

## Research Article

# Developing Blue Ocean Strategy of Sustainable Product Design and Development for Business Opportunities of BOP Groups in Taiwan

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This study expands the definition of the poor group and attempts to delve into and make known the phenomenon of poverty in Taiwan and aims to explore the goals and possibilities of the BOP consumer market. Through a questionnaire survey and expert interviews, this research adopts the concept of sustainability to discuss the lifestyle and consumption characteristics of the BOP group and establishes a design strategic norm of the sustainable products. The findings show that the BOP group in Taiwan is new poverty or working poor and high quality and common prices are the main requirements; these should be introduced into the development model of sustainable design.

## 1. Introduction

The booming of capitalism and industry has enabled many countries to develop and prosper since the beginning of the 20th century. However, due to the implementation of the free economic market system, the gap between rich and poor in those countries continues to increase, resulting in the disappearance of a good part of the middle class and the polarization of classes. In particular, the emerging capitalists among the lower and middle classes account for more than half of the whole nation [1]. In other words, along with the progression of free trade and economic globalization, the emergence of an M-shaped society is growing more apparent and insidiously creating new concepts, such as new poverty, working poor, and varied types of poor groups among the low and mid-levels of the pyramid [2], as shown in Figure 1. BOP belongs to the classification of the underlying model of the economic pyramid. The economic pyramid model is based on wealth and income classification. At the top of the pyramid is the wealthy, who have a lot of opportunities to derive high income; meanwhile more than 4 billion have a daily income of less than \$ 2; a huge population group found mostly

in developing countries [3–5]. Then, sustainable design and development are fundamentally dedicated to satisfying the basic living needs of all human beings [6]. When reviewing the rapid emergence of many developing countries, one finds that such topics are often discussed in developed countries rather than in the fast growing developing countries with large populations at the bottom of the pyramid (BOP) [7]. But the “bottom of the pyramid” population, in fact, is not limited to developing countries; it is also widespread in industrialized countries [4, 7].

The definition of poverty varies in different countries. Beyond absolute poverty, this study expands the definition of the poor group and attempts to delve into, and make known, the phenomenon of poverty in Taiwan. Taiwan defines poverty according to the influence of an M-shaped society and the boundary between “absolute poorness” and “relative poorness” defined by OECD [8] and Directorate General of Budget, Accounting and Statistics, Executive Yuan [9]. We should pay more attention to these two groups: “working poor” and “new poverty.” In Taiwan, such concepts refer to workers who work long hours, yet whose wage increase fails to keep pace with the inflation rate or whose wage is too little

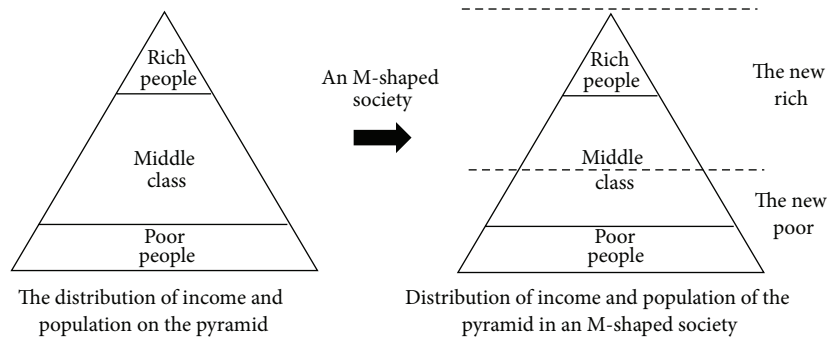


FIGURE 1: A sketch of the new poor group at the bottom of the pyramid.

to live a reasonable quality life [10]. Such concepts can also refer to working people who are usually the breadwinners in a family and have dependent family members or children living at home [11]. Therefore, the emergence of such groups of people signifies the downfall of the middle class, which is compressed to the bottom of an M-shaped society [12]. Unfortunately, the government is unable to provide proper support to this group, which is rejected by the social assistance scheme and believes that the classification of this group is hazy [13–15]. According to a survey conducted by the Directorate General of Budget, Accounting and Statistics, Executive Yuan (DGBAS, Executive Yuan), the rates of youth unemployment and number of unemployed young people are higher in comparison with that of other groups. However, young people in the work force are very likely to work in low-paying, poorly secured, and nonstandard jobs [16]. Furthermore, as a response to global recession, the Taiwanese government has been promoting a policy of NTD 22,000 monthly salary to young graduates since 2009; however, this amount is close to the income threshold of low and middle income households in metropolitan areas, which are eligible for government subsidies [13]. To make things worse, the Consumer Price Index (CPI) has increased by 9% in the past seven years. At present, young people have undoubtedly become the best representatives of newly poor people at the bottom of the pyramid in Taiwan's M-shaped society.

In the approach of combining business development and poverty alleviation, the poor at the BOP are considered as both producers and consumers of products. The design of products is an important ingredient of this market-based approach [17]. Scholars and practitioners have shown that the problem of survival in an existing market requires responsible corporate attention and participation; business and consumers in this market can be both socially responsible and profitable [18]. Some studies on the role of multinational corporations and the ability to raise BOP markets, reduce poverty, and create profit for the poor through the sale of products have been confirmed [19–21]. Companies can transfer their ability to evaluate and adjust their organizational structure and build new functions, stimulating knowledge sharing to improve the international strategy of the pyramid base [19].

The BOP-related literature is based on mutual value creation; important business between development and poverty

reduction has not fully tested relevant propositions but only the relations between the two. There is a study on 64 companies to identify the restrictions which BOP manufacturers face. The aim was to alleviate the constraints of local producers, while also creating value for the enterprise itself [22]. Some studies suggest that consumers should understand how people experience poverty and the social potential to counter poverty. The framework points to consumer choice, the power of products/services, consumer culture, the market, and the potential research stream on relieving the hardship related to spending power [22].

Sustainable development has become an increasingly important topic of business research and practice, along with the rapid depletion of natural resources, the concern over the disparity of wealth, corporate social responsibility, and the results of the past few decades [23]. The social concern for human well-being and sustaining ecological development are broad social goals [24]. Sustainability issues are explored in different ways and in different contexts. In the context of current and expected impact of climate change on environmental, social, and economic issues, and to achieve sustainable consumption and production of low-carbon fossil energy, the application of social efforts has been proposed [25]. Because the design and development of discrete physical products is an important cause of today's environmental problems around the world, many methods have been introduced to make products that are more sustainable. To design new sustainable products in regard to environmental, economic and social aspects, the choice of the highest sustainability index is a multi-criteria decision problem [26]. Some scholars have stressed that sustainable development of new product development and product life-cycle are interconnected and proposed new frameworks and design methods [27, 28].

Undoubtedly, the design phase has been widely recognized as a critical stage of a product's life cycle in the implementation of sustainability. Since the late 1990s, various sustainable design methods and techniques have been developed for sustainable product development requirements [29]. Many studies have examined the decision-making approach to sustainable product design and material selection in order to increase the likelihood of sustainable manufacturing and reduce the impact on the environment [30–34]. Meanwhile, the proposed products and supply chain design under the

sustainable development can be addressed at the product design stage. Therefore, a large number of green products have been classified and comparison studies carried out [35]. While many studies on green product development and marketing have been proposed, the market share of many green products did not significantly change according to academic efforts and increased interest in the last decade. A major reason is that many green products on the market cannot meet consumer expectations because there is a gap between consumer expectations and the views of these products [36]. Finally, some scholars have proposed a concept of integrated product development of the BOP, considering user desirability, technological feasibility, financial viability, and earth sustainability [37]. A clear design goal is the key to any project's success; however, to achieve maximum efficiency, the project objectives require early detection and proper balance in the design process [38].

One of today's most frequently discussed topics in the business world is how to escape from the fierce Red Sea in order to create an undisputed blue ocean [39, 40]. Based on the above, sustainable design and development is fundamentally dedicated to satisfying the basic living needs of all human beings. The emerging BOP group is the source of design strategic innovation. The model of innovative design is introduced in the sustainable design to balance economic development and environmental protection. The study can be divided into three parts with the following objectives.

- (1) Through collecting the related data from relevant studies, a questionnaire survey is conducted with the BOP group to find their acceptance and awareness of green consumption, the consumption characteristics, and requirements of using products.
- (2) Through expert interviews, an analysis is conducted to deduce the developing model of sustainable design along with the business opportunities related to the BOP group and to establish the developing norm.
- (3) By summarizing the consumption model and requirements of the BOP group and the sustainable design norm, the developing strategies of the sustainable design are formed along with the business opportunities related to the BOP group.

## 2. Methods

**2.1. Research Framework.** Since the BOP population has grown rapidly and their daily needs have increased in recent years, this research aims to explore the lifestyle and consumption characteristics of the BOP population in Taiwan. This study uses the literature analysis, a questionnaire, factor analysis, and expert interviews as research methods to construct sustainable product design strategy norms to apply to this population. At the same time, this study attempts to establish a theoretical framework to shed light on contention and ambiguities, contribute to deepening and propelling studies of Taiwan's new BOP problems, and provide directions for policy-makers.

To test the integrity of the research, a follow-up study will examine the research framework of this study through a literature analysis, as shown in Figure 2.

**2.2. Research Subjects.** This study seeks to explore the bottom of the pyramid in Taiwan, in other words, the poor socioeconomic groups of Taiwan. In light of this, as the government has failed to provide a definition of this new poor group [41], and from the literature analysis, this study proposes the use of a salary benchmark announced in 2010 by DGBAS, the Executive Yuan, in order to classify young workers as aged under 40 (approximately 4.6 million people), and whose annual income is less than NTD 540,000 (the same level of salary in 1997), as possible members of the new poor group, who meet the criteria of being among the vast and broadly-defined poor people at the bottom of the pyramid in Taiwan. Therefore, in this study, the first stage of the investigation of the young people in Taiwan who will be provided with questionnaire surveys in order to understand the lifestyle of this population, consumption characteristics, and the market demand for green design cognition.

The second stage is based on visits to product sustainability experts, mainly from the designer's point of view to carry out in depth interviews, in order to understand the methods related to the design process for the BOP population. We expect that the result can be combined with the consumers' view and be able to establish an appropriate market design criteria.

**2.3. Research Design.** This study uses questionnaires and the interview method as the main basis of the investigation; afterwards, the data and results of this study are used to construct a product to be applied to the BOP population in Taiwan.

**2.3.1. Phase 1.** Questionnaire surveys are adopted for research at this stage in order to explore the extent to which sustainable product designs are accepted by the people at the bottom of the pyramid in Taiwan, as well as the relevant experiences, patterns of consumption, and needs of such people. The questionnaire survey at this stage encompasses three parts, with detailed explanations provided, as follows.

The first part consists of research participants' personal data, which has the main function of facilitating good control of demographic variables and other variables; while the purposes are to organize the data of research participants, understand the composition of the demographic structure, and conduct in-depth discussions and analysis of problems.

The second part is to investigate the green consumerism perceptions and experiences of people at the bottom of the pyramid, where question items are designed with reference to relevant studies of green consumerism [42–47], and applicable additions, deletions, and modifications are made. In order to clarify information pertaining to this group's perceptions and experiences of green consumerism, yes/no questions and a 5-point Likert scale are adopted by the survey, and each question item is accompanied with choices of “strongly

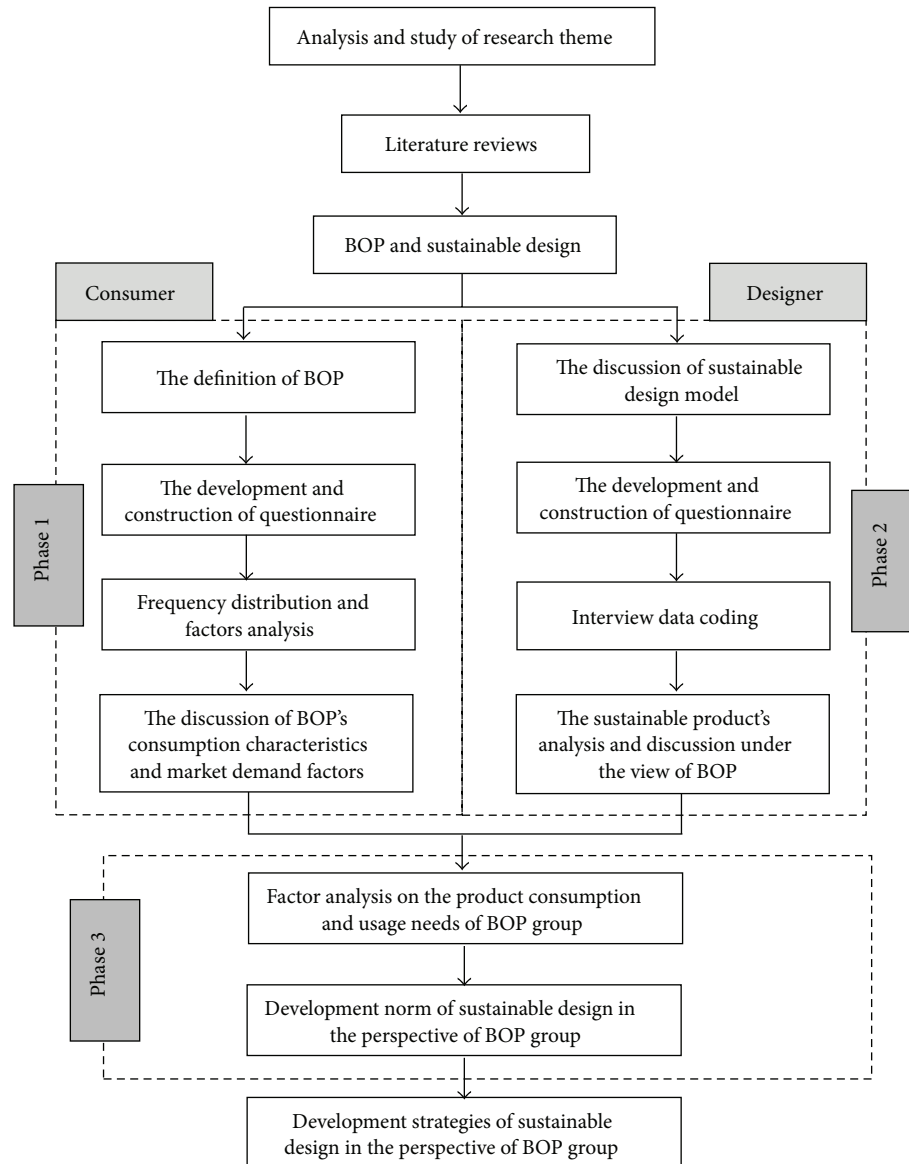


FIGURE 2: Research framework.

agree,” “agree,” “neither agree nor disagree,” “disagree,” and “strongly disagree,” from 5 points to 1 point, respectively.

The third part addresses the patterns of consumption and product/service demands of people at the bottom of the pyramid in Taiwan. Question items of this part are designed with reference to relevant studies [36, 48, 49], and applicable additions, deletions, and modifications are made. In order to gain an in-depth understanding of the needs of the people in this group and analyze relevant elements, the 5-point Likert scale is used, ranging from 5 (strongly agree) to 1 (strongly disagree).

**2.3.2. Phase 2.** The stage uses the interview method to survey experts (Table 1) in sustainable design product regarding their professional views and opinions. The questionnaire is designed based on three basic dimensions: BOP population,

design strategy, and sustainable product design. According to the professional views expressed in the interviews data is collected to understand the point of view of the BOP population in regard to sustainable design strategies, norms, and products to meet the needs of the BOP in Taiwan.

**2.3.3. Phase 3.** This stage is the result of a comprehensive analysis of the consumer side and the designer side, developing strategies, and patterns of sustainable design in the perspective of BOP group in Taiwan.

### 3. Results and Discussion

**3.1. Analysis on Questionnaire.** A total of 205 questionnaires were sent out, among which 190 were valid, after excluding the respondents with the annual income above NT\$

TABLE 1: An expert background table.

Expert	Job title	Professional field	Education	Experience
A	Designer	(i) ID design (ii) RD design	Department of Industrial Design, DaYeh University	ROHA product designer
B	Professor	(i) Innovative product design (TRIZ method) (ii) Quality planning and design (iii) Bionic design (iv) Innovative green design	Ph.D. in engineering mechanics, University of Florida, USA	(i) Professor, Department of Mechanical Engineering (ii) Visiting Researcher at the National Institute of Advanced Industrial Science and Technology (AIST)/a graduate institute of advanced manufacturing technology/a green design and manufacturing research group
C	Professor	(i) Resource management (ii) Resource regeneration system analysis (iii) Corporate environmental management (iv) Production and operations management (v) Green innovation and product development	Ph.D. in industrial engineering, University of Oklahoma, USA	(i) Professor, Department of Resources Engineering (ii) Department chair, Department of Resources Engineering
D	Designer	(i) ID design (ii) RD design	Department of Industrial Design, DaYeh University	Deputy Manager, Section of Technology Innovation and Development

540,000. In the procedure of data analysis, the willingness and experience of green consumption were mainly investigated among the group members to further understand their consumption features and the factors related to product needs. The questions were based on the essentials concluded from the related literature, mainly covering green consumption, consuming behavior and features, and the needs concerning products and services. The findings of this study should serve as the reference for future researches. The distribution of the demographics of the BOP group is shown in Table 2.

*3.1.1. Analysis of Consumers' Green Awareness.* The main part of this questionnaire is meant to understand the underlying population pyramid concept for cognition of green issues. In Table 3, the rate for the concept of environmental awareness and protection is around 90%. However, one can see in the item "I know and understand what green product is," that only 73.16% of the subjects think they know what green products are. As many people do not truly understand green products, public awareness of the concepts and meanings of green products must be enhanced.

*3.1.2. Analysis of Experience and Green Consumption Willingness.* The questionnaire in this section is primarily to understand the BOP group in regard to green consumption experience and willingness. In Table 4, the first half explores the experience of green consumption, 70.53%, the highest degree, were found to buy green living supplies, while, the lowest group, 18.42% were found to buy green furniture. In general, the use of green products in this population is not a high frequency; aside from the green living supplies, the other categories are below 50%, so it is worth exploring the reasons.

The other part of the questionnaire explores the willingness of consumers to engage in green consumption. In Table 5, about 76.84% of the people accept and purchase green-related products. But if the price of green products is

higher than ordinary products, it will reduce their willingness to purchase. In addition, the purchase of green product requirement for the highest quality rates 97.32%; most consumers demand a high level of quality.

*3.1.3. Analysis of the Characteristics Consumption in the BOP Group.* This research aims to understand the consumption characteristics of the BOP group; the topic is based on the five principles proposed by Prahalad [3], as shown in Table 6. In terms of cognitive demand, the vast majority of this population requires the use of daily necessities; 95.26% of the subjects in the "I have to buy daily necessities (e.g., clothing, personal hygiene items)" expressed consent. In addition, 76.84% of the subjects of most of the conceptual work in order to maintain the cost of living, in order to supply the required daily life. In terms of price, 87.37% of the subjects identified themselves as seeking a very reasonable price when shopping. In terms of brand awareness, 65.79% of the subjects in the "I have a brand awareness" expressed consent. In terms of connectivity, 80% expressed consent regarding: "evaluation of the network affects my buying choices." This population often used Internet technology; 93.68% of the subjects expressed consent regarding: "I will use the Internet to obtain information," so the network is one of the major ways to exchange information. For "I am pleased to accept the new technology because I know it will bring change for a better life" 85.27% of the subjects expressed consent. 89.53% of the subjects expressed consent in relation to: "I think technology will bring convenience to my life"; the BOP group is open and receptive to new technology. In terms of product selection based on the style and durability, 75.24% of the subjects agreed with: "For the selection of products, I like to buy a durable style."

*3.1.4. Analysis of BOP's Demand for Products and Services.* The questionnaire results are shown in Table 7. Regarding



TABLE 2: Distribution of the demographics of BOP group.

Item	Number of people	Number of people (%)	Cumulative Percentage
<b>Gender</b>			
Male	98	51.32%	51.32%
Female	92	48.68%	100.00%
Total	<b>190</b>	<b>100.00%</b>	<b>100%</b>
<b>Age</b>			
Less than 18 years old	0	0.00%	0.00%
18–24 years old	39	20.53%	20.53%
25–30 years old	134	70.52%	91.05%
31–40 years old	17	8.95%	100.00%
41–50 years old	0	0.00%	100%
More than 50 years old	0	0.00%	100%
Total	<b>190</b>	<b>100%</b>	<b>100%</b>
<b>Educational level</b>			
Elementary school (and below)	0	0.00%	0.00%
Junior high school	0	0.00%	0.00%
Senior high school and vocational school	4	2.11%	2.11%
University (including college)	102	53.68%	55.79%
Graduate school (and above)	84	44.21%	100%
Total	<b>190</b>	<b>100%</b>	<b>100%</b>
<b>Annual income</b>			
Less than 0.3 million NTD	99	52.11%	52.11%
0.31~0.54 million NTD	91	47.89%	100%
Total	<b>190</b>	<b>100%</b>	<b>100%</b>
<b>Residential places</b>			
Northern Taiwan	136	71.58%	71.58%
Central Taiwan	37	19.47%	91.05%
Southern Taiwan	17	8.95%	100%
Eastern Taiwan	0	0.00%	100%
Off-shore islands	0	0.00%	100%
Total	<b>190</b>	<b>100%</b>	<b>100%</b>
<b>Occupation</b>			
Professional personnel	56	29.47%	29.47%
Service industry	40	21.06%	50.53%
Business	26	13.68%	64.21%
Self Employed	21	11.05%	75.26%
Public official	11	5.79%	81.05%
Labor industry	19	10.00%	91.05%
Agricultural, forestry, fishery, and husbandry	0	0.00%	91.05%
Retired	0	0.00%	91.05%
Others	17	8.95%	100.00%
Total	<b>190</b>	<b>100.00%</b>	<b>100%</b>

“I like the practicality of the product” and “I value the product’s functionality,” 97.36% of the subjects expressed consent, so the vast majority of subjects who purchase products focus on practicality and functionality. In addition, 93.16% of the subjects in the “In the use and operation of the product, I would hope that “the more simple the better” expressed

consent, which represents that the majority of subjects want simple product features.

In terms of appearance, 86.84% of the subjects expressed consent in reply to: “I pay attention to the appearance of the product, and think appearance is very important”; most of the subjects focus on the appearance of the product. In terms of

TABLE 3: Crosstab of BOP’s awareness of green issues.

Item	Yes		No	
	Frequency	Percentage	Frequency	Percentage
I know that the earth’s natural resources will be exhausted one day.	189	99.47%	1	0.53%
I think I am aware of environmental issues.	169	88.95%	21	11.05%
I know that the use of green design products can contribute to the environment.	184	96.84%	6	3.16%
I know and understand what “green product” is.	139	73.16%	51	26.84%
I know what Green Mark is.	155	81.58%	35	18.42%
If there are affordable green products, I will gladly accept and purchase them.	186	97.89%	4	2.11%

TABLE 4: Crosstab of BOP’s consumption experience on green products.

Item	Yes		No	
	Frequency	Percentage	Frequency	Percentage
Have you ever bought any green appliances?	91	47.89%	99	52.11%
Have you ever bought any green clothes?	61	32.11%	129	67.89%
Have you ever bought any green transportation?	47	24.74%	143	75.26%
Have you ever bought any green living supplies?	134	70.53%	56	29.47%
Have you ever bought any green furniture?	35	18.42%	155	81.58%

TABLE 5: Crosstab of BOP’s green consumption willingness.

Item	Yes		No	
	Frequency	Percentage	Frequency	Percentage
I would choose to buy green products, even if the price is more expensive.	74	38.95%	116	61.05%
Since the rise of the green consumer awareness, I will consider green-related products when selecting and purchasing.	146	76.84%	44	23.16%
I will give up buying brand products or green products because of the price.	155	81.58%	35	18.42%
I will buy the products which emphasize environmental protection	116	61.05%	74	38.95%
When buying green products, I will focus on brand.	121	63.68%	69	36.32%
When buying green products, I will attach importance to price.	175	92.11%	15	7.89%
When buying green products, I will attach importance to quality.	185	97.37%	5	2.63%
When buying green products, I will attach importance to functionality.	184	96.84%	6	3.16%
When buying green products, I will make reference to recommendations of friends and relatives.	155	81.58%	35	18.42%
I will buy green products because of environmental labels.	129	67.89%	61	32.11%
When purchasing goods, I will consider whether the product has environmentally friendly features.	150	78.95%	40	21.05%

product usability, in the “I attach great importance to product safety” and “I attach great importance to product durability (e.g., useful life)” 87.9%, 84.21%, respectively, of the subjects expressed consent; safety and durability are important factors determining purchase intention.

In terms of services, 91.58% of the subjects in the category: “I think the product after-sales service is very important” and 85.79% of the subjects in the category: “Under the same conditions, I would choose the products which provide more after-sales service” expressed consent. That is, the service is important for the subjects, so the product design must consider service to meet the consumers’ demand.

3.1.5. *Factor Analysis and Reliability Evaluation.* In order to summarize the consumption features and needs of the

respondents, the questionnaire contains 41 questions for the factor analysis; similar features are summarized together.

In order to know the reliability of the questionnaire, Reliability Analysis is conducted. The higher the Cronbach  $\alpha$  is, the more reliable the scale is. High reliability refers to the Cronbach  $\alpha$  above 0.7. The Cronbach  $\alpha$  of the questionnaire is 0.863, which is above 0.7, showing that the scale of the questionnaire is reliable:

$$\alpha = \frac{k}{k - 1} \left( 1 - \frac{\sum S_i^2}{S^2} \right) = \frac{41}{41 - 1} (0.842) = 0.863. \quad (1)$$

Factor Analysis abstracts the same factors from the variables. After reducing the amount of the variables in order to achieve the effect of simplification, several factor

TABLE 6: Crosstab of consumption characteristics in the BOP group.

Item	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Total
Work to live, in order to maintain basic living expenses.	63 33.16%	83 43.68%	26 13.68%	16 8.42%	2 1.05%	190 100%
I have to buy daily necessities (e.g., clothing, personal hygiene items)	92 48.42%	89 46.84%	7 3.68%	2 1.05%	0 0.00%	190 100%
When shopping, the demand of necessities is greater than the demand of vanity products.	70 36.84%	74 38.95%	34 17.89%	11 5.79%	1 0.53%	190 100%
When I buy something, I will be cautious.	44 23.16%	86 45.26%	42 22.11%	17 8.95%	1 0.53%	190 100%
Price is the most important consideration when I go shopping.	41 21.58%	92 48.42%	41 21.58%	15 7.89%	1 0.53%	190 100%
I would choose a different place to buy goods because of the relative price (e.g., supermarkets, markets, etc.).	56 29.47%	94 49.47%	34 17.89%	4 2.11%	2 1.05%	190 100%
I am sensitive to the price, so I buy the best quality at affordable prices.	70 36.84%	96 50.53%	20 10.53%	4 2.11%	0 0.00%	190 100%
I have financial understanding.	13 6.84%	47 24.74%	103 54.21%	25 13.16%	2 1.05%	190 100%
I would use the coupons and wait for discounts to buy the goods.	19 10.00%	97 51.05%	54 28.42%	17 8.95%	3 1.58%	190 100%
I have brand awareness.	29 15.26%	96 50.53%	58 30.53%	7 3.68%	0 0.00%	190 100%
Brand for me is a guarantee of quality.	25 13.16%	93 48.95%	52 27.37%	18 9.47%	2 1.05%	190 100%
I think that brand can enhance the social status and highlight the taste.	23 12.11%	65 34.21%	70 36.84%	23 12.11%	9 4.74%	190 100%
I will focus on the atmosphere in the living environment.	46 24.21%	106 55.79%	34 17.89%	3 1.58%	1 0.53%	190 100%
I am willing to use my income to buy luxury goods (e.g., 3C products, brands, watches).	17 8.95%	79 41.58%	59 31.05%	24 12.63%	11 5.79%	190 100%
I pursue fashion.	16 8.42%	86 45.26%	58 30.53%	20 10.53%	10 5.26%	190 100%
I have a desire to buy popular seasonal goods.	9 4.74%	68 35.79%	30 15.79%	15 7.89%	15 7.89%	190 100%
Friends will affect my purchase options.	32 16.84%	107 56.32%	44 23.16%	7 3.68%	0 0.00%	190 100%
Evaluation of the network affects my buying choices.	39 20.53%	113 59.47%	35 18.42%	3 1.58%	0 0.00%	190 100%
I will use the Internet to obtain information.	68 35.79%	110 57.89%	10 5.26%	2 1.05%	0 0.00%	190 100%
I often offer new consumer messages to friends and family.	20 10.53%	82 43.16%	63 33.16%	21 11.05%	4 2.11%	190 100%
I am pleased to accept the new technology, because I know it will bring change for a better life.	47 24.74%	115 60.53%	21 11.05%	7 3.68%	0 0.00%	190 100%
I think technology will bring convenience to my life.	61 31.11%	111 58.42%	15 7.89%	3 1.58%	0 0.00%	190 100%
I usually do not buy a new product until mine is completely broken	20 10.53%	85 44.74%	61 32.11%	24 12.63%	0 0.00%	190 100%
For the selection of products, I like to buy durable style.	32 16.82%	111 58.42%	36 18.95%	11 5.79%	0 0.00%	190 100%
If I have extra money, I like to deposit it in the bank.	53 27.89%	90 47.37%	36 18.95%	10 5.26%	1 0.53%	190 100%



TABLE 7: Crosstab of BOP's demand for products and services.

Item	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Total
I like the practicality of the product.	64 33.68%	121 63.68%	4 2.11%	1 0.53%	0 0.00%	190 100%
I value the product's functionality.	63 33.16%	121 63.38%	5 2.63%	1 0.53%	0 0.00%	190 100%
In the use and operation of the product, I would hope that "the more simple the better."	65 34.21%	112 58.95%	13 6.84%	0 0.00%	0 0.00%	190 100%
I requested product material.	44 23.16%	116 61.05%	29 15.26%	1 0.53%	0 0.00%	190 100%
I pay attention to the appearance of the product, and think appearance is very important.	59 31.05%	106 55.79%	25 13.16%	0 0.00%	0 0.00%	190 100%
I hope t the product can match my personal taste.	48 25.26%	110 57.89%	27 14.21%	4 2.11%	1 0.53%	190 100%
I attach great importance to product safety.	69 36.32%	98 51.58%	22 11.58%	1 0.53%	0 0.00%	190 100%
I attach great importance to product durability.	54 28.42%	106 55.79%	25 13.16%	5 2.63%	0 0.00%	190 100%
I attach great importance to product survivability.	54 28.42%	103 54.21%	31 16.32%	2 1.05%	0 0.00%	190 100%
I fear there are too many functions in the product.	16 8.42%	46 24.21%	72 37.89%	40 21.05%	16 8.42%	190 100%
I hope that I am familiar with the product's operation.	44 23.16%	109 57.37%	33 17.37%	4 2.11%	0 0.00%	190 100%
I think the product after-sales service is very important.	93 48.95%	81 42.63%	14 7.37%	1 0.53%	1 0.53%	190 100%
Under the same conditions, I would choose the products which provide more after-sales service.	75 39.47%	88 46.32%	23 12.11%	4 2.11%	0 0.00%	190 100%
I like to use vendor-supplied network services system.	34 17.89%	84 44.21%	59 31.05%	10 5.26%	3 1.58%	190 100%
Compared to the network service system, I prefer to use the telephone voice service system provided by the vendor.	16 8.42%	51 26.84%	86 45.26%	31 16.32%	6 3.16%	190 100%
Compared to digital service systems (Internet and voice), I prefer to use a fixed-point type business service system.	28 14.74%	85 44.74%	58 30.53%	16 8.42%	3 1.58%	190 100%

dimensions are summarized, with the premise that most of the variables are kept. The second step of Factor Analysis is KMO Measure of Sampling Adequacy and Bartlett Sphericity Test. As the Kaiser-Meyer-Olkin (KMO) measure is to compare the simple and partial correlation coefficients between two original variables, the KMO test statistic indicator, as defined by (2) in mathematics, must be established for a comparison of the two. As revealed by (2), the KMO values vary from 0 to 1. A KMO value closer to 1 indicates a stronger correlation between variables and the original variables, which provides greater adequacy for factor analysis. Kaiser suggested that when the KMO value is higher, it is more effective after factor analysis [50]. A value of at least 0.9 means the effect is extremely appropriate, at least 0.8 means the effect is appropriate, at least 0.7 means the effect is acceptable, and at least 0.6 means the effect is normal. Below 0.5 means the effect is inappropriate. And then, the  $KMO = 0.785$  and the significance of Bartlett's test of sphericity is  $X^2 = 0.000$ ,

indicating that the data were proper. The questionnaire will be suitable for Factor Analysis:

$$KMO = \frac{\sum \sum_{j \neq i} r_{ij}^2}{\sum \sum_{j \neq i} r_{ij}^2 + \sum \sum_{j \neq i} P_{ij}^2}, \tag{2}$$

$$X^2 = \frac{(N - K) \ln(S_p^2) - \sum_{i=1}^k (n_i - 1) \ln(S_i^2)}{1 + 1/(3(k - 1)) \left\{ \sum_{i=1}^k (1/(n_i - 1)) - 1/(N - k) \right\}}. \tag{3}$$

After KMO Measure of Sampling Adequacy and Bartlett Sphericity Test mentioned above, the questionnaire is considered suitable for Factor Analysis. Thus the same factors are abstracted by the Principal Components Analysis of the Factor Analysis. From Table 8, it can be seen that the total variance is 62.580% and the lowest eigenvalue is 1.184, which matches the selection conditions, the sum of eigenvalues is above 1, and the total explained variance is 40%.

TABLE 8: Eigen value of factors, explained variance after rotation, and cumulative explained variance of green consumption scale.

Component	Primary eigenvalue		Cumulative explained variance
	Eigenvalues	Explained variance	
1	7.523	18.384	18.348
2	5.088	12.410	30.757
3	2.321	5.662	36.419
4	2.083	5.081	41.500
5	1.868	4.555	46.055
6	1.557	3.797	49.852
7	1.426	3.477	53.329
8	1.329	3.241	56.571
9	1.280	3.122	59.693
10	1.184	2.887	62.580

The next step is to conduct orthogonal rotation by Varimax:  $\text{Max } S_{a_i^2}^2 = (1/m) \sum_{j=1}^k (a_{ji}^2 - a_i^{-2})^2$ . In mathematical theories, converting the Varimax rotation to obtain a new value is to maximize the variant of the squared factor loading of all variables in the same factor or composition in order to better achieve objectives for a simple factor structure, which provide easier explanations of a factor structure, and thus, obtain a clearer concept. The acceptable range of the significant criteria of the factor loadings is above 0.3 by Hair et al. [51]. Thus the 44 questions in the questionnaire are refined to 10 principle factors, as shown in Table 9:

$$\text{Max } S_{a_i^2}^2 = \frac{1}{m} \sum_{j=1}^k (a_{ji}^2 - a_i^{-2})^2. \quad (4)$$

The study names the factors according to the meanings of questions, respectively, including Brand and Personal Taste, Practical Value, Function Simplification, Technology Acceptance, Channel Dimension, Price Perception, Best Use, Product Dimension, Basic Needs, and Service-using Habits, as shown in Table 10.

**3.2. Interview Method.** This study through interviews with four experts will analyze the interview data. In this study, the main research content of the specifications will be used to construct sustainable product design and development according to the BOP perspective on the elaboration of the interview questionnaire design strategies. Furthermore, the scope of classification and induction-related issues and analysis of the internal factors oriented in the three above-mentioned areas will proceed.

**3.2.1. Basic Information on the Respondents.** The interview mainly focuses on the topics related to the BOP group and sustainable design of products; the views and suggestions of four experts from different fields are also analyzed. According to them, it is possible to introduce the views of the BOP group into the studies and theories related to sustainable design and development. Moreover, from the perspective of industrial

designers, we can understand the professional procedures related to the sustainable design, based upon which, the research conclusion can be analyzed and summarized.

**3.2.2. Analysis and Summary of Interview Data.** Based on the results of the interviews, the study obtained and named 176 concepts through open coding. Axial coding is conducted after open coding, whereby the topics are summarized according to the concepts. After the topics were completed, associate categories were further summarized. The study results total 18 associate categories which can be summarized into 4 principle categories: society orientation, consumer orientation, design orientation, and enterprise orientation. The details are as follows:

- (i) Society orientation: market, social economy, government, and awareness;
- (ii) Consumer orientation: consumers, needs, views, and marketing;
- (iii) Design orientation: development, sustainable design, recycling, and cost;
- (iv) Management orientation: management, enterprise, brand, operation, innovation, and renting.

The details of its scope are shown in Table 11. The results of interviews are classified and analyzed according to the characteristics. The orientations of society and consumers lean to the views of the class and the current social situation; thus, they are classified according to the consumption analysis of the sustainable products. The orientations of design and company lean to the developing model of the products for the BOP group. By cross-over analysis, the findings of analyzing the two orientations can be considered as the designing and developing norms of the sustainable products for the BOP group. Finally, induction into the design and development of sustainable development suited to the BOP group's strategy follows.

**3.2.3. Analysis of the Consumption Habits of the BOP Group.** Through interviews, we can learn about the current social situation of this group, their consumption habits and many other aspects. Taking the BOP group as the subject, this study finds from the interviews that the definitions of the group may vary due to different regions. In the case of Taiwan, there is no extremely poor group compared with western countries or the Third World countries, although the gap between rich and poor does exist. Accordingly, the definition of BOP group is the relatively poor group. The summary and analysis of the interviews are presented in Table 11.

**3.2.4. Model Analysis of the Sustainable Product Development for the BOP Group.** For the BOP group, reasonable price is the most important view and the main aim. It also involves design orientation and management orientation. The norm and methods related to the sustainable design and development of the products are discussed from the perspectives of development and the companies. The related data from interviews are summarized and analyzed, as shown in Table 11.

TABLE 9: Component matrix of green consumption scale of principal component analysis after rotation.

Subject of green consumption	Factors									
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
31	<b>0.780</b>	0.114	0.057	-0.025	0.149	-0.143	0.052	0.035	0.131	-0.092
12	<b>0.733</b>	-0.046	-0.070	0.193	0.164	0.174	0.110	-0.060	-0.091	0.068
30	<b>0.725</b>	0.124	0.150	-0.105	-0.043	-0.096	0.001	0.073	0.195	-0.096
13	<b>0.683</b>	0.149	0.017	0.180	-0.118	0.094	0.034	0.151	-0.105	0.040
15	<b>0.674</b>	-0.129	-0.093	0.056	0.285	0.180	-0.085	-0.188	0.042	0.084
10	<b>0.586</b>	0.070	0.019	0.304	0.066	0.305	0.071	-0.042	-0.269	0.076
14	<b>0.569</b>	-0.145	-0.065	0.229	0.264	0.105	-0.203	-0.241	0.003	0.018
11	<b>0.541</b>	0.031	0.055	0.360	0.140	0.247	0.097	-0.059	-0.207	0.227
16	<b>0.527</b>	-0.083	-0.113	-0.093	0.451	0.063	-0.020	-0.210	0.060	0.303
37	-0.041	<b>0.787</b>	0.144	0.133	0.017	0.184	0.013	-0.086	0.090	0.054
34	0.022	<b>0.769</b>	0.135	0.107	0.116	-0.099	0.228	0.138	0.044	0.162
32	0.164	<b>0.681</b>	0.048	0.225	-0.013	-0.015	0.317	0.092	0.093	0.025
33	-0.030	<b>0.680</b>	0.142	0.058	0.068	0.033	0.281	0.159	0.051	0.182
38	0.047	<b>0.599</b>	0.075	-0.032	0.143	0.159	0.014	-0.026	0.135	-0.140
36	0.041	<b>0.536</b>	0.433	-0.168	-0.039	0.137	-0.130	-0.002	0.049	0.169
29	0.398	<b>0.411</b>	0.349	-0.005	-0.008	0.119	0.069	0.085	-0.115	-0.121
27	0.012	0.211	<b>0.807</b>	0.168	0.081	0.007	0.246	0.158	0.098	0.049
26	-0.038	0.075	<b>0.801</b>	0.117	-0.034	0.004	0.294	0.182	0.114	-0.033
28	0.087	0.428	<b>0.652</b>	-0.062	-0.012	-0.029	-0.109	0.033	0.038	0.095
21	0.288	0.163	0.018	<b>0.759</b>	0.103	0.141	-0.059	0.079	0.131	-0.013
22	0.224	0.200	0.072	<b>0.738</b>	0.119	-0.025	-0.020	0.052	0.248	0.001
18	0.229	0.084	0.095	0.231	<b>0.757</b>	-0.047	-0.054	0.141	0.011	-0.042
17	0.251	0.016	-0.069	-0.051	<b>0.735</b>	0.047	0.309	0.021	0.085	0.068
19	0.055	0.283	0.089	0.395	<b>0.600</b>	-0.092	-0.171	0.112	0.013	0.021
9	0.158	0.133	0.076	-0.041	-0.030	<b>0.743</b>	0.077	0.065	0.054	-0.062
8	0.056	-0.002	-0.024	0.085	-0.110	<b>0.714</b>	0.092	0.199	-0.060	0.095
20	0.443	0.038	-0.075	0.145	0.267	<b>0.457</b>	0.011	-0.005	0.082	-0.018
6	0.209	0.227	0.021	-0.030	0.157	<b>0.376</b>	0.174	0.306	0.365	-0.169
24	0.171	0.213	0.189	0.057	0.023	0.034	<b>0.739</b>	-0.014	-0.049	-0.024
23	-0.074	0.234	0.121	-0.083	0.009	0.196	<b>0.560</b>	0.185	0.051	0.099
25	-0.241	0.087	0.346	-0.080	0.189	0.209	<b>0.377</b>	-0.175	0.214	0.139
4	0.035	-0.012	0.053	0.091	0.049	0.093	0.164	<b>0.805</b>	0.023	0.048
3	-0.233	0.125	0.226	-0.040	0.056	0.150	-0.062	<b>0.674</b>	0.017	0.006
7	0.092	0.314	0.140	-0.015	0.170	0.359	0.047	<b>0.426</b>	0.205	0.053
1	-0.033	0.016	0.055	0.098	-0.016	0.024	0.139	-0.094	<b>0.794</b>	0.114
2	0.010	0.163	0.128	0.175	0.108	0.010	-0.150	0.104	<b>0.647</b>	-0.028
5	0.006	0.148	0.050	-0.067	0.004	0.043	0.481	0.315	<b>0.510</b>	-0.013
41	0.024	0.136	0.098	0.053	-0.072	-0.055	0.092	-0.019	0.030	<b>0.781</b>
40	0.061	0.092	0.021	-0.135	0.174	0.058	-0.002	0.066	0.026	<b>0.737</b>
35	-0.001	0.112	-0.075	-0.627	-0.111	0.049	-0.086	0.102	0.033	<b>0.492</b>

3.3. Development Model of Sustainable Design for the BOP Group

3.3.1. Factor Analysis on the Product Consumption and Usage Needs of the BOP Group. The questionnaire analysis is expounded in the descriptive statistics and factor analysis, all of which test consumers' consumption style and product

usage in the market. In addition, 10 elements are abstracted from the factor analysis and combined with the survey to conduct an overall analysis on the consumption and usage needs of the BOP group, which are interpreted as follows:

(i) Brand and Personal Taste. For the BOP consumers, the most imperative factor is the price; however, this group still

TABLE 10: Meanings of names of factors.

Factor	Names	Meanings	Factor loading
Factor 1	Brand and personal taste	(i) I hope the product can set off my personal taste.	0.780
		(ii) The brand will allow me to enhance my social status and highlight my taste.	0.733
		(iii) I pay attention to the appearance of the product, and think the appearance is very important.	0.725
		(iv) I will focus on taste and the atmosphere of the living environment.	0.683
		(v) I care about fashion or popular supplies.	0.674
		(vi) I have brand awareness.	0.586
		(vii) I am willing to use my income to buy luxury goods.	0.569
		(viii) I have the desire to buy popular seasonal merchandise.	0.541
		(ix) I think that brand is a guarantee of quality.	0.527
Factor 2	Use value	(i) I think that product after-sales service is very important.	0.787
		(ii) I attach great importance to product survivability.	0.769
		(iii) I attach great importance to the durability of the product.	0.681
		(iv) I attach great importance to the safe use of the product.	0.680
		(v) Under the same conditions, I would choose the products to provide additional services.	0.599
		(vi) I hope that I am familiar with the operating functions of the product.	0.536
		(vii) I attach great importance to the product material.	0.411
Factor 3	Function simplification	(i) I attach importance to the functionality of the product.	0.807
		(ii) I like practical goods.	0.801
		(iii) In the use and operation of the product, I prefer "the simpler the better".	0.652
Factor 4	Science and technology	(i) I am willing to accept the new technology because I know it will bring life changes.	0.759
		(ii) I think that the technology will bring convenience to my life.	0.738
Factor 5	Channel and network	(i) The network evaluations will affect my purchase choice.	0.757
		(ii) My relatives and friends will affect my purchase choice.	0.735
		(iii) I will use the Internet to obtain information.	0.600
Factor 6	Price perception	(i) I would use the coupons and wait until the discount period to purchase goods.	0.743
		(ii) I'm good at managing finances.	0.714
		(iii) I often provide new the consumer trend messages to friends and family.	0.457
		(iv) I will select different consumer locations, such as hypermarkets, supermarkets, markets, night market, and so forth.	0.376
Factor 7	Best use	(i) In product choice, I like to buy the style to replace what is outmoded and dirty.	0.739
		(ii) I usually wait until the product is completely broken and then buy a new one.	0.560
		(iii) If there is money left over, I want to put it in the bank.	0.377
Factor 8	Cautious purchase	(i) Buying things means careful consideration, no whim purchases.	0.805
		(ii) I prefer necessities to the vanity goods.	0.674
		(iii) With considerable acumen I expect to buy the best quality products at affordable prices.	0.426
Factor 9	Basic needs	(i) Working is to live and maintain basic overhead.	0.794
		(ii) I buy daily necessities such as clothing or personal hygiene items.	0.647
		(iii) The price is the most important consideration in my shopping.	0.510
Factor 10	Habits on service usage	(i) Compared to the network service system, I prefer to use the telephone service provided by the manufacturers.	0.781
		(ii) Compared to a digitization service systems (like Internet and voice), I prefer to use a fixed-point-merchant services system.	0.737
		(iii) I fear products with too many functions.	0.492

TABLE 11: Interview's data coding.

Main dimension	Second dimension	Topic	Concept	
Society orientation	Social economy	Social status	C1, D2, D31: Taiwan applicable theory of relative poverty	
			C4: Revenue for the social bottom 20%	
			B7: Needs of the top social group	
		Economic environment	C2: Lower income groups also have demands	
			C6, D4: Taiwan is a small and closed society	
			C10, D1: Low-pay as a social phenomenon	
	Market	Region	B2: Poor economic environment	
		Social relief	B3: Less resource allocation	
			B13, C11: Meet the regional demand	
	Market	Market demand	C8, D30: Definition of poverty varies by region	
			C16: From the point of view of social assistance	
		Market trends	A1: Market analysis groups demand	
			A17: They have to meet demand	
Awareness	Environmental awareness	D19: Influence the design and development		
		B9: Cheap consumer market trends		
Government	Government policy	C3: Sustainable development requires high-quality		
		C19: View of high-quality and affordability		
		B31: There is a growing public awareness of environmental protection		
		A33: Government can have an impact		
Consumer orientation	Consumers	Consumption patterns	C41: Promote policies	
			D17: Government regulations specification	
			A3: Shopping patterns of self-adjustment	
		Needs	Use requirements	A4: Shopping to have products based
				A5, A13: Reduce the purchase vanity items
				A65: Consumer habits
	Views	Psychological needs	C5, D3: Consumer habits and the top-level population	
			C33: Affordable	
			A18, C20, D22: There are certain quality requirements	
			A19, C18: Products will have the best performance	
	Marketing	Values	A43: Improve product texture	
			A56: Mainly to meet the basic needs	
			D23: Features simple operation	
A27: Pursuit of cheap vanity products				
Marketing	Product value	A34: Product allows users to have a sense of presence		
		A42: Improve product aesthetics		
		C9: Consumption Values		
		C14: Consumer habits vary due to values		
Marketing	Marketing practices	D5: Stimulated by a large number of networks		
		D14: Changes in the concept of green consumption		
		A58, C21, C26: Product highlights certain characteristics		
		A59, C31: Products need to have highlights		
Marketing	Marketing practices	C34: Products need extra value		
		A6: Brand Sale		
Marketing	Marketing practices	A25: Use discount schedule to stimulate consumption		
		A52: Use Anniversary Sale		
Marketing	Marketing practices	D10, D26: Reduce excessive marketing		



TABLE 11: Continued.

Main dimension	Second dimension	Topic	Concept
		Path	C22, D27: Easy to buy C23: Establish contact with the customer and pipeline path D6: Powerful network connection force
		Design flow	A14, D11: Process design to reduce costs A66: Streamline the design process A35: Reduce manufacturing steps A50: Reduce the failure rate of products manufactured C28: Simplify the process C30: The lowest level of consumer acceptance testing B30: A small amount of production is good for the environment
		Machining processes	A20: The use of alternative materials A21: The use of alternative processing mode A46: Product type body shrinking A48: Product is small and beautiful
	Development	Overall factor	A49: Product complexity appearance will lead to increased costs A57: Overall use of the product may increase the value A53, D9: Product is simple, beautiful and small A45: Reduce excessive internal structure of the product C15: Reduced product content and maintenance product quality
		Built factor	C32: Function-oriented D7: Reduce unnecessary functions D8: Optional use of optional features A40: Changes in product assembly methods
		Assembly mode	D16: Replacement of the product in part failure D20: Parts to maintain the same life B14: The idea of using technology from the demand side
		Technical use	D24: Sophisticated technology easy to fault D29: Promotion and use of technology A8: Green products are not durable
		Durability	B12: Have both practical and durable C35: Use of technology to increase product durability C36: Lease to maintain product durability
Design orientation		Volume	A15: Product volume is reduced
		Packaging	A67: Neutral packing material A7: Environmentally friendly products higher price A10: Material cost is difficult to adjust
		Material costs	A16, C29: Saving materials A47: The main factor in the cost of materials B16: Reducing the use of synthetic materials B28: The higher cost of green materials
	Cost	Tooling costs	A11: Mold cost savings A12: Reduce post-processing
		Processing costs	A36: Reduce the processing flow A39: Reduction in composite processing
		Marketing costs	C17: Reduce marketing costs

TABLE 11: Continued.

Main dimension	Second dimension	Topic	Concept
	Sustainable design	Sustainable product design	A9: The concept of sustainable design strategies
			B4, B15: Product design and sustainable design concepts fit the BOP
			B6: Green design meets the needs of ethnic point of view
		Green certification	B20: To improve the environment as a starting point
			D15: Green products and fashion products conflicting
			A2: Use of poison testing and certification
		Green detection	B17: Reduce the use of poison
			A55: Use regulations to detect product problems
		Energy saving	B21: Overall energy savings
	B22: To judge the end result of energy-saving		
	Recycling	Recovery mode	A37: Easy to recycle
			A38: Easy to disassemble
			A60: The basic product recovery
		Recycling detection	A61: Difficulties caused by the recovery of excess processing
			B18: To complete recovery planning
			B27: The need to construct loop recycling
		Resources	B26: Designers and recyclers should take each other into account
			B23: View the proportion of recycled goods
B24: Recyclers must be willing to recycle			
Management orientation	Management	Business operations	B25: Must have effective recycling
			D21, D28: Re-use recycled products
			A24: Enterprises are required to meet the needs of all communities
		Operating experience	A41: Cost reduction is the highest corporate standard
			C13: Understand proper demand
			A51: Estimated sales and net income
	Enterprise	Corporate responsibility	B8: Ten-dollar merchandise store concept
			B1: Companies did not pay attention to their needs
			B35: Enterprises must provide products to meet the need
		Industry opportunities	A22: Corporate Responsibility
			B10: Corporate charitable viewpoint
			B11: Provide basic needs
	Brand	Brand value	B19: Reduce the demand created
			B32, C39: Sustainable product design is the new direction of the industry
			B33: A new opportunity for the industry in the economic downturn
		Brand information	C12: Youth Poverty is a new opportunity for the development of Taiwan
			C38: Green design is a new source of competitiveness
			A23: Brand can add value to products
Innovation	Brand construct	A26: The use of low-cost strategy to make the brand lay down roots	
		C7: Rapid flow of fashion news and brands	
		C24: Construct its own brand	
	Innovative ideas	C25: Construction of sub-brand	
		C27: Main brands to endorse sub-brand	
		B34: Manufacturing technology combined with innovative ideas	
Operation	Industry needs	C40: Change the system	
		C43: Promote an innovation system	
			A54: Convince the boss to reduce costs

TABLE 11: Continued.

Main dimension	Second dimension	Topic	Concept	
			A28: Leasing is a way to provide low-cost consumption	
			A29: Leasing can reduce the economic burden	
	Renting	Lease charges	A30, C37: The high cost of leasing	
			A31: Leasing must become popular	
			A32: Leasing must cut prices	
			Leasing quality	A63: Leasing can maintain product quality
			Product category	A64: Product range will affect leasing results

wants to purchase brand names. People all have vanity and the desire to advance; thus brand and personal taste remain crucial factors. The questionnaire discussion revealed that consumers expect the brand effects in purchase, including mental satisfaction, brand value, quality guarantee, and so on.

(ii) *Use Value*. BOP consumers purchase in a different way due to their limited income. Thus when purchasing or using products, they may mainly consider practicability and endurance. The questionnaire survey showed that the main consumers of the group focus on practical products for daily life needs; that is, they purchase because of need.

(iii) *Function Simplification*. This factor is mainly related to the content of products, in which the parts and functional operation are included. Based on the questionnaire, the group pays great attention to the functions of the products and expects simple use and operation. From the perspectives of design and development, it can be seen that if the functions and contents of products can be simplified, the costs of function development and content materials will be cut; thus the costs of products will be reduced and sustainable design realized.

(iv) *Science and Technology*. During the development of green products, technologies can improve the materials, manufacturing procedure, assembly, and recycling to meet the environmental requirements. The questionnaire shows that the group is aware that they live in an era of highly developed technologies which can change their lives and bring more convenience, so they keep a positive attitude and welcome technologies.

(v) *Channel and Network*. The channel is one of the main factors in selling; it can reach consumers directly. With the fast information flow brought by networks, the group is accustomed to, and greatly relies on, the network. The questionnaire showed that the group is accustomed to getting information from the related assessments gained by browsing the networks; networks are the main way to connect to the group.

(vi) *Price Perception*. Due to the income limitation, the questionnaire showed that the BOP group is sensitive to the price of their consumption habits, and often compares

the prices when purchasing. The BOP group prefers offering consumption information to their family and friends, and purchasing in different places.

(vii) *Best Use*. The BOP group has the concept of best use of the products, that is they never buy a new one until a product wears out. Therefore, the consumption mobility is not high. They consider endurance, lasting beauty and stain resistance that all extend the usage. In other words, the service life of the product is crucial for them.

(viii) *Cautious Purchase*. The BOP group purchases carefully due to the income limitation. Thus on the perspective of product development and preference, products should be cut to a basic level. Those qualities that can improve the purchase intention of consumers should be selected and enhanced in order to attract the BOP.

(ix) *Basic Needs*. For the BOP group, work is for obtaining and maintaining living expenses. Besides price, they mainly want their basic needs met in terms of consumer psychology. Thus the product development should start from the basic and popular products. The sustainable design should be introduced in relation to living necessities; the products should meet the basic living needs of the group. The product developing and designing should follow the principles of being simple, easy and small in quantity to keep the cost down.

(x) *Habits on Service Usage*. It is found that the group fears service that is too complicated, which is similar to the attitude on product usage. Thus to provide products and services to the group, it is suggested to use a more simple way and one which is closer to daily life.

3.4. *Development Norm of Sustainable Design in the Perspective of the BOP Group*. Combining the Green Design Structural Flow sheet [52] of Tu et al. along with the factor analysis of consumption and demand in the sustainable development model, the study summarizes the green design structural flow sheet (Figure 3) in the perspective of the BOP group. In the design procedure, "market survey" and "consumers' views and market positioning" are added. The survey showed that market orientation is quite important for the BOP group. According to the factor analysis, the requirements on price and quality of the BOP group are quite

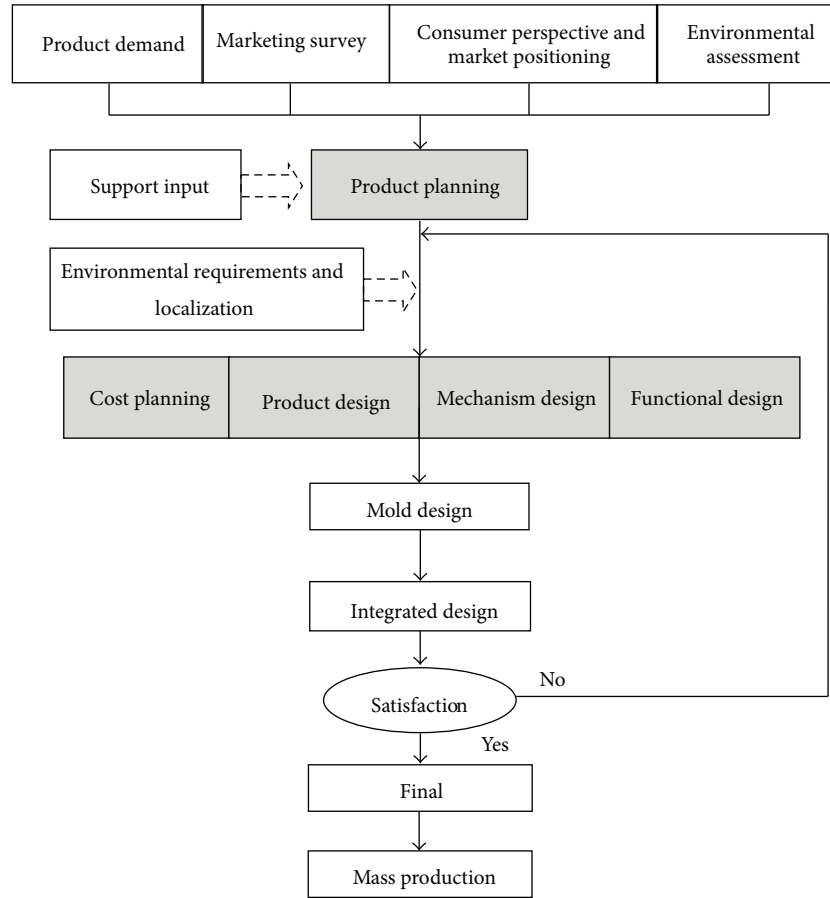


FIGURE 3: The sustainable design process from the BOP standpoint.

different from the previous BOP development model. With regard to the dot lines represent time points of different stages in Figure 3, the concept of “supporting input” has been added, which encompasses analysis of relevant data pertaining to the needs, material characteristics, materials, the environment, environmental indicators, and energy consumption, in order to provide more comprehensive support to product planning. Moreover, the concept of “environmental requirements and localization” is included, as the poor group at the bottom of the pyramid has a large population, resulting in distinct sub-groups being formed within the group. As such, at the early stage of integrated design planning, background information on individuals’ life, resource allocation, and geographical area should be taken into consideration in order that designers can have more comprehensive, strict, and rigorously integrated design planning to meet the needs of this group.

In the third stage of integrating design, the overall cost plan is added. Since the BOP group often takes price into consideration during purchasing, the cost plan is important. There are four main aspects to achieving the cost plan: material cost, mold cost, processing cost, and marketing cost, all of which aim to effectively reduce the related production and marketing cost and the selling price.

The second step is to work out the development norm of sustainable design in the perspective of the BOP group.

After introducing the BOP’s views to sustainable design procedure, the development norm combines the sustainable development model with the view that the lifespan of a product should be taken into consideration in the sustainable design procedure.

In the new development norm of sustainable design, the study adds two new concepts: the market survey and the sales model. The data analysis found that the difference between the development of sustainable design in the perspective of BOP group and the previous concept of sustainable design is that the former has to consider the market orientation and design according to the actual needs of consumers. Moreover, due to the large BOP population, it is necessary to clearly define the differences among the various BOP groups.

The market characteristics of BOP groups are different from those of the common consumers. According to the analysis on product consumption and usage needs of BOP group, it is found that networks should be used frequently, the cost should be reduced and direct contact should be initiated, in order to penetrate the group. Therefore, the study introduces the lifespan of the products into the sales model.

The design and development of specifications in various stages of their life in the new “LC-BOP”, marking a new concept, was added to the bottom of the pyramid view, as shown in Table 12.

TABLE 12: Sustainable product design specification from the BOP's standpoint.

Life recycle	Sustainable product design specification from the BOP standpoint
Marketing survey (LC-BOP)	<ol style="list-style-type: none"> <li>(1) Do exact positioning and distinction concerning consumer groups.</li> <li>(2) Investigate the consumer product demands and consumption habits.</li> <li>(3) The in-depth investigation of consumers, regions and local resources.</li> <li>(4) Designers need to have the concept of BOP and green design to satisfy the needs of the BOP.</li> </ol>
Material selection	<ol style="list-style-type: none"> <li>(1) Select appropriate materials for product use.</li> <li>(2) Select the maximum utilization rate of the material. (LC-BOP)</li> <li>(3) Select high durability material. (LC-BOP)</li> <li>(4) Choose environmentally friendly alternative material under the cost considerations. (LC-BOP)</li> <li>(5) Avoid the use of toxic and harmful ingredients of the raw materials.</li> <li>(6) Avoid excessive use of synthetic materials. (LC-BOP)</li> <li>(7) Try to use biodegradable materials.</li> <li>(8) Simplify the use of material, and avoid mixing different materials.</li> <li>(9) Try to use recyclable and recycled material.</li> <li>(10) Minimize the amount of material.</li> <li>(11) Proper use of raw materials.</li> <li>(12) Attention to the characteristics of the material and conditions of use.</li> <li>(13) Use the compatibility characteristics of the material.</li> <li>(14) Reduce the material for chemical treatment (painting, plating).</li> <li>(15) More use of latch design to reduce the use of screws.</li> </ol>
Mechanism design	<ol style="list-style-type: none"> <li>(1) Avoid designing disposable products.</li> <li>(2) Try to reduce the size.</li> <li>(3) Modeling is not the pursuit of short-term popularity.</li> <li>(4) Material structure simplified.</li> <li>(5) Use mining dismemberment design and easy to disassemble combination instead of one-piece design.</li> <li>(6) Use easy ways to replace parts of the structure.</li> <li>(7) Improve the attitude of the people in using the product.</li> <li>(8) No acute angle design to ensure the safety of users.</li> <li>(9) The life of components has to be unified. (LC-BOP)</li> <li>(10) Reduce the extra unnecessary functions. (LC-BOP)</li> <li>(11) Avoid the use of complicated and too many components. (LC-BOP)</li> <li>(12) Take the idea of function-oriented to achieve the simplification of the product features. (LC-BOP)</li> </ol>
Manufacturing process	<ol style="list-style-type: none"> <li>(1) Select provincial materials processing.</li> <li>(2) Reduce waste generation process.</li> <li>(3) Try to use natural energy in the manufacturing process</li> <li>(4) Reduce process waste water, waste, toxic emissions and noise.</li> <li>(5) Develop manufacturing technology for more provincial energy resources.</li> <li>(6) Use the excess energy in the process.</li> <li>(7) Reduce unnecessary and non-essential processes to achieve the goal of reducing process waste. (LC-BOP)</li> <li>(8) Reduce the failure rate of the product manufacturing process. (LC-BOP)</li> </ol>
Package design	<ol style="list-style-type: none"> <li>(1) Use the design for easy packaging.</li> <li>(2) Simplify the package structure to enhance strength</li> <li>(3) Avoid excessive packaging.</li> <li>(4) Reduce the use of foam plastic.</li> <li>(5) Try to use natural resources or paper.</li> <li>(6) Use non-toxic, easy to decompose, recyclable and renewable packaging materials.</li> <li>(7) The material selections have to be simplified as much as possible.</li> <li>(8) Reduce the amount of ink used.</li> <li>(9) Products and packaging combined into one design.</li> <li>(10) Consider the issue of consumer safety.</li> <li>(11) Use neutral packaging to increase the multi-utilization of the packaging. (LC-BOP)</li> </ol>



TABLE 12: Continued.

Life Recycle	Sustainable product design specification from the BOP standpoint
Transport distribution	(1) Use the most economical mode of transport. (2) Reduce the pollution caused during transportation. (3) Recycle the pallets during transport.
Sales model (LC-BOP)	(1) Highlight the characteristics and value of one item to enhance consumers' willingness to purchase. (2) Use the Internet as a pathway. (3) Create a pipeline to directly contact consumers. (4) Construct a sales database.
Consumer using	(1) Increase consumer use efficiency and satisfaction. (2) Simplify the function and operation. (3) Reduce the chance of error in the operation, and establish the correct operation. (4) Ensure the safety of users. (5) Select the best way with the lowest pollution. (6) Increase energy efficiency. (7) Reduce the use phase pollution emissions generated. (8) Increase the life of the product and the subsequent use value. (LC-BOP) (9) Test consumers' bottom line. (LC-BOP)
Recycling	(1) Guide the user to improve the recycling. (2) Establish and improve the recycling system. (3) Try to promote resource recycling. (4) Select the most appropriate recycling way among the waste disposal methods. (5) Increase the ease of disassembly and easy recovery. (LC-BOP) (6) Re-use and regenerate recycled goods back to the design of the product. (LC-BOP) (7) Construct secondary products to reduce product costs and extend the life of the product. (LC-BOP)
Environment design	(1) The interior design needs to consider the material combination with the neat concept. (2) Provide a beautiful and suitable urban living space planning and design. (3) Consider comprehensive urban landscape design and community planning. (4) Effectively improve the environment as a starting point. (LC-BOP) (5) Do the product design to match the exact needs of the BOP. (LC-BOP) (6) From the view of social care, do comprehensive design planning. (LC-BOP)
Environmental law	(1) Follow environmental regulations and standards. (2) Seek Green Mark certification. (3) Combine the government relief bill with policy. (LC-BOP)

*3.5. Development Strategies of Sustainable Design in the Perspective of the BOP Group.* After discussing the ideas of sustainable design development in the perspective of the BOP group, the study proposes the development strategies of sustainable design in Taiwan. The topics concerning the BOP group mainly start from the consumer orientation. The consumer dimension contains the aspects of society and consumers: development strategies should combine development ideas with consumers' views. The development strategies are shown in Figure 4. The strategies form a development dimension by combining the design ideas and operation ideas, and form a consumption dimension by combining the social views and consumers' views. The two dimensions are combined and the correlation is found.

The development strategies of sustainable design in the perspective of BOP in Taiwan are derived from four aspects:

company orientation, design orientation, society orientation, and consumer orientation. In the strategy figure, the four aspects are classified into company and design and society and consumers, according to the characteristics, shown in detail as follows.

*3.5.1. Enterprise and Society Aspect.* Every enterprise has its own style and responsibility that influence the operation and the brand identity. The brand identity influences the model of developing products. Moreover, consumers' views and market positioning should be taken into consideration during product development, and the factor of environment assessment will make the product plan complete.

During the product planning, environmental requirements and localization (region) should be considered. In

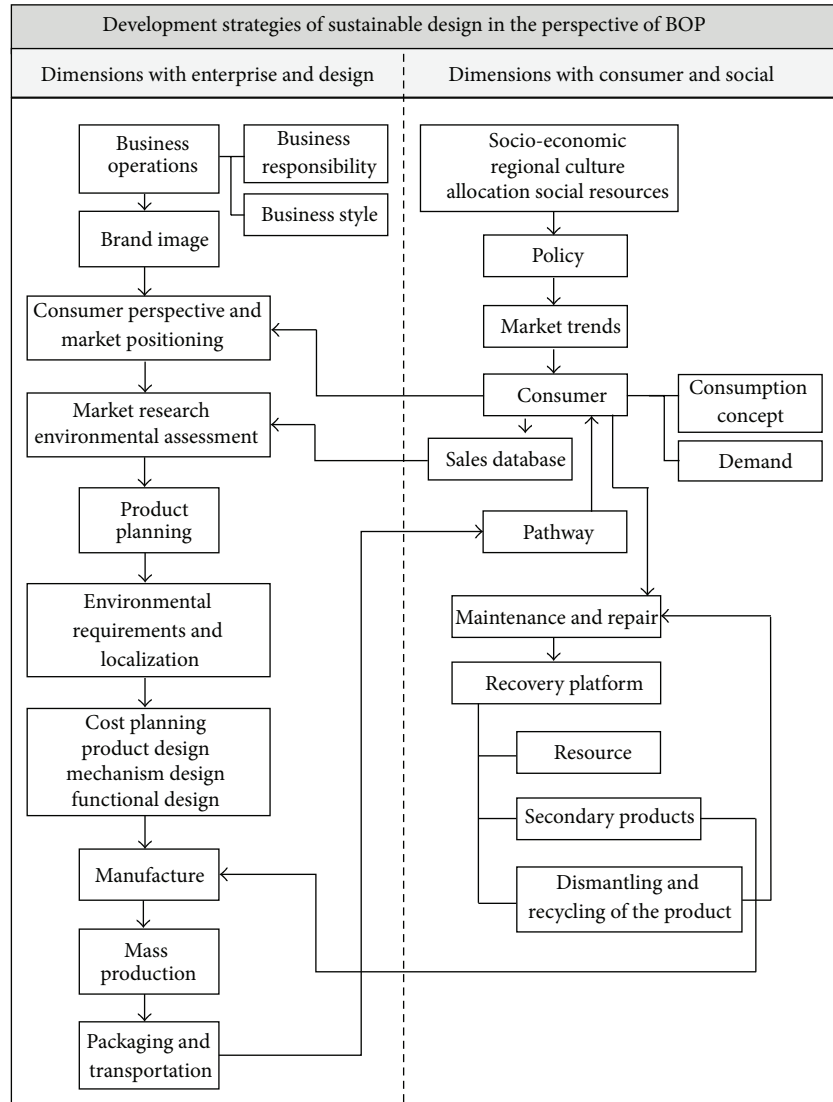


FIGURE 4: Development strategies of sustainable design in the perspective of BOP group in Taiwan.

other words, the region of the consumers should be completely explored during the product planning, to develop the products closer to the needs of BOP group.

3.5.2. *Society and Consumer Aspects.* Society is greatly correlated to consumers. Social economy, regional culture and social resource allocation all affect government policies, while government policies in turn affect market orientation and guide consumption habits. The study found that a sales database should be formed when the consumers make purchases, in order to provide a reference for future analysis based on the classification of consumers' habits, and to help enterprises conduct market surveys and environment assessments.

After the products are packed and sent to the channels and stores, consumers make their purchases, and enjoy the subsequent maintenance and repair service to extend the life span of the product. After the lifespan ends, the product is

recycled into resources (recycling processing), or for second manufacturing (repairing or renewing the recycled products for sales) is conducted.

#### 4. Conclusions

In the results and discussion, this study proposes the development model of sustainable design, including a factor analysis on the product consumption and usage needs of the BOP group in Taiwan, development norm and strategies of sustainable design in the perspective of the BOP group in Taiwan. With regard to the Bop group in Taiwan, this study investigated the young working poor in Taiwan. Relevant studies of the young working poor group and the new poor group largely focus on causes [53, 54], phenomena [55, 56], and corresponding aids [57–59], and some relevant information is mentioned in the introduction of this paper. Despite a small number of studies of the new poor group, the working

poor group, and the group of the left side of the M-shaped society (the low and middle income people) of Taiwan, as well as restricted information regarding purchasing behaviors, relevant studies have identified the emergence of unique views of consumption within this special “new poor group.” The formation regarding views of consumption, which reflect the mindset of social and economic reality, would exercise an action-reaction force on society and the economy and further exert profound and significant influence. Basically, the “new poor group” has become supporters of materialism in terms of objects’ value, hedonism regarding the principles of life, and egotism in interpersonal relationships [60]. The patterns of consumption of this group are completely different from that of poor people in the past. A majority of studies have indicated the consumption of inexpensive, high quality, and high added value products by consumers in this group. They also consider quality, brand name, and taste, as well as seeking good service experiences and feelings [61, 62]. As it is a common practice for businesses to reduce product costs through sale price, manufacturer, product design, packaging, and merchandising in order to provide quality products to consumers in this group [63]. After the analysis of the third stage of the study, four conclusions result, as follows.

*4.1. The Consumption Characteristics and Habits of BOP Group Are Unique so That the Needs of Consumers Should Be Orientated and Integrated into the Design Factor of Sustainable Design.* In Taiwan, the BOP group mainly refers to new poverty or working poor group. Due to the compact society of Taiwan, people are aware of the green concept. Thus if an overall survey on the product usage of the group can be conducted and their needs transformed into design factors of the green products, not only will the consumption willingness of the group be increased, but also the range of sustainable design will be extended.

According to the demand factor of the group, it is found that they have certain requirements concerning the products. Moreover, according to designers and scholars, if cost is considered as a design factor, simplification of product appearance and function is the main requirement, which coincides with the ideas of sustainable design.

*4.2. Due to the Wide Range of the BOP Market in Taiwan, Different Poverty Levels and Regions Affect the Consumption Habits and Styles of the Group, so an Overall Market Evaluation Should Be Done to Define the Actual Business Opportunities of the Group.* The group features a large population. According to interviews, it can be seen that the BOP group members are similar to common people in terms of consumption ability and habits. Different lifestyles may change the other consumption factors, so that an overall market evaluation mechanism should be used to identify the actual needs of the group.

The biggest problem of the BOP group is the unequal distribution of social resources. The companies may find the range to be quite large, when investigating the needs of the group. Thus they should take regional characteristics into

account when developing products based on the needs of the BOP group.

The so-called regional characteristics contain social trends, local resources, indigenous groups, and consumption habits. Those factors serve as important variables in designing for the BOP group, so they should be considered entirely. Different groups have different regional characteristics. Since the BOP group in Taiwan is new poverty or working poor, high quality and common prices are the main requirements; these should be introduced into the development model of sustainable design. The product development should be considered based on reducing costs. And, the results of this study have identical views with the results of relevant studies [60–62].

*4.3. High Quality and Common Price Are the Main Principles in Developing the Business Opportunities among the Group Members: To Achieve the Goal of a Common Price, the Design Cost Should Consider Every Feature to Effectively Reduce the Cost and Attract Consumers.* The BOP group mainly features the requirements of common price and small amount, which coincide with the small-amount production of sustainable design. A simplified manufacturing procedure can reduce the cost. Besides the cost reduction, attracting consumers is the most important aspect; it requires transferring the production cost to other parts, such as product functions, brand, channel convenience, and specialty, to improve the purchase intention and usage willingness of the consumers.

High quality and common price are the main concepts and ideas for BOP group in Taiwan. They can be achieved in all the brands and promoted by developing the subbrands. Besides distinguishing the brands, high quality and common price can also reduce the excessive costs and simplify the products to achieve the concept of sustainable design for the group. And, the results of this study have identical views with the results of relevant studies [60–62].

*4.4. The Development Dimension and Consumer Dimension Are Connected by Consumers and Channels. Consumption Habits of Consumers Can Influence the Development, While the Channels Can Influence Consumers’ Usage and the Recycling of Products.* When developing design strategies, companies must observe consumer needs. Such a model can be divided into two dimensions: the development dimension and consumer dimension; they affect the development models of companies and consumers, respectively.

The needs and consumption styles of consumers may affect the decision-making and evaluation of enterprises during product development. Thus, enterprises should deeply understand the market to continue the product development. After a series of developments, enterprises should get in touch with consumers again through channels. Besides introducing the products to consumers, companies should observe the purchase behaviors of consumers to understand the sales situation of the products in the market. Channels help with the database establishment and play an important role in the recycling to maintain and extend the lifespan of products.

## Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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