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Machine Learning Methods Analysis of Preceding Factors Affecting Behavioral Intentions to Purchase Reduced Plastic Products

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Abstract: The COVID-19 pandemic has led to an increase in the use of personal protective equipment and single-use plastics, which has exacerbated plastic littering on land and in marine environments. Consumer behaviors with regards to eco-friendly products, their acceptance, and intentions to purchase need to be explored to help businesses achieve their sustainability goals. This paper establishes the Sustainability Theory of Planned Behavior (STPB), an integration of the TPB and sustainability domains, in order to analyze the said objectives. The study employed a machine learning ensemble method and used MATLAB to analyze the data. The results showed that support and attitude from perceived authorities were the main variables influencing customers' intentions for purchasing reduced plastic products. Customers with a high level of environmental awareness were more likely to embrace reduced plastic items as a way to lessen their ecological footprint and support environmental conservation, making perceived environmental concern another important factor. This shows that authorities play a big role in the community in influencing people to choose reduced plastic products, making it the duty of governments and companies to promote environmental awareness. This study emphasizes the significance of the latent variables considered when developing marketing plans and activities meant to promote products with less plastic.

Keywords: machine learning; neural network; plastic waste; random forest classifier; sustainable behavior

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1. Introduction

Plastic pollution is one of the most significant environmental issues today. The first synthetic substance, Bakelite, was produced in 1907, which marked the beginning of the global plastics industry. However, the production of plastic did not significantly grow until the 1950s. Over the next 70 years, the annual production of plastics more than doubled to 460 million tonnes [1]. Single-use plastics currently constitute nearly 40% of the plastic produced each year, according to [2]. Although many of these items, like plastic bags and food wrappers, are only used briefly or infrequently, they can persist in the environment for hundreds of years [2].

Plastic pollution is particularly prevalent in the less developed Asian and African nations with weak or nonexistent waste collection systems [3]. The amount of plastic waste created globally has doubled from 20 years ago. The majority of this material is burned or disposed of in landfills and is successfully recycled in only 9% of cases [4]. Environmental contamination from plastic also has an impact on animals' health. Elephants, tigers, hyenas, zebras, camels, cattle, and other large land animals and marine life have all ingested plastics, sometimes to their detriment. Additionally, tests have shown liver damage, cell abnormalities, and reproductive system issues that are causing some species, like oysters, to lay fewer eggs.

Pollution caused by plastics also contributes to climate change. When plastics are burned, a mixture of poisonous substances is created that is bad for the environment and humans who breathe the tainted air [5]. Even if we stopped generating ocean plastic waste by 2020, microplastics would still be present in our surface seas for many more decades because we have a huge legacy of plastics buried and awash on our shorelines that would continue to resurface and be carried to shore [1]. A few of the many actions that must be taken to address this issue include lowering the production of plastic, enhancing waste management procedures, and promoting sustainable alternatives to single-use plastics.

There are two methods for handling plastic. These are the use of recycled products and products with less plastic. Recycled materials are manufactured from plastic that has been collected, processed, and transformed into new products, whereas decreased plastic products refer to items that are designed to use less plastic, such as reusable bags or water bottles [6]. Shredded, melted, and formed into pellets, recycled plastic is used to make items that are of poorer quality than the originals [7]. Recycling is both economical and environmentally friendly; however, it is not a perfect solution. When compared to their virgin equivalents, mechanically recycled polymers may exhibit decreased chemical, thermal, and impact resistance [8]. In addition, the price of recycled plastic has also risen, making it more affordable for producers to use new plastic [9]. Due to the dozens of forms of plastic, and the fact that plastic degrades after one or two uses, recycling plastic is extremely challenging and expensive [10].

The plastics sector is under pressure to cut back on pollution and waste [11]. There are now more opportunities for the packaging sector to achieve this, since consumer and investor attitudes regarding sustainability and plastic packaging have dramatically changed [11]. Plastic usage increased as a result of the COVID-19 pandemic, especially for personal protective equipment (PPE) such as face masks and shields [12]. Due to the required growth in the use of single-use plastics for PPE, some governments and corporations have postponed or abandoned their prohibitions on plastic bags and packaging. However, nations must ensure that long-term progress on the adoption of laws targeted at decreasing plastic pollution is not derailed by these emergency amendments [13]. It is crucial to have legislative initiatives that support policies like banning single-use plastic bags, requiring public procurement, putting money into waste management infrastructure, and forming public–private partnerships [14].

Plastic packaging has changed food packaging, enhanced energy savings, and decreased transportation and fuel costs [15]. To stop the stream of plastic into the ecosystem, however, quick action is required, since plastic waste has reached a crisis point [16]. Although plastic can be recycled, it typically is not, which puts the environment in danger right away [3]. The chemical process industries (CPI) must take action to reduce plastic waste and pollution because they are dealing with significant waste plastic challenges [15]. An international accord called the Kyoto Protocol aims to reduce the amount of gas emissions that cause global warming. The convention required that the emissions of six greenhouse gases be reduced by 5.2 percent from 1990 levels in 41 countries and the European Union [17].

Many companies are making efforts to reduce pollution and plastic usage. Avoiding plastic packaging is one approach to reducing the impact of your products on the environment. As an illustration, the Peach brand has created a line of plastic-free, waterless hair and body care products [18]. Reducing, reusing, and recycling plastic are further options. These ideas replace the "throwaway culture" in the circular economy [19]. Governments and businesses are currently working together to demonstrate reuse strategies, such as through the Ellen MacArthur Foundation's New Plastics Economy Global Commitment [20].

Changes in policy can have an impact on advancements in plastic design, replacements, and recycling, as well as changes in business and consumer behavior. Governments have the power to impose taxes to deter the production or use of single-use plastics. To encourage the use of options other than single-use plastics, they can also offer tax breaks, subsidies, and other financial incentives [13]. Denmark is said to have cut its usage of paper and

plastic by over 70%, and Portugal has successfully used economic methods to stimulate the adoption of reusable and recycled items [12]. According to Marquis [18], companies can help their supply chain partners and other firms to reduce their plastic usage and go plastic-free as consumers' interest in eco-friendly products and practices grows.

Customers are becoming more interested in eco-friendly items, and they are prepared to switch brands when a business transgresses their moral standards [21]. Forbes reports that 72% of consumers worldwide are actively purchasing more ecologically friendly products than they did five years ago, and 81% anticipate doing so even more in the upcoming five years [11]. Consumers want to help the environment and are conscious of how their purchases affect it. It has been shown that 88% of American and British consumers expect brands to assist them in leading more environmentally conscious lives on a daily basis [11]. However, consumers frequently have negative associations with sustainable product options, considering them to be of inferior quality, unsightly, and more expensive. This can make it challenging for businesses to sell environmentally friendly products and for customers to locate plastic-free substitutes.

Despite these challenges, there is evidence that consumers are willing to accept products made from recycled materials [22]. A study found that consumers are willing to reduce plastic usage in food-related consumption decisions [23]. Their study, similar to others, also identified factors that encourage or discourage plastic avoidance, such as convenience, social norms, and perceived effectiveness [23]. Consumers' sustainable behavior towards reduced plastic products is influenced by various factors. Age, sustainable behavior, and environmental concern are some of the factors that condition the purchasing decisions of consumers in the food industry [24]. Consumers lack sufficient knowledge to avoid and recycle plastic waste, and they need more information to make informed decisions [25]. Recycled and recyclable products are more sustainable than virgin or unrecyclable plastic, and consumers need to be aware of this to make sustainable choices [26]. However, the study of German et al. [14] showed how Philippines consumers are aware and considerate of environmental concerns upon choosing services.

In order to reduce and recycle plastic trash, consumer education is essential. According to the literature, the biggest obstacle to recycling plastic packaging is not knowing which polymers can be recycled, which frequently causes material to end up in the incorrect trash stream and be lost to the economy [23]. To encourage consumers to participate in the circular economy of plastics, it is crucial to increase consumer knowledge about recycling. By enhancing and developing packaging and correctly managing it, businesses have the chance to redefine the future of plastic and keep it out of the oceans and in the economy. The disposability of plastics, ease of use, and the absence of environmentally beneficial choices made by designers, producers, and merchants are obstacles to lowering plastic consumption. Consumers need to be motivated to reduce plastic waste by environmental concerns and social norms [25]. Therefore, businesses and policymakers need to work together to provide consumers with the necessary information and incentives to make sustainable choices. These issues mean that consumer behaviors with regards to eco-friendly products, their acceptance, and behavioral intentions, need to be explored to help businesses achieve their goals.

These things considered, this paper applied the Sustainability Theory of Planned Behavior (STPB), an integration of the TPB and sustainability domains, in order to analyze the following objectives. First, to analyze the sustainable behavior determinants for purchasing reduced plastic products. The next objective of this study is to utilize the STPB for assessment by evaluating the preceding determinants simultaneously using a machine learning algorithm (MLA) ensemble method. The final objective was to assess the practical and managerial implications from the analysis and findings. The study and its results are significant to businesses because it can help them understand the factors that influence consumers' intentions to purchase single-use plastic products. The study can provide insights into how businesses can reduce the use of single-use plastic products and promote the use of reusable products. The study can also help businesses to understand

the factors that influence consumers' intentions to use green products, helping to shape strategies for business intent. In local contexts, this study will be significant to governments due to the fact that plastic waste is a significant environmental problem that affects human health and the ecosystem. Governments' efforts to reduce plastic waste require an understanding of the factors that influence consumers' behavior and intentions regarding plastic consumption. By understanding these factors, governments can develop effective policies and interventions to reduce plastic waste and promote sustainable consumption.

2. Literature Review and Hypotheses

2.1. Literature Review

Numerous factors affect customers' intentions to reduce plastic waste, according to studies on behavioral intentions related to buying products made of less plastic [27]. The body of research on the particular variables that affect customers' behavioral intentions when it comes to buying products with less plastic, however, is limited. The research has indicated that recycled products are perceived as having inferior quality, which eventually reduces purchasing intentions [28], but it is not apparent whether the same holds true for products made with less plastic.

One study by Chi [29] examined how ethical consumer behavior can increase the social acceptance of environmentally friendly plastic items. In a further study, the psychological predispositions leading to both private and public anti-plastic behaviors were examined [30]. These predispositions included intentions, perceived behavioral control, personal norms, collective efficacy, and sufficiency orientation. The study discovered that perceived behavioral control had a significantly favorable impact on purchasing and that personal norms were a strong predictor of behavioral intentions. As the study did not concentrate explicitly on behavior towards reduced plastic items, it is uncertain whether the results can be applied to them. Therefore, more research is required to pinpoint the precise variables that affect consumers' behavioral intentions when it comes to buying products made of less plastic.

According to Trinidad [31], sustainability is the capacity to meet present-day demands with resources already at hand without jeopardizing the potential of future generations to do the same. The five domains of sustainability are ecological or environmental, economic, political or productivity, cultural or human, and social [32]. The environmental domain refers to the natural environment, the economic domain refers to the financial system, the productivity domain refers to the government and its policies, the human domain refers to the values and beliefs of a society, and the social domain refers to the well-being of individuals and communities [32].

The theory of planned behavior (TPB), which describes how people behave, is a social psychology theory, according to Bosnjak et al. [33]. According to the TPB, conduct is influenced by attitude (a subjective norm) and perceived behavioral control [33]. Perceived behavioral control refers to an individual's confidence in their ability to engage in a behavior, whereas subjective norm refers to the social pressure to engage in or refrain from engaging in a behavior. The word "attitude" refers to how someone feels about a behavior. The TPB has been applied in environmental research to forecast sustainable behavior [14,34].

The similarities between the five domains of sustainability and the TPB lie in their focus on behavior. The five domains of sustainability consider the behavior of individuals and communities in relation to the natural environment, financial system, government policies, values and beliefs, and well-being [14]. The TPB considers the behavior of individuals in relation to their attitudes, social norms, and perceived control [34]. Both the five domains of sustainability and the TPB recognize the importance of understanding behavior in achieving sustainability. By understanding the factors that influence behavior, sustainable practices can be promoted and adopted.

Therefore, it is recognized that the following factors of the sustainability domains are similar to the factors in the theory of planned behavior. Under the sustainability domains there are five factors being considered, which are social, human, environmental,

economic, and productivity. There have been established theories, such as the theory of planned behavior, which have similarities to the given factors under the sustainability domains as explained by German et al. [14]. Under the social aspect, the subjective norm and behavior is tackled, while for the human factor, attitude and perceived behavioral control are connected. Under the environmental aspect is the perceived environmental concern. The economic factor of sustainability also has similarities with perceived economic concern, and the productivity aspect has similarities with perceived behavioral concern and perceived authority support [14].

2.2. Research Framework

This study framework's theoretical underpinnings are based on the theory of planned behavior (TPB) and how it relates to the sustainability domains. The TPB is a framework that enables researchers to pinpoint the variables that influence environmental behavior during interventions [35]. Since Ajzen first suggested it in 1985, it has been widely used throughout the world. According to the TPB, perceived behavioral control provides the necessary opportunities, skills, or resources, while individual behavior is controlled by volition [36]. The TPB has been utilized in several studies to examine pro-environmental behavior. For instance, one study [37] tried to propose and verify a model based on the TPB to explain consumers' pro-environmental behavior. Another study [38] examined how environmental awareness, subjective norms, and attitudes toward the environment influence pro-environmental behavior. The findings of this study demonstrate how behavioral intention and perceived behavioral control might influence pro-environmental behavior [39]. Perceived economic concern (PEC), perceived environmental concern (PENC), and perceived authority support (PAS) are sustainability factors that were adjusted for the current study. Meanwhile, the TPB domains of perceived behavioral concern (PBC), subjective norm (SN), and attitude (AT) were analyzed concurrently to assess customer perceived value (CPV), leading to a behavioral intention (BI). Figure 1 depicts the link between the two theories, which forms a new theory known as the Sustainability Theory of Planned Behavior (STPB).

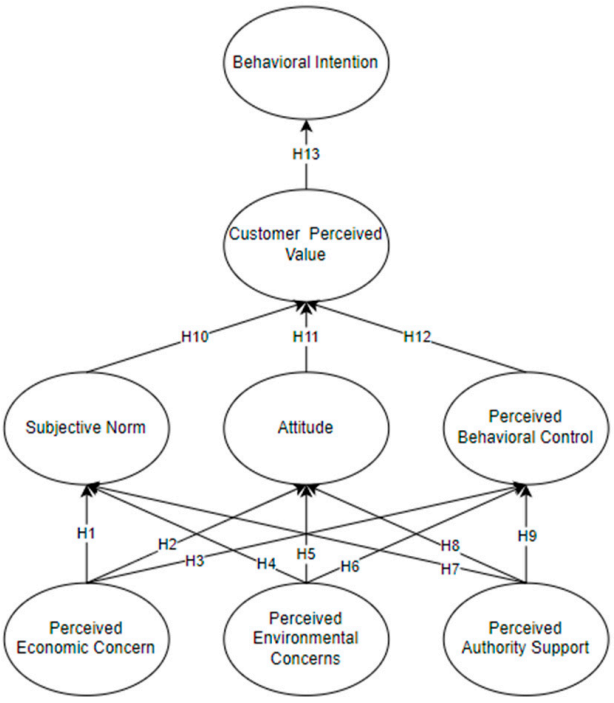

Figure 1. Sustainability Theory of Planned Behavior.

According to Ebner and Iacovidou [40], it is likely that individuals who perceive greater economic concerns due to the COVID-19 pandemic will have higher consideration towards reduced plastic products. This is due to the fact that reduced plastic products are often seen as a more sustainable and cost-effective choice than traditional plastic products. In accordance, it was stated that in times of economic insecurity, individuals are likely to prioritize cost savings. It was also explained in another study that due to the downturns in economic aspects due to the pandemic, financial insecurity has become prominent for many people [41]. This has likely led to a greater focus on cost-saving measures, such as using and considering reduced plastic products. People may be more likely to adopt this behavior if they perceive that their peers are also doing so [40]. This suggests that the higher the perceived economic concern associated with the pandemic, the greater the subjective norm towards using reduced plastic products. In addition, German et al. [14] showed that the influence of economic concerns and community predicaments during the COVID-19 pandemic led to consumers considering using more environmentally friendly products.

The COVID-19 pandemic has had a positive effect on attitudes towards reduced plastic products due to an increased perception of economic concerns. This is likely due to the fact that the pandemic has caused consumers to pay more attention to sustainable products and has driven them towards buying these items [42]. Additionally, the restrictions on transportation and logistics have led to an increase in reliance on local food supply chains, which has improved food safety and revitalized local economies [43]. This shift in consumer behavior has created a "window of opportunity" for changing plastic policies [44], which is positioned at the top of the waste hierarchy, as well as for waste prevention in general [43].

In a study on recycling behavior, perceived behavioral control was discovered to be positively connected to recycling intentions [43]. Perceived consumer effectiveness (PCE), a similar notion, relates to a person's conviction that their actions can have an impact on environmental protection. In contrast to consumers with weak PCE, those with strong PCE are more likely to engage in environmentally friendly actions [45]. Consuming less plastic is a good thing for the environment. According to the TPB, people are more likely to have the intention to choose reduced plastic items if they feel that they have control over their behavior and think that lowering plastic use can have an impact (i.e., PCE). Therefore, it can be inferred that perceived economic concern connected to perceived behavioral control may affect the intention to choose reduced plastic products indirectly through its effect on PCE. Thus, the following were hypothesized:

Hypothesis 1 (H1). *PEC has a positive significant effect on SN, leading to an effect on behavioral intention for purchasing reduced plastic products.*

Hypothesis 2 (H2). *PEC has a positive significant effect on AT, leading to an effect on behavioral intention for purchasing reduced plastic products.*

Hypothesis 3 (H3). *PEC has a positive significant effect on PBC, leading to an effect on behavioral intention for purchasing reduced plastic products.*

There is evidence that subjective norms influenced purchase intention when using mobile applications during the pandemic, according to a study on the effects of COVID-19 on ecologically responsible behavior [41]. Regarding selecting products with less plastic during the COVID-19 pandemic, a different study found a correlation between perceived environmental concern and subjective norm [46]. It was demonstrated that there is a correlation between perceived environmental concern and attitude toward choosing reduced plastic products in increasing customers' pro-environmental buying intentions during the COVID-19 pandemic [47]. A study conducted in Europe found a link between perceived behavioral control (PBC) and the intention to make environmentally responsible purchases (ERPI) during the COVID-19 pandemic. According to the study, PBC and ERPI are positively and significantly correlated [41]. One could infer that the COVID-19 outbreak has opened up a window for altering plastic policy. Health professionals do, however, believe

that the appeal of reusable goods is secure during the pandemic [44]. From the literature, it is evident that behavioral domains precede PENC when it comes to choosing products made from reduced plastic during the COVID-19 pandemic; therefore, the following hypotheses were made:

Hypothesis 4 (H4). *PENC has a positive relationship to SN, leading to an effect on behavioral intention for purchasing reduced plastic products.*

Hypothesis 5 (H5). *PENC has a positive relationship with AT, leading to an effect on behavioral intention for purchasing reduced plastic products.*

Hypothesis 6 (H6). *PENC has a positive relationship with PBC, leading to an effect on behavioral intention for purchasing reduced plastic products.*

Perceived authority support has been shown to have a positive relationship towards subjective norms [14]. According to a study on news consumption and green behaviors, news consumption had a beneficial impact on subjective norms, perceived behavioral control, circular packaging, and environmental attitudes. Creating sustainable habits in daily life can influence consumers to adopt other life-enhancing sustainable behaviors [46]. When it comes to selecting reduced plastic products during the COVID-19 pandemic, perceived authority support has a favorable link with attitude [14]. This was also the finding of a study that looked at how consumers perceived single-use plastic food packaging during the COVID-19 era [47]. According to the survey, those who are older, from the center of Portugal, or who hold a university degree are more likely to cut back on their usage of plastic bags. Additionally, consumers are becoming more knowledgeable and have a better attitude toward recycling as a way to enhance the sustainability of the packaging chain and reduce environmental pollution [48].

The COVID-19 pandemic has increased the use of single-use plastics and personal protective equipment, which has made plastic pollution on land and in the ocean worse. However, there have also been decreases in the economy-wide usage of packaging plastics in industries where output was hampered [49]. Semi-structured interviews were used in a study in Nova Scotia to investigate ways to decrease the use of single-use plastics in food services brought on by the COVID-19 pandemic [50]. Thus, the following hypotheses were created:

Hypothesis 7 (H7). *PAS has a positive relationship to SN, leading to an effect on behavioral intention for purchasing reduced plastic products.*

Hypothesis 8 (H8). *PAS has a positive relationship to AT, leading to an effect on behavioral intention for purchasing reduced plastic products.*

Hypothesis 9 (H9). *PAS has a positive relationship with PBC, leading to an effect on behavioral intention for purchasing reduced plastic products.*

In three dimensions—attitude, perceived behavioral control, and subjective norms—the study conducted in European nations found a positive and substantial relationship between COVID-19 and environmentally responsible purchase intention (ERPI) [41]. Additionally, environmentally friendly choices like purchasing products made of single-use plastic have advantageous side effects. Intentions to buy single-use plastic products were found to be positively influenced by attitude and perceived behavioral control [51]. Therefore, it can be concluded that during the COVID-19 pandemic, subjective norms also favorably influenced intentions to purchase fewer plastic products.

Several studies have looked at how the pandemic affected customer perceptions of single-use plastic food packaging [52]. According to one study, the pandemic has motivated people to reduce their food waste and to be more environmentally conscious [42]. According

to a study on sustainable restaurant practices, customers' views of values are formed in accordance with their judgments of the restaurants, which takes into account elements like social responsibility and environmental responsibility [53]. Therefore, it makes sense to predict that a pro-sustainable mindset would result in higher perceived value for products made with less plastic. Therefore, the following were hypothesized:

Hypothesis 10 (H10). *SN has a positive relationship to CPV, leading to an effect on behavioral intention for purchasing reduced plastic products.*

Hypothesis 11 (H11). *AT has a positive relationship to CPV, leading to an effect on behavioral intention for purchasing reduced plastic products.*

Hypothesis 12 (H12). *PBC has a positive relationship to CPV, leading to an effect on behavioral intention for purchasing reduced plastic products.*

Several studies have investigated how the COVID-19 pandemic affected customers' behavioral intentions to buy green items. According to a study by Zhang et al. [54], customers' behavioral intentions to purchase green products was positively impacted by fear of the COVID-19 pandemic. Another study by Theodorou et al. [55] used the TPB to investigate customers' intentions to shop online during the COVID-19 pandemic and its impact. In the study, views were provided on the window of opportunity that the COVID-19 pandemic presented for altering plastic-use policy [44]. It was suggested that now would be a good time for legislators to alter their stance on plastic. Overall, while there is limited information available specifically on consumer behavior towards choosing reduced plastic products during the COVID-19 pandemic, it appears that there have been changes in household food purchasing and management behaviors brought about by the mandatory lockdowns. Thus, the following hypothesis was formulated:

Hypothesis 13 (H13). *CPV has a positive relationship to BI.*

3. Methodology

3.1. Participants

Participants in this study could include consumers, retailers, manufacturers, and environmental advocates. Consumers would be able to provide their views on the impact of reduced plastic products on their shopping habits and their perspective on how the pandemic has changed the way plastic products are used. Retailers could provide information on their experiences of stocking and selling reduced plastic products and the impact it has had on their businesses. Manufacturers would be able to provide information on the challenges they faced in producing reduced plastic products and the changes they have made to accommodate them. Finally, environmental advocates would be able to provide their perspectives on the importance of reducing plastic products and the impact of the pandemic on their efforts.

This study employed an online self-administered survey distributed through different social media platforms. A convenience sampling approach was utilized to collect a total of at least 500 respondents which would be generalizable to the Philippine population [14]. Following this concept, the population of the Philippines comprised 62.6 million Filipinos, and therefore 399 respondents could be generalized to the population as a whole. Exceeding that target, 530 valid responses were collected from June 2023 to October 2023. Utilizing social media and online communications applications, the survey was distributed among groups on Facebook, Messenger, Instagram, and X. Using a filtering question, only those who were knowledgeable about branded reduced-plastic products were considered for this study. A range of demographic characteristics were represented, as presented in Table 1.

Table 1. Respondents' Demographic Profile.

Characteristics	Category	N	%
Gender	Female	222	41.9%
	Male	299	56.4%
	Prefer not to say	9	1.7%
	Total	530	100%
Age	Less than 18 years old	35	6.6%
	18–25	244	46%
	26–35	61	11.5%
	36–45	70	13.2%
	46–60	76	14.3%
	Above 60 years old	44	8.3%
	Total	530	100%
Area of Residence	Urban	463	87.4%
	Rural	67	12.6%
	Total	530	100%
Employment	Unemployed	25	4.7%
	Student	260	49.1%
	Employed	202	38.1%
	Self-Employed/Business Owner	53	8.1%
	Total	530	100%
Education Level	Attended grade school	6	1.1%
	Attended high school/senior high school	77	14.5%
	Attended college	221	41/7%
	Finished College or Graduate degree	226	42.6%
	Total	530	100%
Household size	1–2	61	11.5%
	3–4	213	40.2%
	5–6	198	37.4%
	Above 6	58	10.9%
	Total	530	100%
Total household income	less than 20,0000	83	15.7%
	20,001–30,000	61	11.5%
	30,001–40,000	100	18.9%
	40,001–50,000	77	14.5%
	Above 50,000	209	39.4%
	Total	530	100%
Frequency of buying Reduced Plastic Products	At least every 1–3 months	290	54.7%
	3–5 months	124	23.4%
	6–9 months	86	16.2%
	10–12 months	30	5.7%
	Total	530	100%

3.2. Questionnaire

The questionnaire consists of two parts: demographic information about possible responders and determinants of the STPB model. The adapted questionnaire is presented in Table 2, employing a five-point Likert scale (1—Strongly Disagree to 5—Strongly Agree) to assess the factors that affect a user's decision to buy reduced plastic products. A total of 31 items were considered to fully assess the objectives of this study.

Table 2. Questionnaire items.

Variable	Code	Description	References
Perceived Environmental Concern	PENC1	I urge people to support the promotion of decreased plastic production methods and reduced plastic usage because I am really concerned about the state of the environment in the world and what it will entail for my future.	[56]
	PENC2	Users of reduced plastic products should encourage the consideration of reduced plastic production techniques and decreased plastic usage because humanity gravely abuses the environment.	[57,58]
	PENC3	When humans mess with nature, the results are frequently terrible. It worries me that consumers of products made of less plastic should encourage the use of less plastic and consideration of less plastic in manufacturing processes.	[57,58]
	PENC4	I keep in mind the environmental impacts when purchasing products	[59]
Perceived Authority Support	PAS1	I believe that consumers of items with less plastic have the option to support the government-provided tactics for taking part in the environmental impact assessment (EIA) procedure.	[57,58]
	PAS2	I believe that consumers of items made with less plastic should support government-sponsored environmental initiatives like the environmental impact assessment (EIA) procedure.	[57,58]
	PAS3	The law allowing citizens to take part in the environmental impact assessment (EIA) procedure has the support of the government.	[57,58]
	PAS4	The government has a big impact on why I choose to buy reduced plastic products.	[57,58]
Perceived Economic Concern	PEC1	I am able to shift and purchase the products I use to the reduced plastic ones	[60]
	PEC2	When choosing what product to buy, I also see what was the product made of	[60]
	PEC3	I feel bad when buying plastic products especially those that has a negative impact on the environment	[61]
	PEC4	I make no second thoughts when buying products made from reduced plastic, even knowing that it is much more expensive compared to plastic made products	[60]
Perceived Behavior Control	PBC1	I believe that the use of reduced plastic usage products improved our society.	[62]
	PBC2	I am confident in using products in terms of quality and reliability made from reduced plastic usage products	[62]
	PBC3	Buying reduced plastic products is entirely my choice and I am not forced by the society	[63]
Subjective Norm	SN1	I believe I should encourage the usage of products with less plastic among the people who are important to me.	[63]
	SN2	I get the support of significant people when I use things with less plastic.	[64]
	SN3	My important friends and family want me to use products with less plastic.	[64]
	SN4	I sense social pressure to use things with less plastic in it.	[64]
Attitude	AT1	The COVID-19 pandemic helped me decide to use reduced plastic products	[65]
	AT2	Using reduced plastic usage products is a good idea for our society	[62]
	AT3	Using reduced plastic usage products benefited our society	[62]
	AT4	I think that using reduced plastic usage products is valuable.	[62]

Table 2. *Cont.*

Variable	Code	Description	References
Behavioral Intention	BI1	I intend to explain to people the positive effects of transitioning to choosing reduced plastic products	[66]
	BI2	I intend to choose reduced plastic products when buying goods.	[65]
	BI3	I would recommend to people to transition in buying reduced plastic made products	[62]
	BI4	I predict that in the near future, people will transition to purchasing goods with reduced plastic made products.	[62]
Customer Perceived Value	CP1	I feel good with myself when I buy reduced plastic made products	[67]
	CP2	Choosing to buy reduced plastic made products gives me more benefits compared to plastic products	[67]
	CP3	Products made from reduced plastic materials have a more positive environmental impact.	[67]
	CP4	I look forward to a society which chooses to purchase reduced plastic made products compared to plastic products.	[67]

3.3. Machine Learning Algorithm (MLA)

This study used an artificial neural network (ANN) and random forest classifier (RFC) to process the data gathered. As previously discussed, the findings of German et al. [14] showed that while studying the variables influencing human behavior in connection to how individuals use technology, a machine learning ensemble method proved to be highly effective. Machine learning models can handle large and complex datasets with high dimensionality, while multivariate statistical analyses are limited to a smaller number of variables [68]. Additionally, MLA models can provide more accurate predictions and better model performances compared to traditional and multivariate analyses [14]. By offering a reference model against which a solely theory-driven model must compete, and having the ability to examine non-linear correlations between elements, machine learning can also be used to enhance explanatory models [69].

3.4. Data Pre-Processing

Correlation analysis is a data pre-processing method, which is used in this study to pinpoint features. Significant indicators for each latent variable are found using this method. According to a study by German et al. [14], those with p-values greater than 0.05 and correlation coefficients of less than 0.20 should be eliminated because they are deemed to be inconsequential. The remaining results will then be merged to create data, which will be utilized as the machine learning algorithm's input parameters. To standardize the data, the min_max scalar package will be applied. The parameters are then optimized using the random forest classifier and artificial neural network. In accordance with Chen et al. [70], the criterion, splitter, training/testing ratio, and depth factors will be considered in this investigation.

3.5. Random Forest Classifier (RFC)

The outputs of numerous decision trees are combined using the machine learning algorithm random forest to produce a single outcome. It is an ensemble learning technique that, during the training phase, generates a huge number of decision trees in order to perform classification, regression, and other tasks [69]. The RFC is able to deliver higher accuracy than other methods by using simpler algorithms, which are driven by the most crucial and determining factors. By searching for the best tree output in each iteration, the RFC also has the ability to find a classification model that is more consistent and predicts human factors and user behavior [13]. The random forest approach constructs an uncorrelated forest of trees, which uses bagging and feature randomness to produce a forecast by committee that is more accurate than that of any individual tree [70].

Thus, to better classify factors affecting sustainability behavior, this study considered RFC as one of the algorithms aside from the more complex artificial neural network [71]. Similar to a study conducted by German et al. [14], the RFC algorithm made use of the Scikit-learn package using the Jupyter Notebook. Tree depths of four to seven were explored, along with criteria of entropy or the Gini coefficient, different training-to-testing ratios, and random or best splitters.

3.6. Artificial Neural Network (ANN)

The biological neural networks found in animal brains provide the inspiration for a type of computing system known as an artificial neural network (ANN). Deep learning algorithms are based on ANNs, a subset of machine learning [72]. They are composed of interconnected nodes, or artificial neurons, that process input signals and transmit them to subsequent nodes in a series of connections to produce the required output [73]. Nonlinear models called ANNs, which can categorize complex interactions, are frequently utilized in studies on human behavior. In comparison to other machine learning algorithms, they have a number of benefits, such as replicating the human brain and the ability to learn and develop without constant assistance from a person [14]. As more data are put into them, they can perform better and handle vast amounts of data [74]. ANNs are able to handle complex data and can spot relationships and patterns that other algorithms might miss [75].

Therefore, the combinations of neural networks and random forests may be able to predict human behavior with higher accuracy [14], which was important for this study's analysis. Similar to the study of Ozturk and Basar [76], the MATLAB program was utilized, with the Levenberg–Marquardt Algorithm employed to identify the optimum neural network model.

As seen in Figure 2, there are going to be three stages. The first stage would be the initial stage where the preparation will happen. This is when the questionnaire that was prepared will be disseminated to gather the data that are to be processed. The second stage is the processing stage, which is where the data that are gathered will be processed. Here, three methods are going to be used to process the data. The first method is data pre-processing, where the gathered data will be fixed so that they can be easily processed by the data processor. The second and third methods are the random forest classifier and the artificial neural network, which are the two data processors that are to be used for processing the gathered data. The last stage is where the results from the two data processors will be seen. Here, the analysis and interpretation of the data will take place and the main factors that affect the behavioral intentions of buyers will be identified.

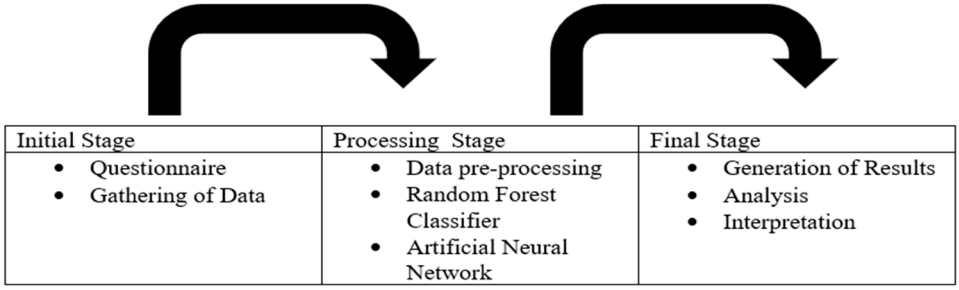

Figure 2. Research process.

4. Results

Random Forest Classifier (RFC)

Table 3 displays the condensed RFC output. The optimization method revealed that depth 6 had the most reliable and accurate rates. Analysis of Variance (ANOVA) was used to determine which differences among the outputs were statistically significant. The best

tree employing RFC may be inferred from the 92% accuracy rates for the Gini criterion and best splitter.

Table 3. Random forest classifier results (depth = 6).

Category	60:40	70:30	80:20	90:10
Best				
Entropy	84.52	83.39	84.48	91.10
Standard Deviation	1.202	0.925	0.887	0.998
Gini	87.39	82.85	88.50	92.00
Standard Deviation	1.216	0.732	0.503	0.000
Random				
Entropy	83.09	80.82	84.48	86.22
Standard Deviation	3.125	3.961	5.234	4.872
Gini	83.05	81.94	84.28	86.36
Standard Deviation	3.654	3.958	4.918	5.280

To produce the best tree output, the parameters best and Gini were set to 90% training and 10% testing. Figure 3 shows the ideal RFC categorization model. According to the findings, PAS (X1) controlled the behavioral intention for accepting lower plastic materials. AT (X0) is regarded as the root node of the tree. Then, X0, X1 (−0.412), and PBC (X2) with a value below or equal to −0.909 are taken into account. People will have very high behavioral intentions if this criterion is met. A high behavioral intention is seen if the X1 (0.412) criterion is not met. This shows that PENC should be emphasized in order to inspire people to have extremely high or positive behavioral intentions. If the first child node criteria are not met, a similar output is visible.

A 0.123 condition for the first child node of X0 is taken into consideration if the parent node with a value of less than or equal to 0.386 is not satisfied. When this requirement is met, X1 will be taken into account, followed by CPV (X3), which will also result in a high behavioral intention. This demonstrates that PAS influences a person's choice to buy reduced plastic items. If the child node criteria are not met, it will then examine X2, X1, and X0, which will lead to very high behavioral intentions of customers embracing reduced plastic products.

The results demonstrate that PAS and AT are the most important variables that significantly influenced people's PBC and CPV to have exceptionally high behavioral intentions towards using fewer plastic items. This shows that PBC and CPV are essential components that may have a significant impact on how well consumers respond to products made with less plastic. The random forest classifier will need additional input from other MLAs, given the variety of components that are still present, in order to produce a precise classification of the latent factors affecting behavioral intentions. In order to locate the relevant latent variables, German et al. [14] used a variety of techniques in addition to the results of the random forest classifier.

The application of the ANN was implemented to support the result of the RFC. In addition, as it was explained by Bhui et al. [74], the utilization of ANNs can produce a more sophisticated classification modeling output. The current study compared Python's Jupyter Notebook and MATLAB R2021a. From the Python-integrated development environment, it was seen that the most accurate output would be produced by including 25 nodes in the hidden layer. The accuracy rates were considered and recorded as 93.56%, 91.37%, and 89.88%. Similarly, MATLAB presented low MSE values of 0.16044, 0.12586, and 0.12725 for the training, validation, and testing output, respectively. Presented in Figure 4 is the optimized ANN classification model, captured from MATLAB after the optimization process.

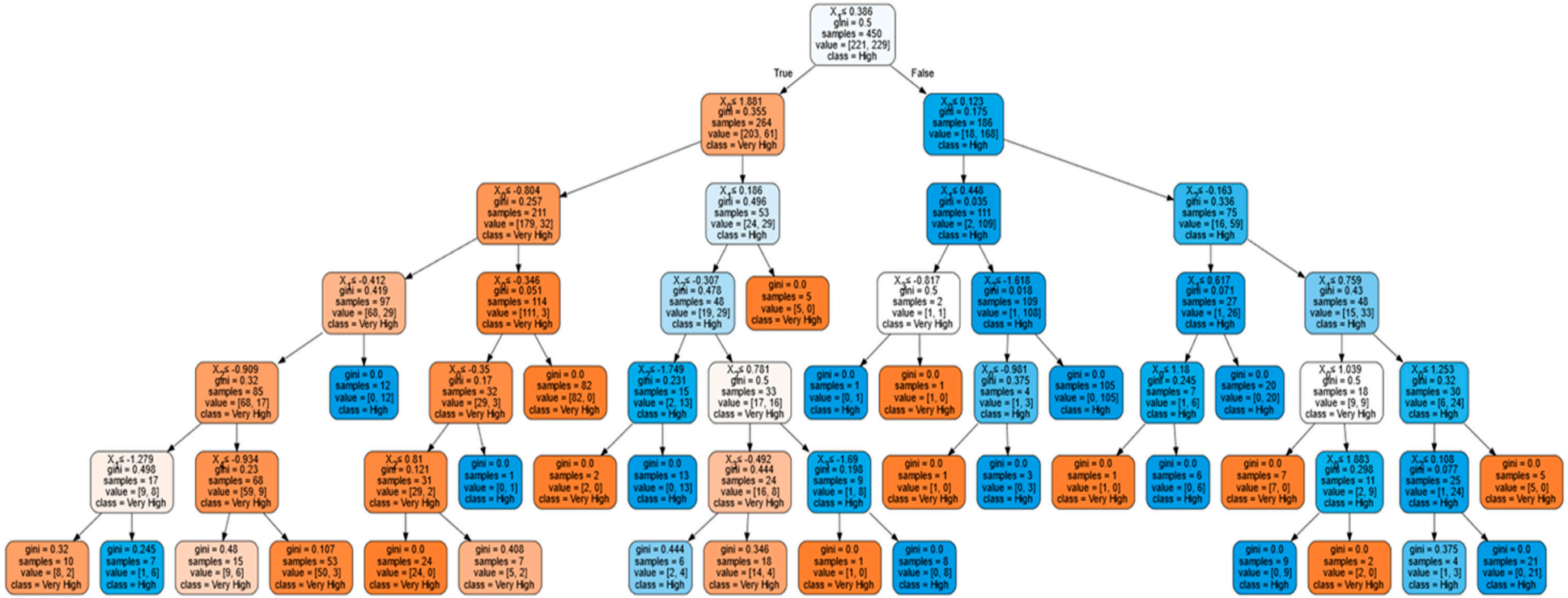

Figure 3. Optimum classification model with RF from Jupyter Notebook.4.2. Artificial neural network (ANN). Legends: X_0—attitude (AT); X_1—perceived authority support (PAS); X_2—perceived behavioral control (PBC); X_3—customer perceived value (CPV); and X_4—perceived economic concern (PEC).

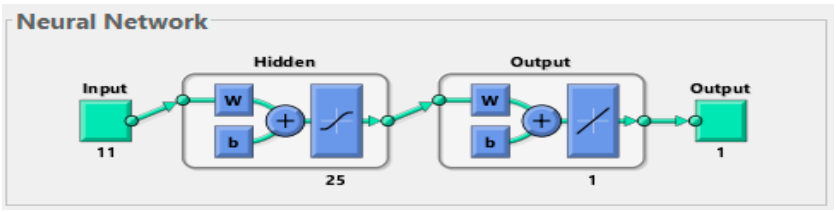

Figure 4. Optimum ANN classification model.

The output of the r-squared value is displayed in Figure 5 for additional validation. Additionally, the SHAP package was utilized to determine the relevance of the various input variables. It is clear that perceived support for authority, attitude, and perceived behavioral control are the most important factors. Customer perceived value perceived economic concern, and perceived environmental concern are listed after this. Finally, the subjective norm was shown to have the least significant impact and the lowest normalized importance score. With a rate higher than 60%, 72.7% is still regarded as substantial [14]. The normalized importance score that is considered in Section 5 is shown in Table 4.

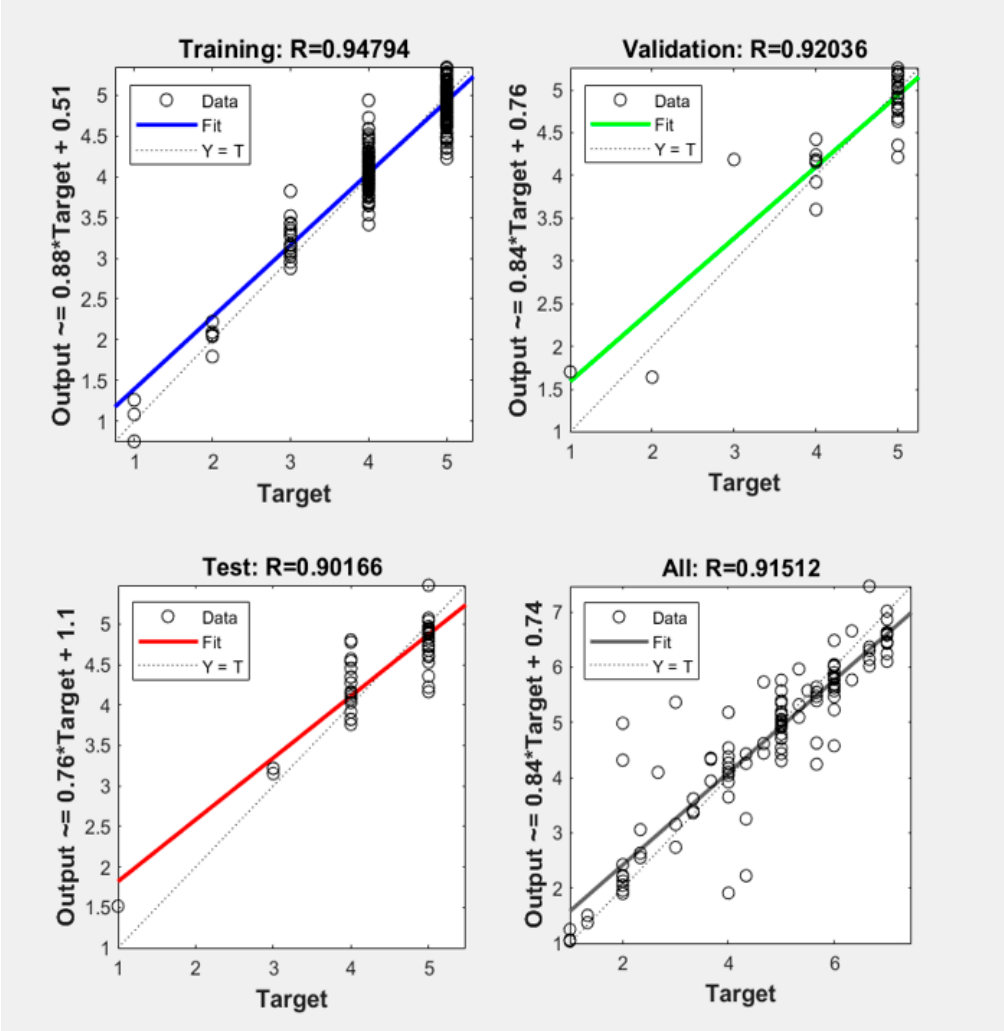

Figure 5. Validation R-squared output from MATLAB output.

Table 4. Normalized score of importance.

Latent Variable	Importance	Normalized Score of Importance
PAS	0.195	100%
AT	0.184	94.6%
PBC	0.178	91.3%
CPV	0.176	90.4%
PEC	0.169	86.7%
PENC	0.160	82.1%
SN	0.142	72.7%

Further insights were obtained through path analysis and hypotheses testing (Table 5). In accordance with the results of the normalized score of importance, consistent outputs were seen. That is, PAS provided the most significant influence, followed by AT being affected by (→) PAS, PEC, and PENC, then PBC being affected by sustainability domains like AT, leading to a significant impact on CPV and BI. In accordance, PEC and PENC were deemed significant on the build-up, while SN presented the least significant impact, with lowest *p*-value and path coefficients among the behavioral domains.

Table 5. Hypotheses testing.

Hypothesis	Relationship	St Dev	Path Coefficient	*p* Values	Decision
1	PEC → SN	0.050	0.184	<0.001	Accept
2	PEC → AT	0.052	0.299	<0.001	Accept
3	PEC → PBC	0.038	0.376	<0.001	Accept
4	PENC → SN	0.056	0.305	<0.001	Accept
5	PENC → AT	0.061	0.478	<0.001	Accept
6	PENC → PBC	0.045	0.652	<0.001	Accept
7	PAS → SN	0.043	0.804	<0.001	Accept
8	PAS → AT	0.037	0.629	<0.001	Accept
9	PAS → PBC	0.035	0.721	<0.001	Accept
10	SN → CPV	0.038	0.193	0.008	Accept
11	PBC → CPV	0.049	0.333	0.011	Accept
12	AT → CPV	0.042	0.455	<0.001	Accept
13	CPV → BI	0.028	0.770	0.012	Accept

5. Discussion

The results showed that perceived authority support (100%) is the highest contributing factor to customers' intentions to consider reduced plastic products. This shows that customers place a significant emphasis on the support, recommendations, or endorsements from authoritative figures or institutions when forming their attitudes and perceptions of control related to using reduced plastic products. Ying and He [51] suggested that if most people who are important to individuals advocate and encourage them to engage in pro-environmental behaviors, such as using reduced plastic products, they are more likely to consider and trust this advice. This implies that they are more likely to consider and trust advice or guidance from sources they perceive as credible and authoritative. Specifically, the authorities considered in this study are governing bodies and policymakers, with regard to their influence among people and the policies they implement in relation to sustainable practices.

Regarding the findings of German et al. [14], the Philippines have been trying to make an effort to enable sustainable practices among industries. Their study highlighting service quality among transportation services provided insights into how the Philippine government tries to promote and advocate sustainability among businesses. Being a study conducted during the peak of the COVID-19 pandemic, it was clear that respondents were able to see a significant effect of the pandemic on the government's policies. From the analysis, this study has highlighted that impactful results were seen from companies—leading to a high relevance of PAS on behavioral intention. Policymakers may also adopt

the measures taken by English-speaking countries by setting bag charges. As explained by Thomas et al. [77], communities have been accepting of this policy because it provides significant, positive environmental impact from the reduction in single-use plastics.

Recently, it has been reported in the Philippines that government efforts are being promoted [78] to try to develop a sustainable economy [79]. In current practice, encouragement of transportation [80], renewable energy [81], and logistics [14] are evident. The cultural context is therefore very important, as this is a very diverse policy area and is difficult to generalize [82]. That being said, consolidation of reduced plastic consumption studies is needed to encompass the total insight—thus reducing cultural and geographical differences. In addition, Majhi [83] and Soomro et al. [84] stated that government efforts should be a significant factor for creating widespread green consumer behavior in a country. Attitudes among consumers will therefore be seen to be highly impactful.

When it comes to attitude (94.6%), customers who perceive authority support are more likely to have positive attitudes toward reduced plastic products. A study on understanding consumers' purchase intentions for single-use plastic products found that policy-oriented perspectives, such as bans on plastic items, are commonly used to influence consumers' attitudes towards plastic products [85]. This implies that when customers perceive that authoritative figures or institutions are taking action to reduce plastic use, they are more likely to have positive attitudes towards reduced plastic products. They may view these products as not only environmentally friendly but also as choices that are endorsed or recommended by trusted figures or organizations. This positive attitude can lead to a higher willingness to use such products.

Comparing our results to the study conducted by Zwicker et al. [86], attitude is seen to be one of the main cognitive and affective drivers of plastic use-related behaviors. It was noted that guilt over negative environmental impacts causes a positive move towards considering reduced plastic consumption. Crowley [87], in a study from the Philippines, showed that educational programs could highlight positive attitudes towards reduced plastic consumption in the Philippines. The emphasis was on the use of plastic for convenience rather than the perception of negative environmental impact among northern Filipinos. Therefore, the need to implement educational programs for behavioral control is important for the reduction of plastic waste.

Another main contributing factor was perceived behavioral control (91.3%), which showed how consumers who perceive greater authority support may also feel a greater sense of control over their ability to use reduced plastic products effectively. This perceived control can stem from the belief that their actions align with guidance from authoritative sources, making consumers more confident in their ability to make sustainable choices [88]. As highlighted by Aruta [88], Filipinos tend to have control on positive behavior when they feel the social obligation to help preserve the environment. In addition, German et al. [14] highlighted that control over behavior among Filipinos for pro-environmental behaviors is increasing. This leads to a more positive PBC among consumers in the latest generation. Subsequently, Allison et al. [89] conducted a systemic review which highlighted that communication and marketing, as well as persuasion, would encourage positive behavior and action among consumers towards reducing plastic waste. Therefore, carefully considered interventions are needed for the behavior to be more significant.

Customer perceived value (90.4%) plays a pivotal role in shaping customers' intentions regarding reduced plastic products. CPV represents the total of the benefits customers believe they receive from these products in comparison with their associated costs. It is a measure of the perceived difference between the benefits and costs of a product. Understanding customer perceived value is crucial for businesses in designing products and services that meet customers' needs and preferences while also being profitable [90]. Consequently, Northen et al. [26] showed that the promotion of convenience, affordability, and product availability would lead to a high perception of value among consumers dealing with reduced plastic consumption. Furthermore, the Portsmouth study showed the benefits should be utilitarian in nature. That is, Filipino consumers would consider a

functional and economically stable product to be valuable. Similar insights were provided by the study of Khan et al. [91] regarding the generalizability to developing countries' consumer behavior. As explained by Valentin and Hechanova [92], ' products' quality and economic sustainability, rather than just their environmental impacts, should be highlighted to consumers in the Philippines to have positive implications on their purchasing decisions.

This leads to the next factor, the perceived economic concern (86.7%). It is a critical factor that can significantly impact customers' intentions when it comes to reduced plastic products. PEC refers to customers' apprehensions and considerations related to the financial aspects of using these products [93]. Customers often assess whether choosing reduced plastic products aligns with their budget and financial priorities. They weigh factors such as the initial purchase price, ongoing costs, and potential savings over time [25]. If customers perceive that opting for reduced plastic products is financially feasible and may lead to cost savings or other economic benefits, they are more likely to develop positive intentions to use these products [94]. Walker et al. [95] suggested that despite non-sustainable packaging costing Canadians more, some consumers are still willing to consider its use. However, more consumers were concerned about the importance of reduced plastic utility—highlighting changes on sustainable packaging. It was added that Canadians, however, were not willing to pay more. In relation to the Philippine context, sustainable practices are positive as long as the companies provide economically reasonable actions and decisions [14].

The next factor in the hierarchy is perceived environmental concern (82.1%). This represents customers' awareness of and sensitivity to environmental issues, which can significantly impact their choices and behaviors. Customers who have a high level of PENC are more likely to develop positive intentions to use reduced plastic products [51]. Reduced plastic products are often viewed as a way to address environmental concerns. Customers who prioritize environmental conservation perceive reduced plastic options to be a means of reducing their ecological footprints. This perception enhances their intentions to use these products as a way to contribute to positive environmental outcomes [96]. As suggested by Smith and Brisman [97], the generalized action being considered has not yet materialized in the current generation. Despite the media discourse and the possible solutions, it is said the global impact is still significant and environmental concerns should be prioritized by countries in order to reduce consequences. Widayat et al. [98] highlighted that heightened awareness drives post-plastic consumption. The study promoted the extension of the TPB with reasonable sustainable variables to holistically measure pro-environmental behavior among consumers. Therefore, much more work is still required before generalized sustainable consumer behavior can be achieved.

The lowest contributing factor on the list is subjective norm (72.7%). This factor represents the influence of social and peer norms on individual behavior and can strongly affect customers' intentions to use reduced plastic products. By recognizing and harnessing the power of social approval, peer influence, and the desire for social acceptance, businesses and organizations can encourage greater adoption of reduced plastic alternatives among consumers [99]. As highlighted by Kahn et al. [91], subjective norm is one of the significant variables affecting reuse and recycling among developing country consumers. This suggests that the practices inherent in a community would lead individuals to conduct positive pro-environmental actions. Similarly, Crowley [87] explained that community behavior in the northern Philippines would continuously promote pro-environmental efforts as long as interventions are practiced. With countries trying to promote pro-environmental behavior following the Kyoto Protocol, the challenges of the social, environmental, and economic aspects are seen among supply chains [13]. Thus, the coherence and combined efforts among consumers, the government, and industries should be promoted, enabling sustainable practices in different countries.

All of the factors analyzed in this study were found to be significant because they all surpassed the significance level of 60%. All were ranked based only on the results from the different methods used for the data analysis of the survey. Overall, it could be seen

that perceived authority support (PAS), attitude (AT), and perceived behavioral control (PBC) are the top factors that need to be focused on for people to consider reduced plastic as an alternative.

5.1. Theoretical Implications

The theory of planned behavior (TPB) framework can be applied to the understanding of the behavioral intentions of people towards reduced plastic products. Several studies have suggested that the TPB framework can be a useful tool for understanding the factors that influence an individual's intention to reduce their use of plastic products. By understanding these factors, interventions can be designed to promote sustainable behavior and reduce plastic waste. The identification of perceived authority support (PAS) as the most influential factor in shaping consumers' attitudes (AT) and perceived behavioral control (PBC) toward reduced plastic products carries several significant theoretical implications. First and foremost, it underscores the substantial impact of external influences, particularly authoritative endorsements, on shaping pro-environmental intentions. This finding aligns with established social psychology theories like the TPB and highlights the role of external social factors in guiding individual decision-making. PAS's prominence implies that not only do individuals look to authorities for guidance and validation regarding sustainable choices, but they also perceive authoritative support as a powerful source of credibility and trust. This aligns with theories on trust-building in environmental communication and suggests that trust in authorities can be leveraged to drive environmentally responsible behavior. Therefore, the established STPB framework could holistically measure sustainable behavior among individuals.

The established theory can therefore be applied and extended among other environment-related studies. Concurrently, the methodology considered in this study promoted a positive high accuracy rate. Furthermore, it was justified with path analysis. With models being highly nonlinear and large, especially current developments, the use of machine learning to depict significance is the established trend among researchers due to its capability to reduce the limitations of multivariate tools. For example, Fan et al. [100] explained that multivariate tools like SEM would provide low significance if mediating variables were present. Woody [101] on the other hand explained that the farther the variable to the target object, the less likely there was to be a significant effect. Thus, studies like those of German et al. [14] and Raghupathi [102] have utilized machine learning for behavioral analyses. Comparing other statistical tools with machine learning, higher accuracy output was observed [76]. Thus, it could be posited that the use of machine leaning enhances the reliability of the output.

5.2. Practical and Managerial Implications

Every government department has a part to play in encouraging the adoption of reduced plastic products in our society. By coordinating their efforts, governments can develop an impactful strategy to combat plastic pollution and encourage people to embrace sustainable alternatives. Presented in Table 6 (1) are the specific departments considered for the different recommendations and implications of this study.

Companies (Table 6 (2)) have the power to make an impact in promoting the adoption of eco-friendly alternatives to plastic among consumers. The table presents some practical suggestions and strategies that companies can implement to encourage this acceptance.

By putting these suggestions and tactics into practice, companies can not only encourage the adoption of reduced plastic products, but also play a part in fostering a consumer culture that is more sustainable and environmentally conscious. This approach has the potential to boost brand reputation, attract eco consumers and ensure long-term business viability.

Table 6. (1) Practical implications for the government. (2) Practical implications for companies.

Department in Charge	Recommendation
(1)	
Department of Education (DepED), Commission on Higher Education (CHED)	Incorporate education into the school curriculum by including lessons that focus on the issue of pollution. Additionally arrange activities and awareness campaigns within schools to further promote consciousness. It is also important to provide teachers with training on topics to ensure they can effectively deliver this information to students, highlighting sustainable behavior.
Department of Environment and Natural Resources (DENR)	Implement rules and guidelines to decrease the usage of plastic. Carry out evaluations to gauge the effects of reducing plastic consumption. Communicate progress made in achieving objectives related to reducing plastic usage.
Department of Health (DOH)	Encourage the exploration of health advantages linked to minimizing exposure to reduced plastic materials. Advocate for the adoption of sustainable healthcare practices, such as utilizing equipment made from non-plastic materials. Keep track of any health-related enhancements that arise from reducing plastic usage and provide reports on these improvements.
Department of Trade and Industry (DTI)	Promote the use of products and packaging by showcasing them at trade exhibitions and fairs. It is important for businesses to clearly label their eco-products to make it easier for consumers to embrace them. Additionally, they should work towards establishing trade agreements that focus on reduced plastic products and materials.
Department of Science and Technology (DOST)	This department should invest in the exploration and advancement of eco-materials and packaging alternatives through research and development. Encourage the progress of waste-to-energy technologies that can effectively handle waste. It would be beneficial to foster the creation of technologies that aid in monitoring and minimizing plastic consumption.
(2)	
Product Development and Innovation	Drive innovation and meet consumer demands it is crucial to allocate resources towards research and development. This will enable the creation of products with reduced plastic content. Emphasis should be placed on product design, functionality, and aesthetics so that they can effectively compete with alternatives.
Marketing and Branding	Develop marketing strategies that highlight the impact of using plastic products on the environment. Share stories of achievement and demonstrate the company's dedication to promoting sustainability.
Sales and purchasing	To reduce waste from packaging consider using materials like cardboard, glass, or biodegradable options. Additionally, focus on designing packaging that highlights the reduced use of plastic and its recyclability.

5.3. Limitations and Recommendations for Future Research

Even considering that there are several positive results in this paper, there are still several limitations and recommendations that future researchers of a similar topic can note.

Cross-Sectional Data: Cross-sectional data, which provide an overview of respondents' perspectives at one particular period, are a common source of information for studies in this field. However, the use of cross-sectional data might not be able to account for evolving attitudes and intents. Longitudinal studies may be used in future studies to better understand how these parameters change over time.

Self-Report Bias: Studies frequently rely on self-reported information, which is prone to social desirability bias. Instead of expressing their real intentions, participants may give replies they think conform to social standards. When possible, researchers should think about adopting other methods, such as conducting interviews and group discussions, to reduce this.

Limited Sample Diversity: It may be difficult to apply some studies' findings to different demographic groups or other social contexts because of the lack of range in some studies' sample groups. Future studies may try to recruit more representative and diverse samples. In the case of this study, Philippines-related future studies could try to

recruit several respondents from across the 17 regions of the Philippines to provide more generalizable context.

Complexity of Behavior: Understanding real behavior requires more than just looking into behavioral intentions. Future studies should investigate the gap between intentions and actions, taking into account elements that either support or restrict the conversion of intentions into actions. As expressed by Shavitt et al. [103], the complexity of consumer behavior relates to culture, as collectivism may play a significant role. In addition, most studies have dealt with individualism and collectivism in a certain country or region. This lack of diversity is one of the limitations of this study and may be mitigated by other researchers. It is suggested that comparative analyses and collective reviews of related studies may be conducted to provide generalizable findings. In relation to this, Sostar and Ristanovic [104] explained that geographical context may also influence generalizability. Therefore, sensitive data collection processes could be considered which are relevant to the geographical settings of future studies.

Incorporate Psychological Variables: It would be informative to investigate the roles of psychological variables such as values, beliefs, and emotions in shaping intentions. Understanding the psychological underpinnings of sustainable behavior is crucial, which future researchers may consider.

Future researchers can contribute to a deeper and more thorough understanding of the variables that affect behavioral intentions for using reduced plastic products by addressing these limitations and following these recommendations. This will ultimately help in the development of more effective strategies for promoting sustainable consumer behavior.

6. Conclusions

The findings showed that perceived authority support (PAS) and attitude (AT) were the main variables influencing customers' intentions of purchasing reduced plastic products. Consumers were influenced by recommendations and endorsements from reliable individuals or organizations, which had a beneficial impact on their attitudes and sense of control about using reduced plastic products. Customer perceived value (CPV), which measures the advantages consumers feel they gain from reduced plastic items relative to their costs, also played a crucial influence. Customers' intentions were further impacted by perceived economic concern (PEC) since financial factors were taken into account when making decisions. Customers with a high level of environmental awareness were more likely to embrace reduced plastic items as a way to lessen their ecological footprint and support environmental conservation, making perceived environmental concern (PENC) another important factor. Lastly, although to a smaller extent than the other categories, subjective norm (SN), which symbolizes social and peer influence, also had an impact on the intentions of customers.

Overall, it was determined that every one of these variables was significant and had a weight greater than 60%. The study shed light on the critical role of perceived authority support, customer attitudes, perceived value, economic considerations, environmental concerns, and social norms in influencing sustainable consumer behavior. It also offered insightful information into the intricate interplay of these factors in influencing consumers' intentions for using reduced plastic products. This study emphasizes the significance of taking these variables into account when developing marketing plans and activities intended to promote products with less plastic. Additionally, it raises the possibility of additional investigation and study of these variables using more sophisticated machine learning techniques and bigger datasets to improve our comprehension of sustainable consumer behavior.

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