing was selected as the study area for this study. Studying the pro-environmental behaviors of millennials in Nanjing will assist in improving environmental quality by decreasing plastic pollution. Nanjing has abundant educational and commercial resources that create a good base to promote plastic reduction education and enhance business awareness and engagement in plastic reduction to reduce environmental degradation. This is why this research is being conducted in Nanjing, which helps to obtain a representative sample and information that will be useful in the elaboration of desirable approaches and actions for decreasing PBS utilization for environmental sustainability. It can also serve as a reference source in other regions. The fact that Nanjing is a representative city and has important significance in China makes it possible to investigate the causes of consumer behavior in decreasing the use of PBS. The study used a well-structured, closed-ended questionnaire to collect data from the Chinese millennials. The partial least squares structural equation modeling was used to analyze the collected data of 567 millennials through convenience sampling.

Results

Description of Items

The consumption of single-use PBS has significant environmental implications, particularly in developing economies. Consumer awareness can play a crucial role in lowering the use of single-use PBS to enhance environmental sustainability. All statements were measured on a 5-point Likert scale, where 1 indicates the lowest level of knowledge, and 5 indicates the highest level of consumer knowledge regarding the environment. Therefore, the average EKN1 (3.84) in Table 1 indicates that respondents have a high level of awareness of the environmental impacts of single-use PBS. Similarly, the average score of 3.74 for EKN2 highlights that the respondents also showed a high level of agreement with wastage reduction due to the use of RB. The lowest average of EKN3 (3.39) with the highest standard deviation demonstrates that the respondents did not have a high level of understanding of how single-use PBS can pollute the natural ecosystem with slightly high variation in responses, indicating that most of the respondents may have substantial understanding, but others do not. A slightly good response to EKN4, with an average of 3.48, indicated that respondents generally considered the role of their choices in lowering plastic pollution in the environment. The overall average of 3.61 indicates the respondent generally has a considerable level of awareness of the environmental impact of single-use PBS.

The use of single-use PBS majorly contributes to carbon emissions, and respondents have shown serious concern with their aim of reducing the carbon footprints regarding their use of PBS. Overall, they indicated a high level of sense (CFR = 3.82) toward carbon footprint reduction by lowering the use of PBS. Among all individual items such as "I believe using RB reduces the carbon footprints (CFR1)," reducing my carbon footprints is important while choosing between single-use plastic and RB (CFR2)," "I am willing to use RB to help reduce greenhouse gas emissions (CFR3)," "I feel a sense of responsibility to reduce the carbon footprint through my bag choices (CFR4)," and "I think using RB is an effective way to reduce carbon emissions (CFR5)" attain a high level of agreement as their average is close to point 4 on a Likert scale. This indicates that the respondents are responsible for lowering the carbon footprint while reducing the use of single-use plastic,

Table 1. Description of items.

Constructs and indicators	Mean	Std. Deviation
Environmental Knowledge (EKN)	3.61	0.95
EKN1	3.84	0.9
EKN2	3.74	0.87
EKN3	3.39	1.02
EKN4	3.48	0.93
Carbon Footprints Reduction (CFR)	3.82	0.78
CFR1	3.83	0.71
CFR2	3.75	0.78
CFR3	3.80	0.78
CFR4	3.82	0.78
CFR5	3.88	0.82
Environmental Concern (ENC)	3.72	0.88
ENC1	3.57	0.89
ENC2	3.79	0.84
ENC3	3.80	0.88
Environmental Policy Perceptions (EPP)	3.63	0.87
EPP1	3.59	0.89
EPP2	3.64	0.85
EPP3	3.75	0.84
EPP4	3.70	0.84
EPP5	3.49	0.90
Environmental Attitude (ENA)	3.62	0.90
ENA1	3.85	0.96
ENA2	3.77	0.88
ENA3	3.61	0.87
Plastic Bag Use Reduction Intentions (PBRI)	3.71	0.89
PBRI1	3.57	0.83
PBRI2	3.68	0.94
PBRI3	3.65	0.86
PBRI4	3.58	0.99
PBRI5	3.56	0.81

and their strong perception regarding RB as compared to single-use PBS indicates that they are feeling responsible for reducing carbon footprints.

The descriptive outcomes indicated that the respondents were also highly concerned about the environmental impact of using single-use PBS. The average ENC1 of 3.57 demonstrates that the respondents have a moderate level of agreement with their use of RB to help protect the ecosystem from plastic waste. The averages of ENC2 and ENC3 are equal to 3.79 and 3.80, respectively, showing that the respondents have a strong concern for the effect of plastic pollution on wildlife and biodiversity (ENC2), and also they believe that their choice to use RB can help in protecting biodiversity (ENC3).

The perception of respondents for EPP (3.63) indicates that they have moderate to high-level agreement with environmental policies regarding the use of PBS. They also showed a moderate level of agreement regarding the influence of government regulations on their decision to use RB, with an average of 3.59 EPP1. Most respondents indicated that they supported policies that restricted the use of single-use PBS (EPP2). Similarly, they also considered that PBS regulations are necessary to protect the environment (EPP3). The average of EPP4 (3.70) indicates that the PBS regulations encourage respondents to switch to RB. EPP5, with an average of 3.49, demonstrates that the respondents are more likely to use RB when there are penalties for single-use PBS, but their responses have considerable variation with a standard deviation of 0.90 and the lowest average as compared to other items in the construct of EPP.

The average ENA consists of three individual items, namely "preferring to use the products having low environmental impact (ENA1)," feeling responsible for making sustainable choices in daily life activities (ENA2)" and "actively looking for alternatives to reduce the use of single-use PBS (ENA3)." Generally, the overall averages of ENA equal 3.62, which demonstrates the respondents have a strong environmental attitude. Among the individual items, ENA1 (3.85) and ENA2 (3.77) highlighted that respondents highly preferred environmentally oriented products and were highly responsible for making sustainable choices. However, ENA3, with an average of 3.61, indicated a moderate to high level of agreement, implying that they still needed motivation in this area.

Overall, respondents had a high level of intention to reduce the use of PBS, with an average of 3.71 of PBRI. The average of all individual items such as "intend to use reusable bag whenever possible instead of single-use PBS (PBRI1)", "plan to increase the use of RB in future (PBRI2)", "committed to using RB regularly (PBRI3)", "choosing RB over single-use PBS during shopping trips (PBRI4)" and "intend to recommend other to use RB (PBRI5)", indicates the moderately positive response. This implies that the response adds considerable positive intentions toward PBS use reduction.

Measurement Model

Before estimating the path coefficients using a structural model, it is necessary to examine the validity of the measurement model. The validity of the measurement model indicates that the items used for

measuring a specific construct are reliable, confirming the internal reliability of the construct. Additionally, it provides information about constructs that are unique to each other and are suitable for further analysis.

Convergent Validity

Convergent validity (CV), which confirms the measurements, converged to ensure the validity of a specific construct. Factor loadings (FL) ensure that items under a specific construct are reliable, and FL scores for each item greater than 0.60 are acceptable [49], while an FL greater than 0.70 under a specific construct means that the items are highly linked with that specific construct. However, items with an FL lower than 0.70 must be removed [50], but items with an FL greater than 0.60 can be retained under a specific construct if their average variance extracted (AVE) is greater than its threshold level (>0.50). Table 2 shows that the FL for each item under each construct is greater than 0.70, and only one item (ENC3) has an FL equal to 0.682, which is close to 0.70, and the AVE of this construct is greater than 0.50. Therefore, each item has an FL greater than 0.70, indicating that these items are strongly interconnected with their specific constructs, implying that the items are reliable.

Considering the reliability and consistency of a specific construct, Cronbach's alpha indicates how consistent a construct is [51]. A value of Cronbach's alpha close to one ensures the consistency of a construct [52], and the findings confirmed the consistency of the constructs, as all of them had a Cronbach's alpha value greater than 0.70. The score of composite reliability (CR) also provides information about the internal reliability of a construct, and a value greater than 0.60 provides robust evidence for internal reliability and consistency of a specific construct [53]. Moreover, the last parameter of CV, AVE, also confirms the convergent validity of the measurement model as its values for each construct are greater than 0.50 [54].

Discriminant Validity

Discriminant validity indicates the uniqueness of the construct. The Fornell-Larcker criterion (FLC) compares the correlation scores of a construct with the square root value of the AVE of that specific construct to confirm the uniqueness of the construct. This implies that the construct is truly different from other constructs. For a construct to be unique, its correlation with other constructs must be lower than the square root of the AVE. The lower part of Table 3 indicates that the correlation score of a specific construct is lower than the square root value of the AVE (scores in bold) of that construct, given in bold format. Similarly, the values of the heterotrait-monotrait ratio (HTMT) lower than 0.90 also confirmed the DV of each construct.

Table 2. Convergent validity.

Constructs and indicators	FL	Cronbach's alpha	CR	AVE
Environmental Knowledge (EKN)				
EKN1	0.833	0.851	0.899	0.691
EKN2	0.853			
EKN3	0.826			
EKN4	0.812			
Carbon Footprints Reduction (CFR)				
CFR1	0.763	0.826	0.877	0.589
CFR2	0.743			
CFR3	0.806			
CFR4	0.789			
CFR5	0.731			
Environmental Concern (ENC)				
ENC1	0.824	0.711	0.839	0.637
ENC2	0.876			
ENC3	0.682			
Environmental Policy Perceptions (EPP)				
EPP1	0.773	0.892	0.921	0.699
EPP2	0.868			
EPP3	0.877			
EPP4	0.849			
EPP5	0.809			
Environmental Attitude (ENA)				
ENA1	0.894	0.83	0.899	0.747
ENA2	0.847			
ENA3	0.851			
Plastic Bag Use Reduction Intentions (PBRI)				
PBRI1	0.750	0.835	0.883	0.603
PBRI2	0.818			
PBRI3	0.809			
PBRI4	0.75			
PBRI5	0.751			

FL = factor loadings, CR = composite reliability, AVE = average variance extracted

Structural Model

The confirmed validity of the measurement model indicates that it is valid and allows for further analysis. The next step is to measure the path coefficients; however, before that, it is necessary to ensure the goodness of fit of the structural model. The value of $\chi 2/df$

Table 3. Discriminant validity.

HTMT						
Constructs	CFR	ENA	EKN	ENC	EPP	PBRI
CFR						
ENA	0.436					
EKN	0.355	0.60				
ENC	0.635	0.84	0.586			
EPP	0.517	0.83	0.58	0.79		
PBRI	0.535	0.86	0.513	0.85	0.72	
FLC						
Constructs	CFR	ENA	EKN	ENC	EPP	PBRI
CFR	0.767					
ENA	0.367	0.864				
EKN	0.293	0.514	0.831			
ENC	0.471	0.727	0.475	0.798		
EPP	0.444	0.803	0.513	0.793	0.836	
PBRI	0.454	0.717	0.439	0.667	0.805	0.776

is 2.11 (<0.30), GFI is 0.903 (>0.90), AGFI is 0.911 (>0.90), CFI is 0.924 (>0.90), NFI is 0.941 (>0.90), and RMSEA is 0.072 (<0.08), confirming the goodness of fit of the structural model.

Direct Effect

Table 4 presents the findings on the direct effects of the variables. R2 of ENA and PBRI indicates that the paths have good relationship, as its score is greater than 0.50 [55]. This demonstrates that the variables have a considerable relationship with the ENA and PBRI and indicates a strong predictive capacity of the model. Similarly, the predictive relevance of each path was also confirmed by a value of Q2 greater than 0, as shown in Table 4. The values of f2 for each path also confirmed that the dependent variables were greatly affected by the structural model, as f2 for each path was greater than 0.35, highlighting a very large effect size.

The non-parametric bootstrapping method [56] was applied to examine the impact of the variables on the dependent variables. Findings indicate that almost all hypotheses are accepted. CFR ($\beta = 0.201$, $p<0.01$), EKN ($\beta = 0.217$, $p<0.01$), and ENC ($\beta = 0.618$, $p<0.01$) significantly affected ENA, which further strongly affected PBRI ($\beta = 0.718$, $p<0.01$). The results indicate that respondents with good environmental knowledge, high concern about the environment, and a strong sense of responsibility for reducing carbon footprint would like to have a strong environmental attitude. Therefore, a strong ENA can enhance the intentions of respondents toward reducing PBS use.

Indirect Effect of Variables on PBRI through ENA

The indirect effect was examined (Table 5) between variables such as CFR, EKN, and ENC through ENA on PBRI. The positive and significant coefficients indicate that CFR ($\beta = 0.0.119$, $p<0.01$), EKN ($\beta = 0.156$, $p<0.05$),

Table 4. Direct effect of variable.

Path analysis	Beta-value	Std. Err.	t-value	f2	Q2	R2	Decision
CFR -> ENA	0.201*	0.075	2.680	0.67	0.452	ENA = 0.565	Accepted
ENA -> PBRI	0.718*	0.047	15.136	1.067	0.625		Accepted
EKN -> ENA	0.217*	0.085	2.555	0.42	0.284	PBRI = 0.516	Accepted
ENC -> ENA	0.618*	0.101	6.147	0.575	0.377		Accepted

*shows significance level at 1%.

Table 5. Indirect effect of variables.

Paths	Beta scores	Standard deviation	t-values	p-values
CFR -> ENA -> PBRI	0.119	0.044	2.704	0.010
EKN -> ENA -> PBRI	0.156	0.062	2.532	0.011
ENC -> ENA -> PBRI	0.444	0.083	5.349	0.00

Note: $p<0.01$ when t-value is greater than 2.32.

and ENC ($\beta = 0.444$, $p<0.01$) had positive impacts on PBRI through the ENA of the respondents.

Moderating Role of EPP between ENA and PBRI

Both EPP ($\beta= 0.676$, $p<0.01$) and ENA ($\beta= 0.195$, $p<0.01$) strongly affected the PBRI at the 1% level of significance (Table 6). Similarly, the interaction term (EPP × ENA) also has a significant positive impact ($\beta = 0.158$, $p<0.01$) on the PBRI. This implies that respondents with highly positive perceptions of environmental policy can act as strong moderators of the effect of ENA on PBRI.

Discussion

Plastic and plastic products are a major threat to the sustainability of ecosystems and are important for the survival of life on the planet. Among plastic products, single-use PBS is widely consumed because of the routine consumption habits of individuals, and the one-time use and low recyclability of single-use PBS attract governments and environmentalists to take effective initiatives to reduce the use of single-use PBS. These initiatives usually include the ban on the production, sale, and distribution of single-use PBS free of charge, but these measures could not result in fruitful outcomes [57]. Moreover, the disposal of single-use PBS is also a great challenge for the stakeholders of the economy, as they can only be turned into microplastic particles that can remain in the environment for a long time. Therefore, consumers can play a role in reducing the use of single-use PBS, as the reduction of PBS is multifactorial and complementary and requires effective policies along with the acceptance of suitable alternatives. The consumer prefers its convenience, and the implementation of policies may not provide the full required outcomes, and it needs an environmentally oriented attitude of the consumer that drives them toward the reduction of single-use PBS. Therefore, the current study aimed to analyze the dynamic relationship of CFR, EKN, and ENC with ENA, which further affects the PBRI of a person.

PLS-SEM provides information about the impact of variables on the ENA and PBRI. The findings reveal the significant positive impact of CFR on ENA, which implies that as a person feels responsible for reducing the carbon footprint, they are more likely to have a more environmentally oriented attitude in their life. People highly believe that the use of RB can effectively reduce carbon emissions because single-use PBS can directly affect their attitudes toward the environment. This implies that reducing single-use PBS through simple actions such as using RB and understanding the personal responsibility for reducing carbon emissions can encourage sustainable behavior. Therefore, people can adopt habits that contribute to environmental sustainability and sustainable consumption by making sustainable choices. Moreover, the CFR also positively affected the PBRI through the ENA. Our findings are in line with those of Hwang et al. [58], who also found a positive correlation between a sense of personal responsibility and an intention to act. Ernst et al. [59] also found a positive impact of ENA and personal responsibility on students' intentions to participate in future environmental actions. Therefore, necessary changes to personal lifestyle are very important in order to counter climate change and for a sustainable environment, and everyone must lower their carbon footprint by adopting effective strategies to enhance their attitude toward sustainable choices [60].

The outcomes of the study also indicated a strong positive impact of EKN on single-use PBS on ENA. This implies that a person who has a strong knowledge of the

Table 6. Moderating role of EPP between ENA and PBRI.

Paths	Beta-value	Standard deviation	t-value	p-values
EPP -> PBRI	0.676	0.074	9.092	0.00
ENA -> PBRI	0.195	0.084	2.327	0.02
EPP x ENA -> PBRI	0.158	0.037	4.27027027	0.00

Note: $p<0.01$ when t-value is greater than 2.32

impact of single-use PBS is more likely to have a strong attitude toward the environment. Similarly, EKN also positively affects PBRI through ENA. This implies that EKN is positively correlated with ENA and the PBRI. When an individual knows the impact of single-use PBS on environmental sustainability, they are more likely to foster an attitude toward the low use of single-use PBS. Moreover, an individual with high EKN views single-use PBS as a harmful substance to the environment, which leads them to foster ENA in order to preserve their environment. Therefore, ENA results in a strong intention to reduce PBS usage. Therefore, a positive EKN can lead to positive action on environmental issues [61]. However, EKN alone does not work without an effective system to take proactive action, which implies that EKN enhances the awareness of the individual, and awareness directs him/her toward ENA, which further develops environmentally oriented intentions [62]. Bala et al. [63] demonstrated that high environmental awareness affects the attitude but does not influence the intentions directly, indicating attitude as a strong mediator between EKN and intentions. Casaló et al. [64] also demonstrated that EKN can promote ENA, which is a prerequisite for strong ENA. Therefore, EKN is a strong predictor of ENA, producing strong environmentally oriented intentions [65, 66]. Safari et al. [59] and Indriani et al. [67] also found a strong mediating role for attitude between EKN and green purchase intentions. Therefore, EKN enhances awareness of the harmful effects of PBS [68, 69], demonstrating ENA, which is necessary for behavioral changes. Moreover, positive ENA positively correlates with the intention to lower the use of single-use PBS [70].

The findings also indicate a significant positive and direct impact of ENC on ENA and an indirect impact on PBRI. This implies that ENC is an important factor in developing positive ENA and the intention to reduce the use of PBS. Suki [71] and Yadav and Pathak [72] signified the ENC as an important determinant of the pro-environmental behavior of consumers. This implies that individuals who are highly concerned about the environment are more likely to perform environmentally friendly actions. Therefore, if an individual has a high degree of ENC and considers PBS as harmful substances to environmental sustainability, he/she will form the intention to reduce the use of PBS. Moreover, ENC also affects the intention to reduce the use of PBS through ENA. Therefore, our findings are consistent with those reported by Sun et al. [3]. Sambath et al. [73] highlighted that high ENC shapes a negative attitude toward the use of PBS; they are more likely to show an intention to reduce the use of PBS [74]. Solekah et al. [75] found no direct impact of ENC on willingness to reduce the use of PBS, but ENC has an indirect effect on PBRI through ENA.

The findings reveal that EPP significantly moderates the relationship between ENA and the PBRI. This implies that the EPP can play a crucial role in shaping the ENA and PBRI of an individual, and that the magnitude of the impact of the ENA on the PBRI is significantly different when the EPP is significantly different among individuals. For example, an effective environmental policy can develop a positive EPP, leading to a strong relationship between ENA and PBRI to adopt eco-friendly alternatives. Moreover, with a positive EPP, individuals reinforce the impact of ENA on their actions. Similarly, individuals with a strong ENA can feel empowered to act on their PBRI under effective environmental policies. Through policies and regulations, governments mostly shape the behavior of the public toward certain actions through education, punishment, and awards [76]. Therefore, when people perceive that a policy is aligned with their goals, they are more likely to have strong intentions and take action. Wang and Mangmeechai [45] confirmed that perceived policy effectiveness strongly affects intentions and pro-environmental behavior. Zhang et al. [77] and Chen et al. [78] also highlighted the role of laws and regulations in promoting eco-friendly behavior. Our findings are in line with Zheng and Wang [79], who also found a significant impact of the interaction term between ENA and policies and regulations on willingness to engage in green consumption behavior.

Conclusion

Plastic bags made of plastic material are very dangerous for the ecosystem, and governments and environmental advocates have started to focus on this harmful substance to achieve environmental sustainability. Consumers are among the major stakeholders that can play a crucial role in reducing the use of single-use PBS by shaping sustainable behavior. The primary objective of this study was to investigate the drivers and their interactions to advance the understanding of sustainable behavior and the influence of environmental policies on reducing PBS usage.

The study findings showed that CFR, EKN, and ENC positively influenced ENA. The results also showed that ENA significantly affected the PBRI. The key findings of this study revealed a significantly positive impact of CFR on ENA. Moreover, the model results revealed a significant role of the EPP in the ENA and PBRI relationship.

Based on the findings of the study, it is necessary to enhance consumers ‘sense of responsibility to reduce their personal carbon footprints. Public awareness campaigns through TV programs, social media campaigns, street signboards, and screen visuals at shopping malls can significantly develop a sense of responsibility for the low use of PBS. Educational institutes must also play a role in enhancing awareness and knowledge about the impact of single-use PBS on the environment. These institutes can start education and public awareness programs to disseminate information about the harmful impact of PBS on human health, marine life, and ecosystems. Fair and strong

enforcement of effective policies can also foster the attitudes and intentions to reduce the use of PBS.

Conflict of Interest

The authors declare no conflict of interest.

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