The Last but Not the Least Piece of Marine Debris Management: Decoding Factors in Consumers' Intentions to Purchase Recycled Marine Debris Products

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Abstract: With a phenomenal amount of marine debris being retrieved from the coast and sea, an initiative to engage in marine debris recycling, particularly of plastic debris, has been on the governmental agenda in Taiwan in recent years. Consumers purchasing products made from marine debris is a critical driver behind this initiative. It is therefore important to understand the factors influencing consumers' purchase intentions towards these products. By employing the Theory of Planned Behavior (TPB), this paper aims to decode the factors and thereby infer potential measures to enhance consumers' purchase intentions for these specific products in Taiwan, where recycling marine debris is at the beginning stage. By conducting a questionnaire survey, the study collected a total of 392 valid samples and found that a high percentage of respondents had not heard of marine debris labels as well as having never bought products made from marine debris. In addition, by testing the hypotheses using binary logit regression, the study found that 'environmental attitude', 'perceived price', 'availability', and 'marine debris label' were the major factors that significantly influenced consumers' intentions to purchase these products. With a view to increasing market penetration of these products, this paper highlights the need to strengthen environmental education, subsidize manufacturers in the production of products, promote labels and enhance product availability, and enhance public participation in marine conservation activities.

Keywords: marine debris; recycling; purchase intention; green products

1. Introduction

Marine debris, particularly plastic, has emerged as a pressing marine environmental concern [1–5]. As defined by the United Nations Environment Programme (hereafter, UNEP), it refers to any persistent, manufactured, or processed solid material discarded, disposed of, or abandoned in the marine and coastal environment [6]. It endangers the survival and diversity of marine species [3,7]. Specifically, marine life dies of or is harmed by ingestion of marine debris or entanglement in abandoned fishing nets [8–11]. Laist [4] notes that marine debris, through ingestion and entanglement, affects a wide range of marine species, including sea turtles, seabirds, and marine mammals. Kühn and Van Franeker [12] suggest that as many as 914 species are currently impacted by marine litter. Wilcox et al. [13] also highlight an increasing percentage of seabirds ingesting fragments of plastic and further estimate that by 2050, 99% of seabirds will be impacted. Additionally, studies have found that marine debris can also damage sensitive habitats [14,15], pose dangers to navigation [16], disrupt ecosystem services in coastal areas [17], and increase the financial costs of policies and management [5].

The United Nations General Assembly particularly highlighted marine debris, plastics, and microplastics as key issues in the 2016 "Oceans and the Law of the Sea" report [18]. In

addition, the G20 focused on marine debris challenges and adopted the "G20 Implementation Framework for Actions on Marine Plastic Litter" in 2019 [19]. To address marine debris problems, a wide range of measures have been framed and adopted worldwide, including four major types: prevention, mitigation, removal, and behavior [20]. Among them, the removal approach, such as beach and ocean cleanups, is perhaps the most commonly employed approach worldwide. Onshore storage, landfills, and incineration are the conventional ways to dispose of the collected waste. However, due to the limitations of storage space and incineration capacity, marine debris buried on land poses a risk of re-entering the ocean [21,22]. This shows that there is an urgent need to deal with the waste collected from marine environments in a way other than the conventional ways. The UNEP particularly notes that management of plastic marine debris should incorporate the concepts of lifecycle as well as the circular economy [23]. In other words, when marine debris is collected from the coast and seas, how to motivate industries to engage in recycling marine debris has become a critical issue in marine debris management if the circular economy is achieved.

Recycling marine debris, particularly plastics, involves a number of complex procedures, including waste sorting, cutting, grinding, and washing in order to reduce its salinity and other contaminants. It is also noted that different treatment methods are used to accommodate various types and attributes of plastic, including mechanical recycling, thermal recycling, and chemical recycling, to transform plastic marine debris into recycled materials, products, and fuels [24–29]. According to personal communications with marine litter recyclers, it is estimated that the cost of plastic materials recycled from marine debris is at least double that of regular plastic materials due to the complex procedures involved. It is therefore expected that the price of the product made from the materials recycled from marine debris (hereafter 'recycled marine debris product') is higher than that of the regular product. Nevertheless, recent years have witnessed a heightened focus on the development of certification and labeling to facilitate consumers' identification of recycled marine debris products. For instance, non-profit organizations and social enterprises such as "Zero Plastic Oceans", "Ocean Cycle", and "Clean Up" have collaborated with third-party certification companies to establish certifications and labels [30–32].

In Taiwan, marine litter problems have gained wide attention in recent years. In 2017, Taiwan's government demonstrated its political will to address marine debris problems in a comprehensive and holistic way by establishing a 'marine debris governance platform'. This platform aims to identify effective and feasible ways to prevent, reduce, and control marine debris. It consists of concerned authorities (e.g., the environment sector, the fisheries sector, the tourism sector, the national park sector, etc.) and civil groups. Through numerous consultation meetings, the platform finally developed the Taiwan Marine Debris Governance Action Plan. This plan lays out major strategies, including source reduction, prevention, cleanup, research, and partnership [33]. A total of 76 specific actions associated with the four strategies have been subsequently proposed and practiced by concerned authorities, including, but not limited to, the provision of free plastic bags not being allowed, the mandatory marking of fishing gear, beach cleanups, fishing for litter, intercepting debris from flowing into the ocean, and regular surveys of waste on the coast and the ocean surface.

Among these measures, the one used to remove marine debris is particularly noticeable in terms of the number of people mobilized. Specifically, beach cleanups, seafloor cleaning, and fishing for litter programs have been practiced around Taiwan. The accumulated amount of debris is phenomenal. Statistics showed that in 2022, a total of 17,257 metric tons of marine debris was removed, of which only 19.6% was recycled. The remaining substantial amount of debris was destined either for incineration or landfills [34]. To enhance the recycling rate of marine debris, the concerned authority established the 'Marine Debris Recycling Coalition' [35]. In addition, the Plastics Industry Development Center (PIDC) also launched the 'Ocean Plastic Coalition' in April 2018 [36]. Both initiatives are intended to enhance the recycling rates of marine debris by uniting all the concerned partners involved in the supply chain of recycled marine debris products, which include

recyclers, suppliers of materials, manufacturers, and financial investors. However, as noted previously, the cost of materials recycled from marine debris is high. It is therefore important to enhance the market penetration of recycled marine debris products, despite the high cost, such that the supply chain will survive and even thrive. To this end, Taiwan has created two certification labels for recycled marine debris products (as seen in Figure 1) as an attempt to facilitate consumers' awareness of such products and to further enhance their intention to buy them. One is the 'Marine Waste Recycling Product Traceability Mark' [37]. The other is the 'Recycled Marine Debris Product Label' [38].

Figure 1. Taiwan's certification labels for products made from materials recycled from marine debris. Source: [1] [37]; [2] [38].

While endeavors are being made to promote marine debris recycling, the recycling rate is still very low. It is worth noting that marine debris recycling and the circular economy industry in Taiwan is still at the nascent stage. Given this, it is important to understand whether consumers are familiar with recycled marine debris products and their intentions to purchase them. It is noted that the Theory of Planned Behavior (TBP) assumes three predictors of intentions, attitude, subjective norm, and perceived behavioral control, and has been validated in predicting consumers' green product purchase intentions [39]. Numerus studies have employed this model to understand consumer green purchase intentions either for specific products (e.g., organic foods, bioplastic products, and green products in general including green foods, non-phosphate detergents, water-saving taps, mercury-free batteries, recycled paper, energy-saving lamps, etc.) or for specific country-context settings (e.g., Shanghai, China; Los Angeles, USA; Germany; or developing countries such as Bangladesh or Thailand) [40–45].

Given the general universality of the TPB model, this study employed it to construct the potential factors influencing consumers' purchase intentions for a new specific product which is made from marine debris in a specific country-context setting in which recycling marine debris is at the beginning stage. It is noted that understanding these factors has significant policy implications if the policy is to increase market penetration of the products and sustain the supply chain of recycled marine debris products. An empirically exploratory study was therefore conducted with the aim of examining consumers' intentions to purchase recycled marine debris products and investigating the factors in those intentions.

This paper is structured as follows. First, it starts with a review of the potential factors in consumers' intentions when purchasing products, particularly green products, and the relation between the factors and intentions. Second, it details the research methods, including the questionnaire design, data collection, and data analysis. Third, it presents

the results. Fourth, a discussion of the results and policy implications associated with enhancing consumers' intention to purchase recycled marine debris products are presented. The final part is the conclusion.

2. A Review of Potential Factors Affecting Consumers' Purchase Intentions

The Theory of Reasoned Action (TRA) posits that an individual's subjective norm and attitude collectively influence their behavioral intention. This behavioral intention serves as a precursor step to their actual behavior and thus it can be used to predict an individual's actions [46]. The Theory of Planned Behavior (TPB) builds upon the concepts of TRA and further proposes that, besides the subjective norm and attitude, an individual's actions or intentions are also influenced by perceived behavioral control [47]. The TPB model has since been widely employed in analyzing consumers' purchase intentions towards products, particularly green products [48–51]. Green products can be defined as those that, throughout their lifecycle, are deemed socially and environmentally responsible in terms of both materials and production methods [52]. By this definition, recycled marine debris products fall under the category of green products. Given the universal application of the TBP model in predicting consumers' behavioral intentions, as demonstrated by numerous previous studies, it was used as the theoretical model for this study.

As noted earlier, the TPB model specifies three predictors of intentions: attitude, subjective norm, and perceived behavioral control. Attitude is defined as an individual's positive or negative evaluation of a specific behavior and is one of the precursors to behavioral intention [47]. Numerous studies have highlighted that consumer attitudes influence purchase intentions or behavior towards green products [53–55]. An environmental attitude can be defined as a psychological inclination expressed through a certain degree of evaluation of the natural environment, reflecting an individual's preference [48,56]. This evaluative predisposition towards the environment influences an individual's purchase intention or behavior concerning green products. For instance, a study in Malaysia by Eze and Ndubisi [57] shows that an individual's value judgment towards environmental conservation significantly impacts green purchasing behavior. Chen and Chang [58] note that an individual's perceived green value positively affects their intention to purchase green goods. Moreover, Follows et al. [59] point out that the potential environmental consequences of purchasing behaviors also affect the intention to engage in green buying behaviors.

A subjective norm refers to the pressure an individual perceives from significant others or groups about whether they should engage in a specific behavior [47]. This implies that, when consumers are uncertain about how to act on a particular behavior, they seek support from trusted cohorts [60]. Consequently, a consumer's intention of purchasing green products depends, to some extent, on the attitudes and opinions of those they deem significant. This subjective or social norm imposed by others has been confirmed to have a direct positive correlation with consumers' green purchasing behaviors in several studies [54,61,62].

Perceived behavioral control refers to an individual's perceived ease or difficulty in performing a particular behavior and is identified as one of the critical factors in behavioral intention [63]. In other words, a behavior possibly occurs when an individual has the ability, motivation, and trust to perform that behavior [50,64]. The ability, motivation, and trust are associated with the attributes of products, including price, convenience/availability, brand name, and certification labels and green advertising [65–69]. As an illustration, Olsen states that the most important control factors that influence consumers' seafood purchasing include affordability and convenience/availability [68].

As for price, studies have shown that product pricing remains a major concern for consumers in their purchasing decisions on green products, particularly for these have limited economic resources [65,70]. A study further presents that when the price of green products surpasses consumers' ethical considerations, the disparity between their attitudes and actual purchasing behaviors is amplified [53]. Moreover, consumers may be reluctant

to pay more for green products if they perceive that the product's performance does not meet their expectations [71].

As for availability, it is noted that limited availability and inconvenience stand as major barriers for consumers to purchase green products [53,72]. A study in Denmark reveals that, while young consumers harbor positive attitudes towards organic food, the lack of product availability prevents such attitudes from translating equivalently into purchasing behavior [73]. In other words, consumers seek ease of access when engaging in green purchasing behavior [74].

As for brand name, a study suggests that consumers possess significantly positive views towards products from established brands but not from startups, owing to reduced concerns about the quality of recycled components in renowned brands [66]. However, another study by Borin et al. [75] indicates that the brand name does not significantly influence purchase intentions towards green products, implying that for consumers valuing green practices, the eco-friendly attributes of a product outweigh the brand name. With the increasing market demand for environmental sustainability, well-known brands have seen increased returns derived from green products [76]. In Taiwan, several private brands have already collaborated with public and private recycling entities to produce products or packaging made from marine debris. For instance, Greenvines biotech, a bath and skincare brand, utilizes materials recycled from discarded fishing nets to produce shampoo bottles [77]. LITE-ON, an electronics firm, manufactures keyboards and mouses by using plastic recycled from marine debris [78].

As for the certification label, it serves as a focus of the product and facilitates consumers' understanding of its eco-friendly attributes [72]. It stimulates consumers to select a green product with minimal involvement and makes them aware of the impact they will have on the environment if they buy the product [69]. Panopoulos et al. [79] reveal that ecolabels have a positive impact on green purchase intentions for people aged between 18 and 25 in the UK. Liang [80] emphasizes that organic food labels, accompanied by detailed information regarding their certification origins, foster trust among consumers towards organic products. Nonetheless, green labels do not always have a positive impact on consumers' purchase intentions. For instance, a study by Nittala [81] focusing on university professors in India found that highly educated consumers expressed skepticism towards the green information provided by products and displayed distrust in labeling and certification processes.

As for green advertising, it is typically used to highlight the environmental benefits pertaining to a specific product, such as pollution reduction or decreased greenhouse gas emissions [82,83]. Such advertisements are used to motivate consumers to buy green products [67]. A study in Malaysia by Tan et al. [84] identifies advertising as one of the crucial predictors of consumer behavior towards buying green products. However, studies also found consumer distrust towards green advertising, mainly due to the negative impressions of greenwashing [82,85,86].

Drawing upon the previous review, this study initially identified seven potential factors influencing purchase intention: environmental attitude, subjective norm, perceived price, availability, brand name, certification label, and green advertising. Despite this initial identification of the factors, it is admitted that the identification inevitably involves a certain degree of researchers' judgement. To alleviate the potential subjective judgement, the factors and their associated statements were then submitted for a further check by five experts, which is detailed in the research methods.

Lastly, the independent variable—purchase intention—is defined as consumers' intention to purchase recycled marine debris products, which is the behavioral intention as indicated in the TPB model. It serves as a precursor step to the actual purchase of such products.

3. Research Methods

3.1. Identification of Factors via Consultations with Experts

After a compilation of potential factors, five experts were further consulted to check whether the initially identified factors are appropriate, whether any factors need to be added or deleted, and whether the statements of factors are relevant to the assessment of that particular factor and adequately reflect the core concept. Among the five experts, two are scholars in the field of marine debris management, two are scholars in the field of consumer behavior, and one is in the private sector and has projects promoting green products. The main outcomes from this consultation showed that the identification of the seven factors was deemed appropriate and adequately covered all the dimensions relevant to purchase intentions specific to recycled marine debris in the context of Taiwan. However, the statements have been slightly revised to better reflect the core concept and enhance understandability. With the inputs from experts, the questionnaire reached a certain level of content validity [87].

3.2. Questionnaire Design

A structured questionnaire was used to assess consumers' views on the factors in consumers' intentions of purchasing recycled marine debris products. It consists of three sections. The first section deals with respondents' demographic profiles. The items include the following: gender, age, education, employment, and place of residence. The second section focuses on respondents' engagement in marine conservation activities and marine debris issues. It covers the following questions: whether they have participated in marine conservation activities (e.g., beach cleanups, marine ecotourism activities, funding for ocean conservation campaigns, volunteering in NGOs or governmental agencies); whether they are aware of recycled marine debris products; whether they have heard of marine debris labels; and whether they have ever bought recycled marine debris products and, if so, which types of products. It is noted that pictures of recycled marine debris products are specifically presented in the first page of the questionnaire as an attempt to remind respondents of their experiences (if any) with recycled marine debris products.

The third section examines respondents' views on the factors and the intention to purchase recycled marine debris products. As noted in the previous review, the factors include 'environmental attitude', 'subjective norm', 'perceived price', 'perceived availability', 'brand name', 'marine debris label', and 'green advertising'. The views towards the factors are measured using a five-point Likert scale with 1 being "strongly disagree" and 5 being "strongly agree" [88]. One additional question in this section is the intention to purchase recycled marine debris products.

The questionnaire was amended and finalized with inputs from a polit study of five typical people. They were chosen to help improve the quality of the questionnaire on the aspects of the clarity of words, the flow of the questions, the length of the questionnaire, and the time needed to complete the survey. The final version of the questionnaire is seen in Appendix A.

3.3. Research Design

Based on the previous review of the potential factors in consumers' purchase intentions, seven hypotheses in relation to the identified factors were proposed, as below. The proposed research design is seen as Figure 2. The factors serve as explanatory variables, and the intention to purchase recycled marine debris products serves as the dependent variable.

H1. *An individual's environmental attitude significantly and positively influences the intention to purchase recycled marine debris products.*

H2. *Subjective norms significantly and positively influence the intention to purchase recycled marine debris products.*

H3. *The perceived price of recycled marine debris products significantly and negatively influences the intention to purchase recycled marine debris products.*

H4. *The availability of recycled marine debris products significantly and positively influences the intention to purchase the products.*

H5. *The brand name significantly and positively influences the intention to purchase recycled marine debris products.*

H6. *The marine debris label significantly and positively influences the intention to purchase recycled marine debris products.*

H7. *Green advertising significantly and positively influences the intention to purchase recycled marine debris products.*
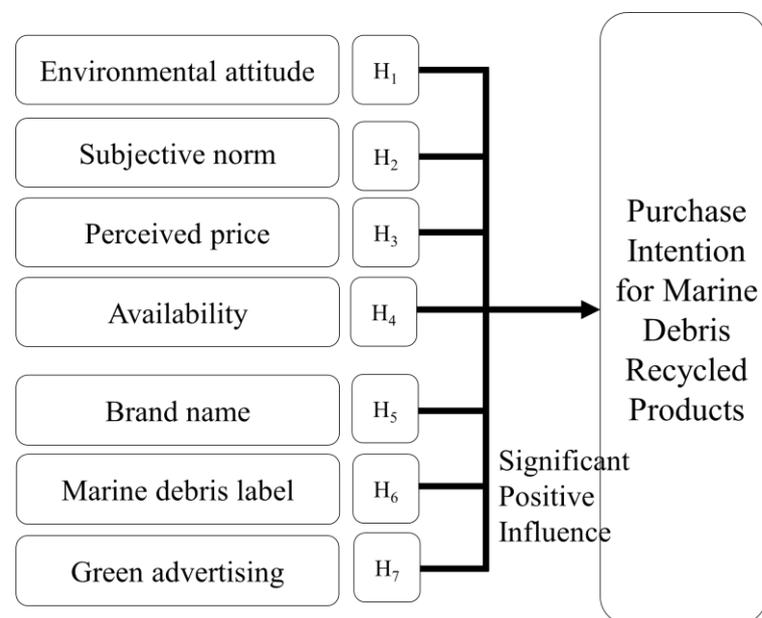

Figure 2. Research framework model. Source: authors' own work.

3.4. Data Analysis

Descriptive statistics were employed to calculate the frequency, mean, and standard deviation (SD) of the questions. Analysis of variance was conducted to check the differences of means regarding gender, age, education, employment, residential place, and engagement in marine-related activities.

A binary logit regression was conducted to examine the relationship between factors (explanatory variables) and purchase intentions (independent variable). The regression has a categorical outcome variable with a binary attribute, which is calculated through continuous or categorical explanatory variables [89]. It analyzes the consumer's choice behavioral intention by estimating which of two categories a person is likely to belong to given certain information, as indicated in the explanatory variables. Furthermore, the parameter estimations derived from the model were used to test whether the proposed hypotheses were supported or not. This regression model has been employed in several empirical studies [45,90–92]. All data analyses were conducted using the SPSS software (version 14.0), and a *p* value of 0.05 was used to determine if there are significant differences in means or the association between variables.

3.5. Sample and Data Collection

Adults aged 18 and above were the target population. A convenience sampling was employed [57,93]. The survey was conducted online via a platform which offers the survey service (SurveyCake) and social media platforms such as Facebook and Line. A total of 392 valid samples were collected between March and June 2023. The sample size was computed at a 95% confidence interval, with a 5% sample error utilizing Cochran's formula [94].

Slightly more than half (53%) of the respondents were male. About one-third of the respondents were aged 30–39, 30% were aged 40–49, 22% of age 18–29, and 16% were aged 50 or more. The majority of respondents had a bachelor's degree (67%), followed by high school or below (17%), and master's degree or above (16%). More than half of the respondents worked in the private sector (56%), followed by "other" (24%) (including self-employed, freelancers, retirees, etc.), students (11%), and the public sector (9%). The majority of respondents resided on Taiwan's main island, with 46% in the north (46%), 27% in the central, and 23% in the south region. Only a small portion were from the east and outlying islands (4%). Forty-five percent of the respondents had annual incomes between 500,000 and 999,999, 41% less than 500,000, and 14% 1 million or more.

4. Results

4.1. Respondents' Engagement in Marine Conservation Activities and Marine Debris Issues

Slightly more than half of the sample reported that they had participated in marine conservation activities during the past three years (58%) and were aware of recycled marine debris products (54%). However, as high as 73% of the respondents reported that had not bought recycled marine debris products. This indicates that awareness of recycled marine debris products does not necessarily translate into green actions. In addition, 70% of the sample stated that they had not heard of marine debris labels. For those who had ever bought such products, the top three products reported are as follows: souvenirs (35%), backpacks/bags (30%), and clothing (20%). The results noted above are summarized in Table 1.

Table 1. Respondents' engagement in marine activities and marine debris issues (*n* = 392).

Items		Frequency	Percentage (%)
Have you ever participated in marine conservation activities [a] during the past three years?	Yes	227	58
	No	165	42
Are you aware of recycled marine debris products?	Yes	212	54
	No	180	46
Have you ever heard of marine debris labels?	Yes	118	30
	No	274	70
Have you ever bought recycled marine debris products?	Yes	106	27
	No [b]	286	73
If 'yes' for the above question, which types of products have you purchased? (multiple possibilities allowed) (*n* = 106)	Souvenir	37	35
	Backpack/bag	32	30
	Clothing	21	20
	Shoe	10	9
	Keyboard/mouse	6	6
	others	2	2

[a] Marine conservation activities are those such as beach cleanups, marine ecotourism activities, funding for ocean conservation campaigns, volunteering in NGOs or governmental agencies. [b] This category of No also includes the individuals who are not sure if they have ever bought recycled marine debris products.

4.2. Respondents' Views on Factors in Purchase Intentions

The mean scores of the factors are presented in Table 2. The factors perceived price and marine debris label were rated with high levels of agreement (4.20 and 4.02, respectively), indicating that these two factors matter most in respondents' decisions on purchasing

recycled marine debris products. The mean scores of the remaining factors are as follows: environmental attitude (3.88), availability (3.81), green advertisement (3.70), brand name (3.65), and subjective norm (3.63). A further t-test of these factors showed that the mean score of each factor is greater than three but less than four (at 0.05 level), suggesting that respondents slightly agree with these items. Moreover, it is worth noting that in comparison with other items, the standard deviation of the factors green advertising and brand name seems to be slightly bigger. This suggests that a larger extent of divergent views among respondents towards these two factors exists.

Table 2. Mean scores of potential factors in purchase intentions ($n = 392$).

Factors	Items	Mean [a]	S.D. [b]
Environmental attitude	My belief in environmental protection affects my intention to purchase recycled marine debris products.	3.88	0.865
Subjective norm	Recommendations from significant others increase my intention to buy recycled marine debris products.	3.63	0.863
Perceived price	The price of recycled marine debris products influences my purchase intention.	4.20	0.921
Availability	The ease of buying recycled marine debris products affects my purchase intention.	3.81	0.887
Brand name	A well-known brand of recycled marine debris products affects my purchase intention.	3.65	1.232
Marine debris label	Products with a marine debris label increase my purchase intention.	4.02	0.855
Green advertising	Advertisements for recycled marine debris products affect my purchase intention.	3.70	1.268

[a] Five-point Likert scale was used for rating the agreement of each factor ranging from 1 (strongly disagree) to 5 (strongly agree). [b] S.D. is standard deviation.

Few statically significant differences were found in the purchase intention with regard to gender, age, employment, residential place, and awareness of recycled marine debris products. However, the intention differed significantly in relation to incomes (F = 2.498, $p < 0.05$), participation in marine conservation activities (t = 6.135, $p < 0.05$), awareness of marine debris labels, and purchase of recycled marine debris products (t = 5.433, $p < 0.05$). This shows that respondents having higher incomes had a higher intention to buy recycled marine debris products than those having lower incomes. In addition, respondents that had participated in marine conservation activities, were aware of marine debris labels, and had ever purchased recycled marine debris products had a higher intention to purchase recycled marine debris products than those who had not.

4.3. Association between Factors and Intentions to Purchase Recycled Marine Debris Products

More than half of the sample (57%) revealed an intention of purchasing recycled marine debris products. A binary logit regression was performed to examine the relation between respondents' intention and the factors. The independent variables (factors) are numeric, measured by the five-point scale. The dependent variable (intention) is binary. The result is shown in Table 3. The model is statistically significant (Nagelkerge R-squared = 0.451, Chi-square = 93.82) and can distinguish respondents with intention (yes) from those without intention (no). Specifically, it correctively classified 70.4% of the cases. Among the group 1 cases (total = 223) and the group 2 cases (total = 169), 153 and 122 were correctively classified, respectively.

Table 3. Results from the binary logit regression (*n* = 392).

Factors	EA	SN	PP	AV	BN	ML	GA
Coeff.	0.422 *	−0.156	−0.566 *	0.332 *	0.078	0.611 *	0.063
Wald	11.121	3.882	16.471	10.544	3.104	12.577	5.417

Notes: *n* = 392, Chi-square = 93.56, *p* = 0.000. The variables are defined as follows: intention = 1 if respondents have intention to purchase recycled marine debris products; otherwise. EA, SN, PP, AV, BN, ML, GA are factors referring to environmental attitude, subjective norm, perceived price, availability, brand name, marine debris label, and green advertising, respectively. The factors are numeric values measured by the five-point scale. * = Significant at the 5% level.

By checking the coefficients of the independent variables shown in Table 3, the positively significant factors (at 0.05 level) in determining respondents' intention to purchase recycled marine debris products are 'environmental attitude', 'availability', and 'marine debris label'. This suggests that the higher agreement to these factors the respondents show, the higher the intention they have to purchase recycled marine debris products. On the other hand, a negatively significant factor is 'perceived price'. This suggests that the higher agreement the respondents show to these factors, the lower the intention they have to purchase recycled marine debris products. The above results show that H1, H3, H4, and H6 are supported, with the factors 'perceived price' and 'environmental attitude' being the most powerful predictive factors.

5. Discussion

The agreed factor regarding consumers' views towards the environment revealed that consumers' intentions might be dictated by environmental attitude. In addition, as shown in the binary logit regression analysis, there is a positive significant relation between this factor and the intention. The findings are in line with previous studies, suggesting a link between a person's attitude towards environmental protection and his/her green purchasing intentions or behaviors [42,55,93,95]. This link can be established and further strengthened via education. Environmental education argues that behavior can be changed by making people more knowledgeable about the environment and its associated issues [96]. It is also held that raising awareness and strengthening education facilitate the reduction of marine litter [97]. This indicates that education might incline consumers to buy recycled marine debris products. From a policy perspective, it is suggested that concerned authorities, schools, or NGOs are encouraged to sponsor or hold educational and outreach programs for the public and students. The programs may have a focus on raising people's awareness of marine environments, the severity of marine litter pollution, the impacts of marine litter on the ecosystems, and the various measures currently used to address marine debris problems, particularly including marine debris labels and recycled marine debris products.

It is not surprising to find that the price of recycled marine debris products features in consumers' decision-making on the purchase of such products, as indicated in the high agreement towards the factor of perceived price as well as a significantly negative relation between this factor and consumers' intentions. This result is in line with many prior studies on green consumption [57,70,84], showing that price does constitute a barrier to consumers' decision-making on the purchase of green products. Practically speaking, given that the cost of plastic materials recycled from marine debris is higher than that of regular plastic materials, manufacturers of recycled marine debris products face a trade-off between pursuing profits and enhancing consumers' purchasing intentions. It is therefore challenging for recycled marine debris products to outcompete similar products in the market. A policy implication would be that subsidizing the marine debris recycling industry, especially during the early stage of its development, is recommended.

The subsidy approach can partially offset the extra cost of treating marine debris and thereby narrow the price gap between recycled marine debris products and their counterparts in the market. This approach is crucial in terms of securing a certain market

share of recycled marine debris products, particularly when the products make their debut in the market. In practical terms, only when a certain market share is secured are the concerned partners in the supply chain willing to engage in this industry. However, it is noted that offering subsidies is not a long-term solution. What matters most is that recycled marine debris products finally reach a point of differentiation in the market where consumers purchase them, and the recycling industry is therefore sustained and can even thrive in the future.

Marine debris labels represent a symbol by which consumers are able to differentiate recycled marine debris products from regular products. The label may play a significant role in consumers' decision-making, particularly for those who see themselves as green consumers. This argument can gain support from the results of the binary logit regression, which revealed a significantly positive relation between awareness of marine debris labels and the intention to purchase recycled marine debris products. However, the results showed that a high proportion (70%) of the respondents have not heard of marine debris labels. This indicates that consumers may fail to recognize recycled marine debris products even if these products are labelled. In this regard, promotion of labels is critical to facilitate consumers' awareness and understanding of the label. This can be achieved through sponsoring education programs and promotional activities. Specifically, concerned authorities and schools, in partnership with environmental NGOs and recycling industries, are encouraged to arrange various eco-marketing activities and to make use of social media and internet advertising to enhance the market exposure of marine debris labels and their associated products. It is worth noting that green marketing efforts through social media have been verified to attract the notice of consumers, though not yet as much as presumably desired [98], and has a positive impact on green purchasing intentions [99]. In particular, green marketing by influencers is highly recommended since they are capable of initiating discourses and raising awareness regarding particular subjects using hashtags which influence user-generated content [100,101].

However, it is also noted that consumers might harbor skepticism about the environmental benefits touted by the ecolabels [82,85]. In this regard, policymakers need to advance the certification process in a standardized and transparent way which allows for audits by third parties. In this way, consumers are more likely to build trust toward the products certified with ecolabels [102,103].

In addition to consumers' unfamiliarity with marine debris labels, this study also found a significant relation between perceived availability of and purchase intentions towards recycled marine debris products. This is in line with the results from Tanner and Kast [104] and Goriparthi and Tallapally [105], both of which indicate a significantly positive relation between the availability of green products and purchase intentions. However, it is noted that, given that marine debris recycling and its associated circular economy industry in Taiwan is at its nascent stage, consumers face limited availability as well as inconvenience in accessing the products. This limited availability stands as a barrier to consumers' purchasing intentions [50,74,106]. From a policy perspective, it is important to enhance product availability. Expanding physical sale sites (e.g., convenience stores) and using online shopping channels are ways to enhance product availability. With these approaches, consumers are able to minimize the time and effort spent in seeking recycled marine debris products.

This study showed that respondents who have participated in marine conservation activities had higher intentions to buy recycled marine debris products. This indicates that experience in marine conservation activities fosters consumers' action on environmentally responsible behavior. Similar views underpinning this argument can be found in several studies. Chen and Tsai [107] and Zsóka et al. [108], for example, found that students who had marine-related experience were more likely to foster positive attitudes toward marine environments and engage in environmental behavior. Lee and Moscardo [109] argued that participation in nature activities led to environmental behavior. Chiu et al. [110] stated that eco-travel experiences are able to influence tourists' environmentally responsible behavior.

Therefore, if the policy is to enhance consumers' purchasing intentions for recycled marine debris products, emphasis should be placed on promoting people's participation in marine conservation activities such as beach cleanups.

In light of the above discussion, specific recommendations are accordingly proposed to enhance consumers' intentions to purchase recycled marine debris products, including strengthening environmental education, subsidizing manufacturers in the production of recycled marine debris products, promoting labels and enhancing product availability, and enhancing public participation in marine conservation activities.

6. Conclusions

This study emphasizes an urgent need to promote marine debris recycling. This need is based on the fact that a substantial amount of marine debris is not recycled and the potential environmental concerns that arise as a result. It also elaborates Taiwan's efforts on this by establishing a supply chain of recycled marine debris products and creating labels. However, the high extra costs incurred from the complex procedures in recycling marine debris may deter industries from engaging in marine debris recycling. It is therefore important to understand the factors in consumers' purchase intentions towards the products in terms of market penetration. The TPB model was then used as a research framework to find the potential factors influencing purchase intentions.

This paper presents an empirical study on decoding the factors in consumers' purchase intentions towards recycled marine debris products. It found that people participating in marine conservation activities, being aware of marine debris labels, and having ever bought such products exhibited a higher intention to purchase the products than those who did not. Furthermore, it showed that 'environmental attitude', 'perceived price', 'perceived availability', and 'marine debris label' play a significant role in the decision-making on the purchase of the products. A number of specific recommendations are further proposed, including strengthening environmental education, subsidizing manufacturers in the production of recycled marine debris products, promoting labels and enhancing product availability, and enhancing public participation in marine conservation activities.

The main notable contributions of this study are to explore these factors for a new type of green products—recycled marine debris products, which have never been studied before. Furthermore, it contributes to establishing a sustained supply chain of the products by proposing specific recommendations in a specific country-context setting where recycling marine debris is at the initial stage.

Despite the contributions noted and the interesting results with practical significance derived from this study, limitations do exist. First, this study has not tested the robustness of the prediction model of purchase intention. Therefore, it would be a meaningful area for future research to test the real explanatory power of the factors by targeting more consumers, particularly when consumers are more aware of the products. The results can be used as a benchmark to refine the model established herein. Secondly, this paper divided intentions into only two categories, which may not be able to depict consumers' intentions in a more precise way. A more refined model can be made with more categories of intention. This can be achieved with discriminant analysis, which allows for more than two categories in the dependent variable. Thirdly, while the results derived from the questionnaire survey shed light on ways to enhance purchase intentions, social media data, user-generated content, and digital traces have potentials to provide extensive materials for studying user opinions. A direction for future research may focus on these types of data and make a comparison between the results derived from different sources of data.

Given that a wide range of management measures are already in place to tackle marine debris issues, it is believed that recycling marine debris, embracing the concept of circular economy, is a key component and the last but not the least piece of marine debris management. Only when a certain level of market penetration is secured, will the industries involved in the supply chain of recycled marine debris products be able to sustain and even thrive in the future, thereby increasing the recycling rate of marine debris.

Appendix A

Questionnaire
1. Background information
(1) Gender: male or female
(2) Age: 18–29, 30–39, 40–49, 50–59, 60 and above
(3) Education: High school or below, bachelor's degree, master's degree or above
(4) Employment: private sectors, public sectors, students, others (e.g., self-employed, freelancers, retirees)
(5) Place of residence area: north region, central region, south region, east region and outlying islets
(6) Annual income: less than NTD 500,000; 500,000 to 999,999; 1,000,000 or more

2. Engagement in marine conservation activities and marine debris issues
(1) Have you ever participated in marine conservation activities (e.g., beach cleanups, marine ecotourism activities, funding for ocean conservation campaigns, volunteering in NGOs or governmental agencies)? Yes or No
(2) Are you aware of recycled marine debris products? Yes or No
(3) Have you ever purchased recycled marine debris products? Yes or No
(4) If 'yes' for the above question, what types of products you have purchased (multiple possibilities allowed)? souvenirs, backpacks/bags, clothing, shoes/sockets, keyboards/mouse, others.

3. Factors in intention of purchasing recycled marine debris products (Five-point Likert scale)
(1) My belief in environmental protection affects my intention to purchase marine debris products.
(2) Recommendations from significant others increase my intention to buy marine debris recycled products.
(3) The price of marine debris recycled products influences my purchase intention.
(4) The ease of buying marine debris recycled products affects my purchase intention.
(5) A well-known brand of recycled marine debris products affects my purchase intention.
(6) Products with a marine debris label increase my purchase intention.
(7) Advertisements for recycled marine debris products affect my purchase intention.

4. Intention to purchase recycled marine debris products
Do you intend to purchase recycled marine debris products? Yes or No

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