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Key Factors of Sustainability for Smartphones Based on Taiwanese Consumers' Perceived Values

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Abstract: The rapid growth of smartphones over recent decades has brought a large amount of e-waste as well as an increased carbon footprint. Facing severe environmental issues, sustainable development of smartphones has become a particularly important public concern. The main aim of this study was to clarify the key factor of sustainability for smartphones based on Taiwanese consumers' perceived values. Apple's iPhone was taken as an example. First, key factors of perception that smartphone consumers valued the most in terms of sustainable practice were extracted through a factor analysis. Second, demographic differences related to these key factors were investigated through *t*-test and one-way ANOVA analyses; demographic variables were gender, age, education level, occupation, and income level. The results were as follows: (1) the key factors were "recognition", "brand advantage", "service quality", "usage period", and "perceived price"; (2) there was a significant difference between genders on the key factors of perceived value ("recognition", "brand advantage", and "perceived price"). Specifically, females have higher perceived values of "recognition", "brand advantage", and "perceived price" than males; (3) there was a significant effect of income level on the key factor ("perceived price") of perceived value. Specifically, respondents with an income level of NTD15,001–30,000 had a higher perceived value of "perceived price" than respondents earning NTD30,001–45,000. Among the five key factors, "recognition" and "brand advantage" are primary factors influencing purchase motivation; "recognition", "brand advantage", and "service quality" are primary factors that could influence brand loyalty; "perceived price" is the primary factor that affects purchase intention. This study contributes to the green market segmentation of smartphones. The limitations of the study relate to the size and distribution of the samples.

Keywords: consumers' perceived value; smartphone sustainability; key factors; green market segmentation

1. Introduction

1.1. Research Background

Since the beginning of the 21st century, science and technology has developed rapidly, accompanied by the emergence of various electronic devices, which have gradually but significantly changed people's daily lives. With the economic growth in many Asian countries, increasing numbers of people now have the ability to purchase electronic devices. Among these, smartphones are recognized as the most common and popular device. The majority of people in industrialized Asian countries are using smartphones for private and business activities, promoting the rapid development of smartphones. Facing a large profitable market, brands constantly innovate and promote new products, which has led to a rising trend in smartphone sales. From 2009 to 2014, the annual growth rate of smartphones was more than

25% [1]. According to Gartner, an international research institute that collects the global market statistics of smartphones, in the first quarter of 2018, the global sales of smartphones exceed 300 million, reaching a growth rate of 1.3% compared with the same period last year [2].

However, the development of the smartphone industry has a strong impact on the environment. While consumers are immersed in the freshness of ever-updating smartphones and sellers are celebrating rich market returns, our living environment continues to deteriorate. The steady growth of personal portable electronic devices over recent decades has considerably increased the related carbon footprint [3]. Furthermore, the lifecycle of smartphones is limited due to function improvements and people's changing preferences. Most abandoned smartphones end up as e-waste—a burden to the environment and a threat to people's health. In 2016, the amount of global e-waste increased by 8% compared with 2014, a maximum increase among all types of waste [4]. E-waste contains many toxic substances, such as lead, mercury, cadmium, and lithium. If not treated appropriately, such e-waste could result in severe adverse environmental and human health impacts [5].

Accordingly, green consumption is gaining an increasing amount of attention. It forms part of a healthy lifestyle as well as being associated with social responsibility [6]. Green marketing has evolved in line with an increase in consumer concern for the environment [7], with green development and green consumption becoming the trends of the times. Increasing public attention on social responsibility and sustainability calls for responsible consumer choices [8]. Concern about environmental degradation has led to a new segment of consumers who care about green, ecological issues [9]. Consumers are willing to take the environmental impact into consideration when purchasing a product or choosing a brand. They are more inclined to pay for the products or services with the least environmental impacts.

This perceived value of sustainability is highlighted and promoted under contemporary social and environmental backgrounds. Perceived value occurs at various stages of the purchase process, including the pre-purchase stage [10]. Users' sustainable perceived values toward smartphones are a complicated combination of emotional bond, personal values, usage experience, cultural background, personalization, social status, and anticipation, all of which are important aspects of achieving more sustainable development for both industries and the environment. Personal perception, environmental attitude, and green purchasing behavior are closely connected, and personal values can effectively influence green purchasing behavior [11]. Sustainable perceived value is a key indicator for market segmentation because it offers valuable information on target groups. Therefore, it is crucial to find the key factors of perception that smartphone users value the most in terms of sustainable practice.

1.2. Research Purpose

In the last decade, although sustainability in electronic industries has been a widely researched topic, little attention has been paid to the factors that favor sustainable development from the point of view of users. In the context of environmental concern and social responsibility, it is imperative to study the sustainability of smartphones while catering to consumer needs. To achieve this goal, the first step is to determine the real attitudes and expectations of consumers toward sustainable smartphones, summarize the key factors, and then make corresponding changes and strategies. However, differences in purchasing preference, which are unpredictable, exist for every consumer. If the sustainable key factors of smartphones could be summarized and then transformed into appropriate marketing strategies, this would likely contribute to harmonious development among consumers, smartphone brands, and the environment. Thus, the main aim of this study is to identify the key factors that users perceive toward smartphones, which could contribute to the environment and sustainability of green marketing. In view of the reasons mentioned above, the key objectives of this study are as follows:

(1)　Extract key factors of smartphones from the consumer perspective;
(2)　Find and compare demographic differences in key factors;
(3)　Clarify associations between key factors and the sustainability of smartphones.

1.3. Research Scope

This paper focuses on smartphone users in Taiwan as the targeted group. As one of the "Four Asian Tigers" (four affluent areas in Asia), Taiwan has had a world-wide reputation for electronic production since the last century [12]. In the past four decades, an electronic industry ecological chain has been established [13]. Taiwan's electronic devices have had an important role in the global market (see Table 1). In 2016, out of the 1850 listed companies in Taiwan, 830 companies were related to electronic industries [14]. However, the large amount of production has led to environmental concern. In 2015, the e-waste production per person in Taiwan was approximately 19 kilograms [15], while the total garbage production per Taiwanese person was about 310 kilograms in the same year [16].

Table 1. World ranking of Taiwan's electronic devices [1].

Item	Output Value [2]	World Ranking	World Market Share
Laptop	573.1	1	92%
Large liquid crystal display screen	301.6	2	42%
Liquid crystal display	164.8	1	69%
Wafer foundry	141.9	1	69%
Integrated circuit design	119	1	28%
Integrated circuit packaging test	101	1	51%
Printed circuit board	97.5	1	24%
Small liquid crystal display screen	49.1	2	24%
Dynamic random-access memory	49	2	20%
Mother board	46.1	1	94%
Digital camera	34	1	40%

[1] The information was presented in 2010; [2] Unit: hundred million US dollars (Source: [12]).

Some smartphone brands have maintained a relatively stable reputation among consumers in Taiwan. This paper selected Apple's iPhone (Cupertino, CA, USA) as an example, because the iPhone has the largest market share compared with other brands in Taiwan. Huang, Su, and Zhou (2017) carried out a study on customer satisfaction and usage time of smartphones in Taiwan to determine the four most popular smartphone brands in Taiwan according to customer satisfaction [17]. Apple's iPhone ranked first, followed by Samsung (Seoul, Korea), Sony (Tokyo, Japan), and HTC (New Taipei City, Taiwan). Statistics showed a high level of loyalty to Apple: 79.3% of the consumers would still purchase an iPhone if their previous smartphones were also iPhones, illustrating a much higher loyalty than other brands. Further, the purchasing transfer rate from other brands to Apple was quite high. More than 20% of consumers transferred their choices from Samsung or HTC to Apple. Regarding the satisfaction level, Apple's iPhone had an obvious advantage as compared with HTC, Sony, and Samsung. Besides gaining popularity among Taiwanese consumers, Apple also maintained good cooperation with Taiwan's electronic enterprises; Taiwan's electronic enterprises play a key role in Apple's supply chain system. According to Apple's latest released top 200 global supply chain lists, the number of Taiwan enterprises increased from 39 in 2017 to 42 in 2018 [18].

The concept of sustainability is constantly being expanded and enriched. In this study, "sustainability of smartphones" has two meanings: (1) the sustainable development of smartphone brands; (2) sustainable purchasing by consumers.

2. Literature Review

2.1. Perceived Value of Consumers

A focus on value for customers emerged as an important marketing concept, particularly during the 1990s [19]. Perceived value was once regarded as a balance between benefit and sacrifice, and it originated from transaction utility theory [20]. This theory took the position that consumer behavior not only depends on price or service but is also determined by consumer perception and mental

awareness [21]. Monroe and Krishnan (1985) proposed that perceived value influences the willingness to purchase [22]. If some product or service is highly evaluated, the consumers' perceived value of it was relatively high. Zeithaml (1988) studied the relationship between price, perceived quality, and perceived value, and defined perceived value as "the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given. Though what is received varies across consumers (i.e., some may want volume, others high quality, still others convenience) and what is given varies (i.e., some are concerned only with money expended, others with time and effort), value represents a tradeoff of the salient give and get components" [23] (p. 14). A similar opinion is that perceived value is the ratio or trade-off between quality and price, a money-related conceptualization agreed upon by some other researchers [24]. Researchers in the 1990s forecasted that perceived value would still be an important imperative for producers and retailers in the 21st century [10,25].

Later, more emotional and social considerations were accounted for. Perceived value turned into a social, economic, and emotional multi-conceptual combination constructed from multiple dimensions. Sweeney and Soutar (2001) developed a multiple item scale of consumers' perceived value in a retail purchase situation and termed the four dimensions emotional, social, quality/performance, and price/value for money [26]. These dimensions were found to be efficient in explaining consumer attitudes and behaviors. Parasuraman and Grewal (2000) summarized four different types of perceived value that have been identified in the literature: acquisition value, transaction value, in-use value, and redemption value [27]. They also considered perceived value to be a dynamic construct in that the relative emphasis on each component may change over time. Cengiz and Kirkbir (2007) analyzed the dimensionality of the concept of perceived value in the health sector, incorporating valuations of functional and affective aspects and obtaining an overall quantification of the value perceived by the patient [28]. Perceived value was found to be a multidimensional construct composed of dimensions including functional value (installation, service quality, price, and professionalism), emotional value (novelty, control, and hedonics), and social value. Sheth, Newman, and Gross (1991) developed a theory to explain why consumers make the choices they do [29]. This theory identified five consumption values that could influence consumer choice behavior associated with social, emotional, functional, epistemic, and conditional factors. Sánchez et al. (2006) developed a scale of measurement of the perceived value for the purchase of a tourism product, with 24 items being grouped into six dimensions: functional value of the travel agency (installations), functional value of the contact personnel of the travel agency (professionalism), functional value of the tourism package purchased (quality), functional value price, emotional value, and social value [30]. Some multi-dimensions of perceived value determined by researchers are listed in Table 2.

Table 2. Multi-dimensions of perceived value.

Dimensions	Definition	Measurements
Quality value	The utility derived from the perceived quality and expected performance of the product.	It has consistent quality; it is well made; it has an acceptable standard of quality; it would perform consistently.
Emotional value	The utility derived from the feelings or affective states that a product generates; the utility acquired from an alternative's capacity to arouse feelings or affective states.	It would make me want to use it; it is one that I would feel relaxed about using; it would make me feel good; it would give me pleasure; it is something new and different; I want to share the experience with others afterwards.
Price value	The utility derived from the product due to the reduction of its perceived short and longer-term costs.	It is reasonably priced; it offers value for money; it is a good product for the price; it would be economical.

Table 2. *Cont.*

Dimensions	Definition	Measurements
Social value	The utility derived from the product's ability to enhance social self-concept; the utility acquired from an alternative's association with one or more specific social groups.	It would help me to feel acceptable; it would improve the way I am perceived; it would make a good impression on other people; it would give its owner social approval.
Functional value	The perceived utility acquired from an alternative's capacity for functional, utilitarian, or physical performance.	It has good functions; it is serviced in a timely manner; it has approachable, courteous, and polite employees, who are easy to contact.

(Sources: [19,26,29–34]).

Recently, Quade and Leimstoll (2017) studied the perceived value of smartphones and tablets for mobile business in small and medium enterprises and developed a model to identify the impact that perceived value has on the productive business processes of companies [35]. Different from the business-oriented purpose of Quade and Leimstoll's research [35], this study attempts to determine how perceived value contributes to the sustainable development of smartphone enterprises when environmental considerations are highly valued. Regarding the use phase, consumers' perceived value was found to be influential. Some studies determined that such perceived value may have a positive impact on satisfaction, which is a key determinant for market share [36]. Ralston (2003) investigated the effects of customer service quality, brand-advertising expenditure, and real price competitiveness on customer value among residential local telephone customers [37]. Wang (2010) studied the moderating effect of environmental attitude on personal values and green purchasing behavior, finding that personal values and environmental attitude have significantly positive effects on green purchasing behavior [11]. Therefore, consumers' perceived value should be a key focal point and receive sufficient attention.

2.2. Sustainability of Electronic Devices

In 2005, in order to outline the sustainable growth of the world-wide electronics industry, the International Electronics Manufacturing Initiative issued an authoritative guideline—the 2004 iNEMI Environmentally Conscious Electronics Roadmap—to identify future research, development, and implementation needs. This roadmap focused on five key areas: design, energy, recycling, materials, and sustainability. Among the five areas, sustainability was identified as a new topic of focus to guide electronics industry practice [38]. In 2015, United Nations members and leading development institutions established the Sustainable Development Goals (SDGs) as a global development framework, which appealed for sustainable consumption and production patterns as well as urgent actions to combat climate change and its impacts [39].

The issue of sustainability has also received significant academic attention. Surrounding this highly debated topic, relevant studies have been published, particularly in the last decade. Some research relating to sustainability discussion has focused on the use phase of a product's lifecycle because this phase is important for the sustainability of smartphones. Scharnhorst et al. (2005) analyzed three lifecycle phases (production, use, and end-of-life treatment) of second-generation mobile phone networks, with results indicating that "the environmental impacts attributable to the use phase dominated the environmental impacts incurred over the entire life cycle of the network" [40] (p. 540). Paiano et al. (2013) also considered that the behavioral patterns of the users would influence the sustainability of mobile phones [41]. Other studies have focused on the sustainable business model of smartphones, for example, Schneider et al. (2018) proposed a sustainable smartphone business approach by combining product modularity, product-service systems, and design [42]. They argued that this approach would reduce the environmental impact of the smartphone during the production phase, which accounts for most of the emissions throughout a smartphone's life cycle. They also discussed the impact of users' behaviors through emotional bonds, personalization, and technology appropriation, which act as predictors of attachment to products and can even lead to

an extended lifespan of smartphones. There have also been related studies that aimed to identify the key indicators related to environmental management. Saura, Reyes-Menendez, and Alvarez-Alonso (2018) highlighted the key factors related to environmental management detected by travelers during their stays in hotels and found that these factors were meaningful as they allowed hotel managers to improve their services as well as enhancing the value of sustainability pursuit [43]. In terms of the industry's response to sustainable practice, Moyle et al. (2018) concluded that the tourism industry was more actively committed to sustainable environmental practices [44].

In the modern world, environmental demand by consumers has led to the emergence of green markets, and environmental concerns have begun to be displayed in purchasing patterns, with so-called environmentally friendly products gaining increasing preference [45]. Environmental needs of consumers are being recognized by the market, including the electronics industry. Liao (2003) conducted a study investigating consumers' recognition of green products in Taiwan. The results indicated that 78% of the consumers had heard of "green products" and 73% of them had grasped some related knowledge [46]. However, the study only provided an overview of Taiwanese opinion and awareness toward green products without identifying the smartphone area. Studies focusing on electronic devices have primarily analyzed strategy from an industry perspective, for example, how to minimize energy consumption [47], how to develop an efficient sustainable system [48], and approaches for recycling e-waste [49]. Some of these studies focused on smartphones but lacked discussion about users' perspectives.

3. Conceptual Framework and Hypothesis Development

Gender, age, education, occupation, and income are five common demographic variables that were used as bases for segmenting and profiling green consumers in previous studies [50–52].

Some of these studies found that males and females had different responses towards environmental issues. Males were more environmentally knowledgeable than females [53,54], while the latter were more ecologically conscious and engaged in eco-conscious behaviors [51,52,55,56]. Based on previous research, we propose the following hypotheses:

Hypothesis 1. *Gender will have a significant effect on the key factor of perceived value related to sustainability.*

The relationship between age and environmental consciousness has proven to be more consistent [7]. Some studies presented a significantly negative relationship between age and environmental knowledge, attitude, and behavior [51,53]. However, younger people are more concerned with the deterioration of the environmental [57], and older consumers tend to engage in more ecologically conscious behaviors [58]. Based on previous research, we propose the following hypothesis:

Hypothesis 2. *Age will have a significant effect on the key factor of perceived value related to sustainability.*

Some studies have shown that education is positively correlated with environmental knowledge, attitude, and behavior [51,58]. A few studies, however, have found that education is not a good predictor of environmental concern or purchasing behaviors [58,59]. Based on previous research, we propose the following hypothesis:

Hypothesis 3. *Education level will have a significant effect on the key factor of perceived value related to sustainability.*

Previous studies regarding the influence of occupation on environmental consciousness have yielded inconsistent results [7]. While some studies reported a significant relationship between occupation and environmental attitude [60], other works have noted no such relationship [59,61]. Based on previous research, we propose the following hypothesis:

Hypothesis 4. *Occupation will have a significant effect on the key factor of perceived value related to sustainability.*

Some studies have shown that income level is positively related to ecologically conscious behaviors, based on the belief that people with a higher income level can afford the higher costs associated with green products and the support of green causes [52,62]. However, other studies noted an insignificant or even negative relationship between income and environmental knowledge, attitude, and behavior [58,59,61]. Based on previous research, we propose the following hypothesis:

Hypothesis 5. *Income level will have a significant effect on the key factor of perceived value related to sustainability.*

4. Research Method and Process

4.1. Development of Questionnaire

After the discussion and integration of literature, this study took the results of integration as the structure of questions for the interviews and survey, and then conducted in-depth interviews with four experts from specific professions relating to the study. They were three professors from three top universities in Taiwan and one senior designer from ASUS, one of the leading electronics brands in Taiwan. Their background information is listed below (see Table 3).

Table 3. Background information of the experts.

Code	Name	Professional Background	Specialty
P-Y	Professor Y	PhD, professor at the National Taiwan University of Science and Technology	Environmental engineering study
P-H	Professor H	PhD, professor at the National Taipei University of Technology	Enterprise sustainable management study
P-Z	Professor Z	PhD, professor at the National Yunlin University of Science and Technology	Brand development study
D-X	Designer X	Senior designer at ASUS	Electronics design practice

A 40-min interview outline was drafted for each of the four experts. The key contents of the interview comprised four parts: correlations between product design and consumer behavior, consumers' different perceived values, correlations between consumption behavior and environmental influences, and the sustainable development of smartphones. The four experts were invited to share their knowledge, experience, and opinions regarding the topic, and follow-up questions were involved as supplements. The data were collected by recording and were then converted into words. Through open, axial, and selective coding processes, the interview transcripts were summarized, and the core information was extracted as follows: (1) consumers' perceived value and sustainability awareness should be highly valued in a smartphone's R & D process; (2) consumers' perceived value is closely connected with the design, marketing, and service quality of smartphones; (3) if perceived value was considered in product design process, a smartphone's market competitiveness would increase while consumers' usage experience would be enhanced; (4) the sustainability endeavor and practice of smartphones could contribute to loyalty to brands.

The formal questionnaire was composed of three parts:

(1) "Basic data"—comprising five items: gender, age, education level, occupation, and income level. Respondents were asked to check the given options.

(2) "Preference order of iPhone", which was a combination of five questions set to acquire the current usage situation of iPhone and consumers' sustainable awareness. The questions were as follows: Q1: What are the reasons to buy an iPhone? Q2: What are the reasons to be an iPhone follower? Q3: What are the reasons preventing you from buying an iPhone? Q4: How do you deal

with an outdated iPhone? Q5: What is the average usage time for your iPhone? Q1–Q4 were multiple choice questions, while Q5 was a single choice question.

(3) "Consumers' perceived value and sustainability of iPhone", which was constructed based on the literature review and expert interviews. This section comprised 37 questions, which were intentionally designed to be related to the sustainability issue. An overall reliability analysis of the 37 questions was conducted to test the reliability and validity of the questionnaire. When the Cronbach's Alpha is higher than 0.7, the factor being analyzed can be said to be of high reliability [63]. The overall reliability of the questionnaire in this study was 0.976, which indicates that the questionnaire in this study is reliable. These 37 questions were measured on a 5-point Likert scale, ranging from 1 (extremely disagree) to 5 (extremely agree).

4.2. Data Collection

In order to collect data regarding the perceived value of Taiwanese consumers toward Apple's iPhone, an online questionnaire survey was conducted. Firstly, a pre-test involving 30 volunteers was carried out to test the drafted questionnaire. Then, the modified questionnaire was used for formal testing with 522 participants. Since this study took Apple's iPhone as an example, the questionnaire was intentionally designed so that participants were required to have had an iPhone usage experience, otherwise some items in the questionnaire could not be successfully answered. Therefore, the final sample size was 522.

4.3. Data Analysis

4.3.1. Factor Analysis

Factor analysis is a scientific method to reduce the complicated dimensions of variables while maintaining most of the original information. Before conducting the extraction process through factor analysis, KMO (Kaiser–Meyer–Olkin) sampling adequacy detection and Bartlett's tests were conducted to judge whether factor analysis was applicable to the data. As for KMO detection, Kaiser—the inventor—suggests that the value should be between 0 and 1, and the larger the value is, the more common the factors between variables are and the more applicable it is to conduct a factor analysis [64]. The KMO value of the formal questionnaire was 0.971, and the significance by Bartlett's testing was 0.000. Therefore, factor analysis was applicable to the data. Next, a principal component analysis (PCA) in factor analysis was used to extract common factors out of the 37 variables. Principal component analysis (PCA) is a multivariate technique that analyzes a data table in which observations are described by several inter-correlated quantitative dependent variables [65], and in this study, it could reduce the number of variables considerably while still retaining much of the information in the original data set. Rotation by Varimax was applied for the purpose of satisfying the simple structure and ultimately the factorial invariance criterion [66]. The value after rotation by Varimax was selected as the total variance, and the sum of an eigenvalue greater than 1 was the screening condition. Finally, five factor components were extracted, and the total variance was 71.946% (see Table 4).

Table 4. Total variance explained.

Component	Extraction Sums of Squared Loadings		
	Total	**% of Variance**	**Cumulative %**
1	20.145	54.446	54.446
2	2.296	6.205	60.651
3	1.781	4.814	65.465
4	1.376	3.719	69.184
5	1.022	2.762	71.946

Extraction Method: Principal Component Analysis.

According to the factor loading significance principle which was put forward by Hair et al. (1998), when factor loading reaches 0.4, the scope of acceptance is reached [67]. A heatmap was applied to visualize the factors (see Figure 1).
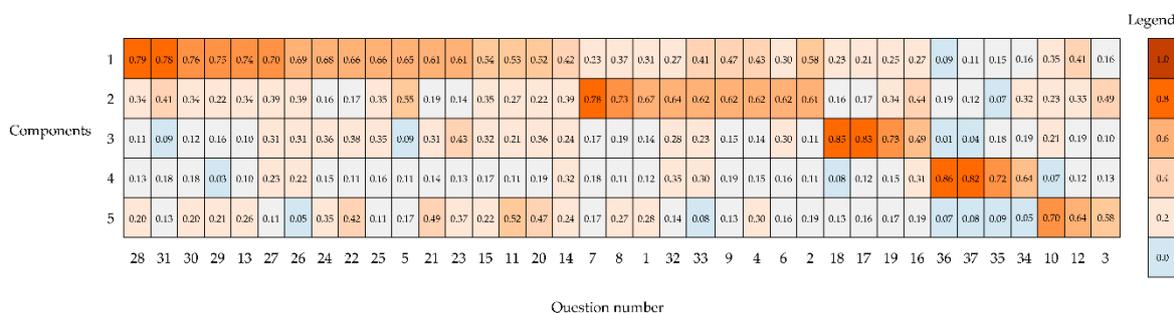

Figure 1. Heatmap after rotation of the Principal Component Analysis (PCA) of the questionnaire.

4.3.2. Variance Analysis

An independent samples *t*-test (*t*-test) and Analysis of Variance (ANOVA) were applied. The *t*-test is used to compare two groups of samples, while ANOVA is normally used to compare samples with more than two groups. In this study, the *t*-test was applied to compare the differences between "genders" on the key factor (Hypothesis 1), while one-way ANOVA was applied to compare the differences among "ages", "education levels", "occupations", and "income levels" on the key factor (Hypotheses 2, 3, 4, and 5 respectively).

5. Research Results

5.1. Summarization of Demographic Statistics

The basic demographic data of respondents from the online questionnaire survey was summarized by frequency distribution in the statistical analysis (see Table 5). The results of the numerical analysis and data specifications were as follows:

- With respect to the frequency distribution result of "gender", most respondents were female, 321 persons in total, accounting for 61%.
- Regarding "age", the majority of respondents were young people or middle-aged—in total these two groups accounted for almost 90%. They were mostly aged between 21–30 years old, followed by people aged under 20 years old; these two groups accounted for 53% and 34%, respectively. Respondents aged above 50 years were the least common, only accounting for 2%.
- Regarding the "education level", individuals with university/college degrees made up the largest proportion of the sample, accounting for 76% of respondents; followed by master's and doctoral degrees, accounting for 14%. Therefore, most respondents were well educated.
- Regarding "occupation", students took up the largest proportion of the sample in the questionnaire, with 360 persons in total, accounting for 69% of respondents.
- Regarding the "income level", since most respondents were students, the highest proportion of individuals were earning NTD15,000 and below, accounting for 60% in total; the highest income level, NTD105,001 and above, only accounted for 2% of respondents.

Table 5. Basic demographic data of respondents.

Demographic Variables		Number	Percent	Cumulative Percent
Gender	Female	321	61.49%	61.49%
	Male	201	38.51%	100.00%
Age	20 years and below	179	34.29%	34.29%
	21–30 years	279	53.45%	87.74%
	31–40 years	35	6.70%	94.44%
	41–50 years	17	3.26%	97.70%
	51 years and above	12	2.30%	100.00%
Education level	Junior high school	3	0.57%	0.57%
	Senior high school	47	9.00%	9.58%
	University/college	397	76.05%	85.63%
	Master's and doctoral	75	14.37%	100.00%
Occupation	Student	360	68.97%	68.97%
	Public service	24	4.60%	73.56%
	Manufacturing	45	8.62%	82.18%
	Agriculture	2	0.38%	82.57%
	Commerce	23	4.41%	86.97%
	Service industry	44	8.43%	95.40%
	Medical industry	9	1.72%	97.13%
	Others	15	2.87%	100.00%
Income level (NTD/per person/per month)	0–15,000	312	59.77%	59.77%
	15,001–30,000	99	18.97%	78.74%
	30,001–45,000	59	11.30%	90.04%
	45,001–60,000	24	4.60%	94.64%
	60,001–75,000	13	2.49%	97.13%
	75,001–90,000	5	0.96%	98.08%
	90,001–105,000	2	0.38%	98.47%
	105,001 and above	8	1.53%	100.00%

5.2. Consumers' Basic Perception toward the iPhone

Multiple choice questions were applied to gather consumers' preference order relevant to iPhone usage sustainability. The results are listed in Table 6.

- In terms of the reasons to buy an iPhone, most confirmed that "it is easy to handle", which was followed by "attractive appearance", "fashionable style", "influenced by surrounding people", "symbol of status", "good marketing", and "good quality".
- Regarding the reasons to continuously purchase an iPhone, "good quality" was the first consideration, which was followed by "personal preference", "brand popularity", "reliable to use", "good service", and "compatible with Mac".
- Regarding the reasons preventing the purchase behavior, the main reason was "economic consideration", which was followed by "not satisfied with the brand", "curious to try new brands", "not get used to the design", "support native brand", and "not get used to the system".
- Regarding the disposal of old iPhones, most respondents chose the response "leave it at home", which was followed by "give it to others", "sell it", "hand to the recycling institution", and "use as a spare".
- Regarding the average period to change a new iPhone, most respondents responded "2–4 years", followed by "1–2 years", "within one year", "4–5 years", and "as long as possible".

Table 6. Basic perceptions of the iPhone.

Questions	Ranking and Votes Number						
	1	2	3	4	5	6	7
What are the reasons to buy an iPhone? *	Easy to handle (330)	Attractive appearance (207)	Fashionable style (118)	Influenced by surrounding people (100)	A symbol of status (68)	Good marketing (62)	Good quality (25)
What are the reasons to be an iPhone follower? *	Good quality (398)	Personal preference (199)	Brand popularity (174)	Reliable to use (173)	Good service (115)	Compatible with Mac (3)	
What are the reasons preventing you from buying an iPhone? *	Economic consideration (538)	Not satisfied with the brand (132)	Curious to try new brands (21)	Not used to the design (15)	Support native brand (2)	Not used to the system (2)	
How do you deal with an outdated iPhone? *	Leave it at home (355)	Give it to others (228)	Sell it (171)	Hand to the recycling institution (119)	Use as a spare (12)		
What is the average usage time for your iPhone?	2–4 years (277)	1–2 years (125)	Within one year (67)	4–5 years (36)	As long as possible (17)		

Note: * multiple choice question.

5.3. Factor Analysis of Consumer's Perceived Value of the iPhone

Five factors were extracted from the consumers' usage experiences. According to the contents contained, this study named them "recognition" (α = 0.970), "brand advantage" (α = 0.943), "service quality" (α = 0.885), "usage period" (α = 0.816), and "perceived price" (α = 0.798). The following are descriptions of the implications of the five factors (see Table 7):

- Recognition: this factor includes 17 items, covering different aspects of consumers' instinct comprehensive preferences when purchasing an iPhone. Consumers stated that they are willing to purchase an iPhone at a high price, even though they know it is more expensive than with other brands. They noted that the iPhone deserves the money spent and they will be loyal iPhone followers. They are satisfied with their usage experience and are glad to recommend this particular phone to family and friends. They commented that purchasing an iPhone is a good decision, and they are willing to pay for good service. They noted that this brand considers their needs and is very attractive to them. These items show strong subjective and sentimental preferences towards the iPhone, a heartfelt recognition without any doubt.
- Brand advantage: this factor includes nine items, covering brand advantage through comparisons. Consumers stated that the iPhone has a longer lifecycle, better function and quality, a more recyclable design, a safer system, and improved usage experience. They noted that the brand's advantages are very important considerations when purchasing.
- Service quality: this factor includes four items, covering service considerations from objective services to mental safety senses. Respondents stated that this brand can offer the required service and fulfill promises in time. They felt assured after purchasing and consider the iPhone to be reliable.
- Usage period: this factor also includes four items, reflecting consumers' anticipation of a longer usage period. Usage period was shown to be an important consideration, even when purchasing an iPhone. Respondents commented that it is important to use a smartphone for more than two years and that the usage time of smartphones could be prolonged. If an iPhone is broken within two years, they consider its lifetime to be short.

- Perceived price: this factor comprises three items, reflecting consumers' perception toward price. Some stated that the price of an iPhone is fair, others noted that this phone's price is worthy of its value, and some even consider that the iPhone should be more expensive to match its perceived high value.

Table 7. Factor loadings of five factors.

Factor	Name	Contents	Factor Loadings
1	Recognition (Cronbach's α = 0.970)	28. I am glad to buy an iPhone at a high price	0.794
		31. I will purchase the iPhone again in the future	0.781
		30. I will recommend the iPhone to my family and friends	0.761
		29. I am a loyal customer of the Apple brand	0.749
		13. I would still choose an iPhone even if it was more expensive than other brands	0.744
		27. I always think purchasing an iPhone is a good decision	0.704
		26. I am satisfied with the iPhone's usage experience	0.687
		24. I think devotion to the iPhone is worthwhile	0.677
		22. I consider the iPhone to be worthy of its price	0.662
		25. I enjoy the purchasing experience	0.660
		5. I am willing to buy another iPhone when the old one is broken	0.654
		21. I think it is worth buying an iPhone	0.613
		23. I believe it is acceptable to wait for the new type of iPhone for a long period	0.609
		15. I think the iPhone considers my needs	0.537
		11. I am willing to pay for good service	0.531
		20. I think the iPhone is worth more than its price	0.521
		14. I think the iPhone is attractive	0.424
2	Brand advantage (Cronbach's α = 0.943)	7. I think the iPhone has a longer lifetime than other brands	0.781
		8. I consider that the function of the iPhone to be better than other brands	0.726
		1. I think the quality of iPhones is better than that of other brands	0.670
		32. I believe that iPhones are more recyclable than other brands	0.643
		33. I feel that I will use an iPhone longer than other brands	0.620
		9. I would still choose an iPhone if price was not a consideration	0.619
		4. I think the design of the iPhone is better than other brands	0.616
		6. I think iPhones have a safer system	0.615
		2. I consider that the iPhone provides a better usage experience	0.607
3	Service quality (Cronbach's α = 0.885)	18. I think Apple could provide an in-time service	0.852
		17. I believe that Apple is committed to its promises	0.830
		19. I think Apple products are safer to use	0.727
		16. I consider iPhones to be reliable	0.485
4	Usage period (Cronbach's α = 0.816)	36. I think it is important to use a phone for more than two years	0.864
		37. I believe that the usage time of smartphones could be prolonged	0.822
		35. I consider that a smartphone's lifetime is short if it is broken within two years	0.716
		34. I think usage period is an important consideration	0.638
5	Perceived price (Cronbach's α = 0.798)	10. I consider the price of iPhones to be fair	0.696
		12. I believe that the iPhone's price is worthy of its value	0.635
		3. I think the iPhone should be more expensive than other brands	0.578

5.4. t-Test and One-Way ANOVA on the Key Factor

Based on the demographic variables and key factors found in previous phases, this study investigated the scoring differences among five variables (gender, age, education level, occupation, and income level) on the key factor. A *t*-test was used to test the scoring differences between genders on the key factor, and one-way ANOVA was used to test the scoring differences among other variables on the key factor. For the ANOVA, if the F-value is significant, a post hoc Scheffe test was used to find the source of the difference. Statistical significance was set as 0.05.

As shown in Table 8, the scores sorted by gender reached a significance level for "recognition", "brand advantage", and "perceived price", as judged by a *p*-value of less than 0.05. It was concluded that gender had significant effects on "recognition" (t = −2.602), "brand advantage" (t = −2.365),

and "perceived price" (t = −2.336). Females (f) had a higher mean score (M) than males (m) for all three factors, M (f) = 3.35, 3.97, 3.50 and M (m) = 3.16, 3.78, 3.32, respectively. Regarding the "service quality" and "usage period", the scores did not reach significance levels ($p > 0.05$), and thus respondents of different genders were not shown to have significantly different perceived values for "service quality" and "usage period". This result shows that gender significantly influences the key factor ("recognition", "brand advantage" and "perceived price") of perceived value. Thus, Hypothesis 1 was supported.

Table 8. *t*-test of gender on key factors.

Factors	Gender	Number (N)	Mean (M)	Standard Deviation (SD)	T-Value	*p*-Value
Recognition	Male	201	3.1572	0.8849	−2.602 *	0.010
	Female	321	3.3507	0.7253		
Brand advantage	Male	201	3.7805	0.9820	−2.365 *	0.019
	Female	321	3.9720	0.7499		
Service quality	Male	201	3.7164	0.8477	−0.638	0.524
	Female	321	3.7617	0.6830		
Usage period	Male	201	4.0920	0.6993	−0.368	0.716
	Female	321	4.1153	0.7038		
Perceived price	Male	201	3.3217	0.9518	−2.336 *	0.020
	Female	321	3.5016	0.6745		

Note: * $p < 0.05$.

With respect to the influence of age, none of the five age groups (20 years and below, 21–30 years, 31–40 years, 41–50 years, 51 years and above) reached a significance level on the key factor ($p > 0.05$); hence, no matter how old the respondents were, they did not have significantly different perceived values toward "recognition", "brand advantage", "service quality", "usage period", or "perceived price" (see Table 9). This result shows that age had no significant effect on the key factor. Thus, Hypothesis 2 was not supported.

Table 9. ANOVA of age on key factors.

Factors	Age	N	M	SD	F-Value	*p*-Value
Recognition	(1) 20 years and below	179	3.2688	0.8222	0.458	0.766
	(2) 21–30 years	279	3.2745	0.7903		
	(3) 31–40 years	35	3.3899	0.6938		
	(4) 41–50 years	17	3.0865	0.7205		
	(5) 51 years and above	12	3.3627	0.9431		
Brand advantage	(1) 20 years and below	179	3.9162	0.8272	0.881	0.475
	(2) 21–30 years	279	3.8678	0.8850		
	(3) 31–40 years	35	4.1333	0.6655		
	(4) 41–50 years	17	3.8105	0.8125		
	(5) 51 years and above	12	3.7778	0.9368		
Service quality	(1) 20 years and below	179	3.7709	0.7625	1.839	0.120
	(2) 21–30 years	279	3.7518	0.7290		
	(3) 31–40 years	35	3.7571	0.8100		
	(4) 41–50 years	17	3.2647	0.8075		
	(5) 51 years and above	12	3.8125	0.6836		
Usage period	(1) 20 years and below	179	4.0782	0.7525	1.396	0.234
	(2) 21–30 years	279	4.0923	0.6767		
	(3) 31–40 years	35	4.2857	0.6158		
	(4) 41–50 years	17	4.0294	0.8191		
	(5) 51 years and above	12	4.4375	0.4146		
Perceived price	(1) 20 years and below	179	3.4376	0.8105	0.536	0.709
	(2) 21–30 years	279	3.4158	0.8194		
	(3) 31–40 years	35	3.5619	0.4767		
	(4) 41–50 years	17	3.2745	0.7568		
	(5) 51 years and above	12	3.5833	0.9003		

Regarding the scores of respondents with different education levels (junior high school, senior high school, university/college, master's/doctoral), they still did not reach significance ($p > 0.05$) (see Table 10). Thus, irrespective of the respondents being well educated or not, they did not have significantly different perceived values toward the five key factors. This result shows that education level did not significantly affect the key factor. Thus, Hypothesis 3 was not supported.

Table 10. ANOVA of education level on key factors.

Factors	Education Level	N	M	SD	F-Value	*p*-Value
Recognition	(1) Junior high school	3	3.1961	1.3379	0.927	0.427
	(2) Senior high school	47	3.2303	0.8546		
	(3) University/College	397	3.2557	0.8089		
	(4) Master's and doctoral	75	3.4165	0.6526		
Brand advantage	(1) Junior high school	3	3.7037	1.5126	2.059	0.105
	(2) Senior high school	47	3.8747	0.7991		
	(3) University/College	397	3.8603	0.8842		
	(4) Master's and doctoral	75	4.1215	0.6299		
Service quality	(1) Junior high school	3	3.5000	1.8028	0.748	0.524
	(2) Senior high school	47	3.8723	0.7624		
	(3) University/College	397	3.7229	0.7528		
	(4) Master's and doctoral	75	3.7867	0.6812		
Usage period	(1) Junior high school	3	3.7500	1.5207	1.506	0.212
	(2) Senior high school	47	4.1223	0.8240		
	(3) University/College	397	4.0800	0.6893		
	(4) Master's and doctoral	75	4.2500	0.6380		
Perceived price	(1) Junior high school	3	3.2222	1.6443	2.243	0.082
	(2) Senior high school	47	3.3688	0.8023		
	(3) University/College	397	3.4005	0.8179		
	(4) Master's and doctoral	75	3.6489	0.6000		

As for respondents with different occupations (student, public service, manufacturing, agriculture, commerce, service industry, medical industry, and others), their scores for the five key factors still did not reach significance ($p > 0.05$) (see Table 11). Thus, respondents with different jobs did not have varying perceived values towards the five key factors. This result shows that occupation had no significant effect on the key factor. Thus, Hypothesis 4 was not supported.

Table 11. ANOVA of occupation on the key factor.

Factors	Occupation	N	M	SD	F Value	*p* Value
Recognition	(1) Student	360	3.2938	0.8058	0.426	0.886
	(2) Public service	24	3.1887	0.9539		
	(3) Manufacturing	45	3.1399	0.6942		
	(4) Agriculture	2	3.3529	0.5823		
	(5) Commerce	23	3.2839	0.8350		
	(6) Service industry	44	3.2995	0.7529		
	(7) Medical industry	9	3.5229	0.4756		
	(8) Others	15	3.1647	0.8706		
Brand advantage	(1) Student	360	3.8917	0.8880	0.495	0.839
	(2) Public service	24	3.6574	0.9708		
	(3) Manufacturing	45	3.9407	0.6773		
	(4) Agriculture	2	3.8333	0.2357		
	(5) Commerce	23	3.8937	0.8372		
	(6) Service industry	44	3.9773	0.6297		
	(7) Medical industry	9	4.1852	0.6597		
	(8) Others	15	3.9259	0.9953		

Table 11. *Cont.*

Factors	Occupation	N	M	SD	F Value	*p* Value
Service quality	(1) Student	360	3.7764	0.7559	1.063	0.386
	(2) Public service	24	3.7188	0.8448		
	(3) Manufacturing	45	3.4611	0.7150		
	(4) Agriculture	2	3.7500	0.3536		
	(5) Commerce	23	3.7500	0.7111		
	(6) Service industry	44	3.7500	0.7606		
	(7) Medical industry	9	3.8889	0.6264		
	(8) Others	15	3.7500	0.6409		
Usage period	(1) Student	360	4.0931	0.7215	0.565	0.330
	(2) Public service	24	4.1146	0.8109		
	(3) Manufacturing	45	4.0667	0.6427		
	(4) Agriculture	2	3.0000	1.4142		
	(5) Commerce	23	4.0761	0.6503		
	(6) Service industry	44	4.2273	0.5494		
	(7) Medical industry	9	4.3333	0.5303		
	(8) Others	15	4.2333	0.6371		
Perceived price	(1) Student	360	3.4593	0.8124	0.586	0.489
	(2) Public service	24	3.1667	0.9428		
	(3) Manufacturing	45	3.3481	0.7070		
	(4) Agriculture	2	3.1667	0.7071		
	(5) Commerce	23	3.6087	0.7010		
	(6) Service industry	44	3.3864	0.7807		
	(7) Medical industry	9	3.6296	0.6550		
	(8) Others	15	3.2444	0.6722		

Regarding respondents with different income levels (NTD0–15,000, NTD15,001–30,000, NTD30,001–45,000, NTD45,001–60,000, NTD60,001–75,000, NTD75,001–90,000, NTD90,l001–105,000, NTD105,001 and above), only the score for "perceived price" reached significance ($p < 0.05$, F = 2.048) (see Table 12). To further find the source of difference, a post hoc Scheffe test was applied. It was found that respondents with an income level of NTD15,001–30,000 (M = 3.44) had a higher perception of "perceived price" than respondents with an income level of NTD30,001–45,000 (M = 3.28). Income levels had a significant effect on the key factor ("perceived price") of perceived value. Thus, Hypothesis 5 was supported.

Table 12. ANOVA of income level on key factors.

Factors	Income Level (NTD/per Person/per Month)	N	M	SD	F-Value	*p*-Value	Post Hoc
Recognition	(1) 0–15,000	312	3.2291	0.7849	1.424	0.193	
	(2) 15,001–30,000	99	3.3607	0.8134			
	(3) 30,001–45,000	59	3.2443	0.8460			
	(4) 45,001–60,000	24	3.4926	0.7720			
	(5) 60,001–75,000	13	3.1448	0.7353			
	(6) 75,001–90,000	5	3.9059	0.6676			
	(7) 90,001–105,000	2	2.7353	0.2912			
	(8) 105,001 and above	8	3.6103	0.6888			
Brand advantage	(1) 0–15,000	312	3.8486	0.8624	1.312	0.242	
	(2) 15,001–30,000	99	3.9315	0.7942			
	(3) 30,001–45,000	59	3.9134	0.9262			
	(4) 45,001–60,000	24	4.1343	0.8822			
	(5) 60,001–75,000	13	3.9402	0.6948			
	(6) 75,001–90,000	5	4.5778	0.4932			
	(7) 90,001–105,000	2	3.2222	0.1571			
	(8) 105,001 and above	8	4.2778	0.6719			

Table 12. *Cont.*

Factors	Income Level (NTD/per Person/per Month)	N	M	SD	F-Value	*p*-Value	Post Hoc
Service quality	(1) 0–15,000	312	3.7508	0.6967	1.496	0.166	
	(2) 15,001–30,000	99	3.7778	0.7929			
	(3) 30,001–45,000	59	3.5975	0.9389			
	(4) 45,001–60,000	24	3.7292	0.6912			
	(5) 60,001–75,000	13	3.5577	0.8111			
	(6) 75,001–90,000	5	4.6000	0.5184			
	(7) 90,001–105,000	2	4.0000	0.0000			
	(8) 105,001 and above	8	3.9063	0.7312			
Usage period	(1) 0–15,000	312	4.0761	0.7276	0.989	0.438	
	(2) 15,001–30,000	99	4.0556	0.6715			
	(3) 30,001–45,000	59	4.1780	0.7223			
	(4) 45,001–60,000	24	4.3750	0.5161			
	(5) 60,001–75,000	13	4.3462	0.5998			
	(6) 75,001–90,000	5	4.1500	0.7826			
	(7) 90,001–105,000	2	4.0000	0.0000			
	(8) 105,001 and above	8	4.1875	0.3720			
Perceived price	(1) 0–15,000	312	3.4199	0.7775	2.048 *	0.048	2 > 3
	(2) 15,001–30,000	99	3.4444	0.8330			
	(3) 30,001–45,000	59	3.2825	0.8550			
	(4) 45,001–60,000	24	3.8056	0.7218			
	(5) 60,001–75,000	13	3.3846	0.7051			
	(6) 75,001–90,000	5	4.2000	0.5055			
	(7) 90,001–105,000	2	2.6667	0.4714			
	(8) 105,001 and above	8	3.5417	0.7754			

Note: * $p < 0.05$.

6. Discussion

Based on previous work and expert interviews, consumers' perceived values were extracted and analyzed to aid in the sustainable development of smartphones. Environmental items were taken into consideration. From that, this paper proposes a more sustainable set of perceived values compared with previous dimensions of perceived value.

The key factors are related to previous discovered dimensions of perceived value. Regarding "recognition", its subjective feature is similar to "emotional value" (see Table 2), but the connotation is richer, covering more diversified considerations, such as quality, price, function, and design of the product. As for "brand advantage", it describes a sense of superiority based on comparisons with other brands. In this way, this factor is similar to "social value" (see Table 2) because both of them involve making a good impression on other people through comparisons. As for "service quality", it is similar to "functional value" (see Table 2) because they both put service into an important position. However, "service quality" in this study extends service measurements into reliability and trust-related scales. As for "usage period", it is connected with "quality value" (see Table 2) in the usage performance of a product. With respect to "perceived price", it is similar to "price value" (see Table 2), which is measured as the "reasonable price", "offers value for money", and "be economical". However, in this study, "perceived price" not only focuses on economic considerations, but also includes feelings and expectations.

In the second part of the formal questionnaire, we tested "preference orders toward iPhone", which was a combination of questions used to gather consumers' basic perceptions toward the iPhone. When comparing the items of "preference order of iPhone" with five extracted key factors, some similarities were found. It was observed that "recognition" and "brand advantage" contained items that are key reasons to purchase an iPhone; "recognition", "brand advantage", and "service quality" contained items that are key reasons to be an iPhone follower; and "perceived price"

contained items that are key reasons to prevent consumers from buying an iPhone. It can be inferred that "recognition" and "brand advantage" are primary influential factors in purchase motivation; "recognition", "brand advantage", and "service quality" are primary influential factors in brand loyalty; "perceived price" is the primary influential factor in purchase intention.

We believe that all five key factors could contribute to the sustainability of smartphones. With "recognition", consumers would attach to the brand willingly in a sustained status, a key factor for the sustainable development of smartphone brands. It is the hardest, but most rewarding factor for brands to achieve. "Brand advantage" is the result of constant comparisons among brands from the consumer perspective; thus, this factor is a driver for brands to develop. Because social and environmental responsibilities are also used in consumers' judgments when performing a comparison, sustainable development is an indispensable consideration for brands. As for "service quality", it is influential on both the sustainable development of smartphone brands as well as the sustainable purchasing mode of consumers, because this factor has been found to be important for consumers in terms of being a brand follower. "Usage period" directly influences the purchasing frequency, and therefore, this element is more connected to the sustainable purchasing mode. "Perceived price" was the most commonly provided reason related to the prevention of consumption and is therefore also a factor that influences consumers' purchasing modes.

Gender had a significant influence on the key factor of perceived value related to sustainability. Specifically, responses to "recognition", "brand advantage", and "perceived price" were significantly different between genders, and females had higher scores than males in all three key factors. This result indicated that males and females have different perceived values toward the iPhone, and that females are more sensitive than males to "recognition", "brand advantage", and "perceived price". This result may be due to sensibility and rationality differences between genders, or "gender role differences" mentioned in previous work [51–56].

Income level also significantly affected the key factor of perceived value related to sustainability. Specifically, respondents with low income level (NTD15,001–30,000) had a higher score than respondents with personal income of NTD30,001–45,000 for "perceived price", which indicates that the price of products is highly valued by low-income-level respondents. This result may be because respondents with a low-income level are more sensitive to price and deliberate more when spending a limited amount of money.

This study found that age, education level, and occupation did not significantly affect the key factor of perceived value related to sustainability. This result may be due to the sample distribution. Most of the respondents were aged below 30-year-old students with a university education level. Therefore, the difference of perceived value toward sustainability of smartphones may not have been obvious due to the limited number of groups.

As for the variability of the factors, "recognition" explained half of it, and the others only explained a few percent. The result may be due to the different features of the items contained in the five key factors. Items in "recognition" were more sophisticated and emotional, while those in the other factors were more direct and rational. Therefore, "recognition" is a comprehensive combination of respondents' perceived value compared with "brand advantage", "service quality", "usage period", and "perceived price". This result may relate to the inherent feature of consumers' perceived value, which contains both emotional and rational factors, while emotional factors have a primary role.

The one-way ANOVA results showed a low degree of difference, partly because the variable categories of perceived value were not distinctive enough to allow clear separations from each other, and they were determined by the vague and unstable feature of perceived value mentioned previously. Therefore, the limited differences found for the result should be highly valued and properly applied.

Some demographic samples had a limited number, such as participants with a junior high school background, in an agricultural occupation, or with an income level of NTD90,001–105,000. With respect to the original data, we still presented these samples in the paper to present an objective and complete analysis.

6.1. Implications

The results indicate that some demographic factors may impact consumers' perceived value towards the sustainable development of smartphones. This finding may contribute to green market segmentation by smartphone companies by leading to appropriate sustainable marketing strategies. Green market segmentation refers to the process of classifying consumers into segments based on their level of environmental awareness, concerns for, and emotional attachment to the environment [7]. It enables firms to better understand people who care for the environment and to design suitable targeting strategies to attract customers [52,68,69]. Because gender has an impact on "recognition", "brand advantage", and "perceived price", smartphone marketers may make corresponding strategies to satisfy target gender preferences. Females were more easily affected by perceptual factors such as appearance, purchasing experience, and subjective recognition. If their anticipation is satisfied, they are more willing to buy an iPhone, even at a high price, and consider the purchase to be a good deal. Therefore, sentimental purchasing characteristics, such as feelings of well-being, happiness, and satisfaction, should be primary considerations for a green marketing strategy. This result supports the finding of Phau and Ong (2007) that environmentally conscious consumers anticipate intrinsic rewards when they participate in activities that could benefit the environment [70]. Future environmental strategies could focus on how smartphone companies effectively convey such emotional benefits to female consumers.

It was also shown that females tend to make decisions through multiple comparisons, and they enjoy perceived superiority over other brands. Focused on this mentality, companies may consider a market strategy that delivers detailed comparisons on environmentally beneficial product attributes or practices, such as a longer usage period, better recyclable mechanism, or stronger environmental endeavor, to effectively convey a green image and stimulate a favorable perception to females.

Participants with relatively low incomes had more concern regarding the price, and they expected the product to be worthy of its value. It is recommended that smartphone companies highlight the hidden environmental value of the product through green marketing to make consumers perceive the added value from the money spent contributing to environmental protection.

Further, because respondents are used to leaving their outdated cellphones at home after an average 2–4 year usage period, a certain amount of e-waste is gradually generated. Thus, family-based recycle mechanisms could be considered through cooperation of related parties including government, smartphone companies, and communities.

6.2. Limitations

The sample, which was acquired through online questionnaires, had an uneven demographic distribution, with most respondents being students in university aged under 30 years. Thus, the findings may be more suitable to be generalized to the student group. Nonetheless, young people are often highly targeted in consumption contexts due to their growth potential and lifetime value as customers [71]. Moreover, the younger generation may offer significant potential to change marketing practices and consumption habits [72]. Our findings may provide insight into young consumers' perceptions toward the sustainability of smartphones. A possible direction for expansion of this study is replication with larger samples and more even demographics.

7. Conclusions

Effective green market segmentation is crucial to a successful green marketing. The importance of this study lies in providing approaches and factors which could contribute to the green market segmentation of smartphones by clarifying demographic differences in the key factor of perceived value related to Apple's iPhone.

Five key factors were extracted based on respondents' usage experiences with the iPhone—"recognition", "brand advantage", "service quality", "usage period", and "perceived price".

Based on these previously defined dimensions, the five key factors further complement the meaning and scope of perceived value. "Recognition" is the comprehensive heartfelt preference toward this particular phone brand, a very sentimental and subjective combination factor compared with other factors; "brand advantage" represents the advantage of the brand, implying perceived superiority over other brands; "service quality" is the guarantee that assures consumers and promotes them to continue to use the iPhone, a source of trust and good brand image; "usage period" involves a relatively objective perception toward the iPhone because utility is still a major consideration; "perceived price" is a mental perception and even involves anticipation of the price of the iPhone, an area which is beyond economic concern.

Regarding Hypothesis 1, our results demonstrate that gender has a significant influence on the key factor ("recognition", "brand advantage", and "perceived price") of perceived value related to sustainability. Females have higher perceived values of "recognition", "brand advantage", and "perceived price" than males.

However, our results do not support Hypotheses 2, 3, and 4, which means that age, education level, and occupation do not significantly affect the key factor of perceived value related to sustainability.

With regard to Hypothesis 5, our results confirm that income level also significantly affects the key factor ("perceived price") of perceived value related to sustainability. Respondents with an income level of NTD15,001–30,000 have a higher perceived value of "perceived price" than respondents earning NTD30,001–45,000.

Among the five key factors, "recognition" and "brand advantage" are influential factors on purchase motivation; "recognition", "brand advantage", and "service quality" are primary influential factors on brand loyalty; and "perceived price" is an influential factor on purchase intention.

Smartphone marketers are encouraged to make full use of these findings to develop better strategies and decisions with respect to green marketing in Taiwan for sustainable development.

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